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annual report
CSIR

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COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH TWENTY-NINTH ANNUAL REPORT 1973

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CSIR
P O Box 395
Pretoria
0001
1st May 1974

The Hon. J J Loots, M P
Minister of Planning and the Environment
Private Bag X213
Pretoria
0001

Sir

I have pleasure in presenting to you the twenty-ninth Annual Report of the Council for Scientific and Industrial Research. This report covers the period 1st January 1973 to 31st December 1973.

Balance sheets and statements of income and expenditure for the financial year ended 31st March 1973, certified by the Controller and Auditor-General, are included.

Yours faithfully

(sgd) C v d M Brink
President: Council for Scientific
and Industrial Research

MEMBERS

OF THE

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

1973

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
Dr B Gaigher	Member Board of Trade and Industries
Mr G C V Graham	Managing Director Fine Wool Products of South Africa Ltd Uitenhage
Dr J N van Niekerk	Head Basic Research Division Research Department, ISCOR
Dr P J Riekert	Chairman Economic Advisory Council
Mr J D Roberts	Chairman Murray & Roberts Holdings Ltd
Dr A J A Roux	Chairman Atomic Energy Board
Mr J W Shilling	Director Anglo American Corporation of South Africa Ltd
Prof. E J Woodburn	Head Department of Chemical Engineering University of Natal

THE YEAR IN RETROSPECT

The announcement in July 1973 of the planned phasing out by NASA of the Hartebeesthoek Space Research Station, as part of an overall consolidation activity now in process in the world-wide tracking and communication network, heralded the end of an era in which South Africa, through the CSIR, played an important role in the United States' Space Programme. With the manned space programme having come to an end in late 1973 and consideration being given to the use of data relay satellites to perform much of the work hitherto done by ground stations, several changes have been made in the NASA tracking networks. The phasing out of the Hartebeesthoek station follows the closing of the station at Fort Myers, Florida, and at Woomera in Australia.

In announcing the closing of the Hartebeesthoek station, Dr James C Fletcher, Administrator of NASA, paid tribute to the work of the tracking stations in South Africa and stated that NASA would always be grateful for the technical support and cooperation received from the CSIR. As the only ground-shielded radio site within easy reach of research laboratories in Johannesburg and Pretoria, Hartebeesthoek will probably be retained as an interference-free area and consideration is being given to its use for extending South Africa's radio astronomy programmes.

Another development in space research has been the intergovernmental agreement concluded during the year between South Africa and France whereby the tracking station at Paardefontein, established and operated since 1965 by the Centre National d'Etudes Spatiales (CNES), will gradually be taken over and operated by CSIR personnel. The station's operation will continue to be directed by CNES. The Paardefontein tracking facility is one of a chain of six built by CNES and equipped for transmitting commands to French satellites in orbit and acquiring data from them, and also includes a centre for the launching of balloons for research at extremely high altitudes.

Another joint venture is the South African Astronomical Observatory (SAAO) which is operated by the CSIR in collaboration with the Science Research Council of the United Kingdom. The SAAO observing station at Sutherland (in the arid Karoo region of the Cape Province) was officially opened by the Prime Minister, the Hon. B J Vorster, on 15th March 1973 and among the distinguished guests present were the Rt Hon. Mrs Margaret Thatcher, the United Kingdom Secretary of State for Education and Science. Also present were nine



Dr C v d M Brink, President

world-renowned astronomers from various countries who took part in an astrophysical symposium in Cape Town that preceded the opening ceremony at Sutherland. In his opening address, the Prime Minister stressed the need for international cooperation in establishing sophisticated and costly research facilities such as those of the SAAO and expressed the hope that the unique facilities there would be used by leading astronomers from all over the world in furthering man's knowledge of the southern skies.

A major organizational development announced towards the end of 1973 was the establishment of a National Research Institute for Oceanology and the appointment of Professor E S W Simpson of Cape Town as its Director with effect from 1st February 1974. The new Institute will take over and merge existing CSIR activities in the field of physical oceanography, civil engineering hydraulics and biological-chemical marine pollution which formerly fell under the control of other CSIR Institutes and which in recent years have expanded to such an extent that it has become desirable to combine them into a separate institute. Among the assets to be acquired by the new Institute are the extensive buildings and laboratories of the National Mechanical Engineering Research Institute's Hydraulics Research Unit on the campus of the University of Stellenbosch, together with the facilities of the National Physical Research Laboratory's Division of Oceanography in Durban including the CSIR's oceanographic research ship, the *MV Meiring Naudé*. The administrative headquarters of the Institute will be in Stellenbosch.

At the beginning of 1973 the CSIR's Fibre Research Unit in Durban, formerly controlled by the National Mechanical Engineering Research Institute, was brought under the control of the South African Wool and Textile Research Institute. The Unit, which is doing important



Dr F.J. Hewitt, Deputy President; Dr P J Rigden, Vice-President; Dr J F Kemp, Vice-President; Dr A P Burger, Vice-President.

research work relating to the decortication of phormium (a replacement for jute used in the manufacture of bags) is located in Durban because of ready access to the main growing areas of this plant in Zululand and the Transkei.

The work of the CSIR's South African Wool and Textile Research Institute in Port Elizabeth, as well as other CSIR-supported activities in the Eastern Cape, was featured during visits by Members of Parliament and representatives of commerce, industry and education in the Eastern Cape. These visits coincided with the Council meeting held in Port Elizabeth during October, in accordance with the Council's policy of holding one of its four meetings each year in a centre of CSIR activity outside Pretoria. Among the visitors on this occasion was the Minister of Planning and the Environment, the Hon. J J Loots.

A new appointment to the CSIR Council announced towards the end of the year was that of Dr P S Rautenbach, Secretary for Planning and the Environment. Dr Rautenbach, whose appointment takes effect from 1st January 1974, replaces Dr P J Riekert, Economic Adviser to the Prime Minister, who has served a 3-year term on the Council and has declined re-appointment because of pressure of other commitments. Three other members — Dr Ben Gaigher, who is a member of the Board of Trade and Industries, Mr J W Shilling, a Director of the Anglo American Corporation of South Africa, and Prof A J Brink, President of the South African Medical Research Council — have been re-appointed to the Council.

Dr A P Burger, formerly Director of the CSIR's National Research Institute for Mathematical Sciences, was appointed to the Executive of the CSIR as a Vice-President with effect from 1st March 1973. After a period of service in the research division of the South African Weather Bureau, Dr Burger joined the CSIR staff in 1957 as Head of the Applied Mathematics Division of the

National Physical Research Laboratory and in 1961 he became the first Director of the newly established National Research Institute for Mathematical Sciences.

On 1st July 1973, Prof. C Jacobsz was appointed Director of the National Research Institute for Mathematical Sciences in succession to Dr Burger. Prof. Jacobsz, who joined the CSIR in 1964 as Head of the Numerical Analysis Division of this Institute, was previously Professor of Mathematics at the Universities of Pretoria and Stellenbosch and also served many years as an engineer with ISCOR.

Another senior appointment during the year was that of Dr D A Williams-Wynn as Director of the South African Paint Research Institute in Durban with effect from 1st March 1973. Dr Williams-Wynn was formerly attached to the staff of the Leather Industries Research Institute in Grahamstown and also worked in the research division of a large paint manufacturer.

During the year a high honour was bestowed on the President of the CSIR, Dr C v d M Brink, when he was elected a fellow of the Royal Society of South Africa.

Another member of the CSIR honoured during the year was Mr T Hodgson, Director of the CSIR's Technical Services Department, who was awarded the gold medal of the South African Institute for Refrigeration and Air-conditioning for outstanding contributions in the fields of air-conditioning and refrigeration. This medal has been awarded only twice before in the history of the Institute.

The international leadership achieved by South Africa in the field of water treatment and reclamation was emphasized during the year by an invitation to Dr G G Cillie, Director of the CSIR's National Institute for Water Research, to play a prominent part in a summer school on water treatment organized by the Australian Water and Waste Water Association and held at the Australian National University in Canberra.

Among the distinguished visitors to the CSIR during the year was Sir Harold Thompson, Professor of Chemistry at the University of Oxford, who gave the keynote address at a symposium on molecular spectroscopy held at the National Physical Research Laboratory of the CSIR in January. While in South Africa Sir Harold also visited the South African Astronomical Observatory and the National Chemical Research Laboratory of the CSIR as well as several universities and other institutions.

Another distinguished visitor was Dr R Bruce Lindsay, Professor emeritus of Physics at the University of Rhode Island, USA, and an international

expert in acoustics, who was guest speaker at a colloquium on acoustics held during March at the CSIR in Pretoria.

During March the CSIR was also visited by Dr Phillip Law, Chairman of the Australian National Council for Antarctic Research — a visit that provided the opportunity for useful discussions on matters of mutual concern in Antarctic research.

In April one of the world's leading scientific figures in the field of desalination, Mr Reuven Matz (a former South African now living in Israel) attended a workshop meeting on the desalination of water at the CSIR where he played a key role in the proceedings.

In August a one-day symposium on low-cost automation was presented by the Technical Services Department of the CSIR in four major centres — Johannesburg, Durban, Port Elizabeth and Stellenbosch. This 'travelling' symposium was intended to demonstrate to South African industry how the introduction of low-cost automation can benefit small and medium as well as large industries. The keynote address was given by Mr J Hutchinson, a low-cost automation expert from the United Kingdom.

In collaboration with the South African Advisory Committee to the Textile Institute and the South African Bureau of Standards, the CSIR organized a symposium on soft floor coverings in Durban during September. This symposium, which brought together many experts to explain the properties of various kinds of floor covering, was intended mainly to give the consumer guidance and overcome the confusion which often results from the availability of a wide variety of coverings and conflicting reports on their properties.

A major achievement announced during the year was the development of a new and greatly improved 'Tellurometer' distance measuring system. This represents another chapter in what is probably one of the CSIR's most persistent success stories — a story that started in 1955 with the invention of the original 'Tellurometer' system by the National Institute for Telecommunications Research. It was the world's first practical radio system for measuring distances with an accuracy acceptable for geodetic purposes. When first produced commercially by a South African company in 1957, the instruments were an immediate success. Surveyors were quick to realize the potential of the system which has since revolutionized surveying practice.

Another important milestone was reached with the development and manufacture of a silicon monolithic integrated circuit by scientists of the National Electrical Engineering Research Institute. This was the first time that a compact circuit of such complexity had been produced in South Africa and it placed the CSIR in a position where it can advise and give practical assistance to South African industry in this field of electronics.

Finally, the CSIR would like to express its gratitude to legislators and others concerned in passing the 1973 Amendment to the Anatomical Donations and Post Mortem Examinations Act, which will enable scientists to obtain enough human pituitary glands to produce human growth hormone for the treatment of all pituitary dwarfs in South Africa.

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, biochemistry, inorganic chemistry, organic chemistry, macromolecular chemistry, 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. In addition the Laboratory included a Bantu Beer Research Unit, which will be transferred to the National Food Research Institute in 1974.

Pharmacologically active substances

New methods have been developed for the synthesis of sugars which could be used as building units for pharmacologically active substances such as antibiotics and modified nucleosides. The latter compounds are being evaluated at the National Institutes of Health in the USA for anti-tumour activity. Publication of this work has aroused wide interest overseas, and proposals for collaboration by a large British pharmaceutical company have led to an agreement between the National Chemical Research Laboratory, the South African Inventions Development Corporation and the company concerned.

In steroid research the emphasis is now on total synthesis, as mentioned in the previous annual report. A provisional South African patent has been filed for the synthesis of a 9β -methyl analogue of retrotosterone. The progesterone analogue is expected to have interesting pharmacological properties and its total synthesis is under way. In the course of this investigation a unique method for construction of the progesterone side-chain has been developed.

New more sensitive Jasco J-20 apparatus for measuring optical rotation dispersion and circular dichroism.

Metabolites of poisonous fungi

In collaboration with the Department of Agricultural Technical Services a chemical investigation of fungi implicated in photosensitization diseases of ruminants has been initiated. This is a long-term investigation and limited progress has been made. The collaboration of the National Institute for Nutritional Diseases of the Medical Research Council has been very fruitful and the isolation and structure determination of several new fungal metabolites have been undertaken.

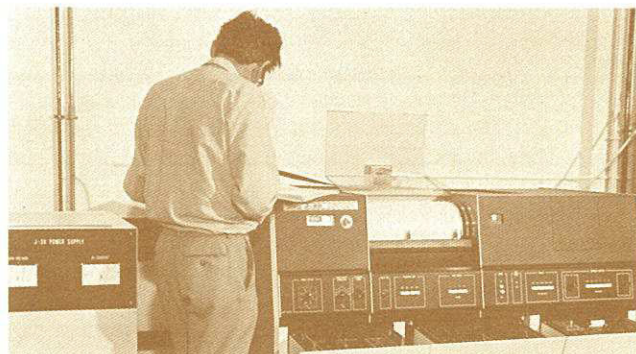
A study of precursors in the biogenesis of cyclopiazonic acid, a toxic metabolite of *Penicillium cyclopium*, proved that the key intermediate differs from that of the related ergot alkaloids.

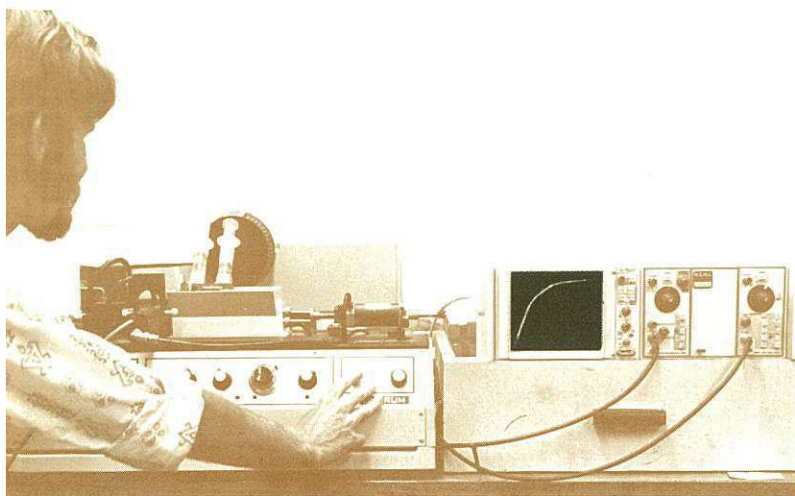
Bacterial polysaccharides

A new project on lipopolysaccharides of *Salmonella* species was initiated in collaboration with the Veterinary Research Institute at Onderstepoort. The O-specific side-chain of the lipopolysaccharide of *Salmonella gallinarum* is being studied and a preliminary structure for the repeating unit has been determined.

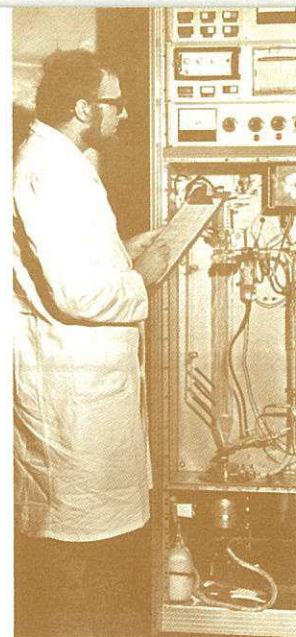
Protein studies

The National Chemical Research Laboratory has established world leadership in studies of the amino-acid sequence of snake venom proteins and during the past year the sequences of a number of neurotoxins and cardiotoxins as well as certain enzymes have been determined. The availability of a unique collection of important physiologically active proteins presented an excellent opportunity for the study of structure-function relationships, and active collaboration in this field with several other institutes and organizations has been a feature of the past year's activity. Studies include the fibriolytic





Left: This 'stopped-flow' spectrophotometer is used for measuring fast chemical reactions in solution. The reaction depicted on the oscilloscope screen is completed in 50 milliseconds.



Continuous culture system for studying the physiology of growth of strictly anaerobic rumen bacteria.

factors in bile and snake venom which play a role in the blood coagulation process, a kinetic study of phospholipase A and the selective cytotoxicity of cobra venom cardiotoxins for cancer cells.

The determination of the amino-acid sequence of high-sulphur proteins of reduced wool has led to a better understanding of the ancestor sequence from which the complex wool proteins evolved.

Cancer biochemistry

Since it is suspected that one of the basic lesions in the cancer cell lies in the control of the transport of messenger RNA from nucleus to cytoplasm, attention was directed to the membrane in particular. Nuclear membranes from normal rat liver and from a transplantable liver tumour were isolated. The electron microscope showed no morphological differences but significant differences have been found in the protein composition of the two membranes.

Digestion and metabolism of ruminants

In the project on the digestion and metabolism of ruminants (undertaken in collaboration with the Veterinary Research Institute at Onderstepoort) the determination of the growth constants of rumen bacteria in continuous culture is of prime importance. In the past, progress was slow because of the long time required for the system to acquire a steady state. The problem has now been solved with the aid of the National Electrical Engineering Research Institute and a method has been developed to provide the required information in days instead of months.

Human growth hormone

The amendment of 1973 to the Anatomical Donations and Post Mortem Examinations Act has now made it possible to collect enough pituitaries for the production of the growth hormone by the National Chemical Research Laboratory. Thus the last obstacles have been removed to ensure that all pituitary dwarfs in South Africa can be treated.

The NCRL had previously achieved great success in developing a new method for the cheaper preparation of human growth hormone in a higher yield and with a purity of 95 per cent instead of the 45 per cent of the commercial product. The activity of the South African product is also double that of the overseas product.

The successful completion of this project is largely due to the excellent collaboration by colleagues at the Medical Research Council, the Medical Schools of the Universities of Natal and Cape Town and the Faculty of Law of the University of South Africa.

Analytical methods

A new ion exchange chromatographic method for silicate rock analysis has been developed, which is more accurate than known wet chemical methods and the newer instrumental analysis methods.

A single column method has been developed for the separation of thorium from all the other elements of the periodic system. Similar methods can also be used for the separation of uranium and copper.

In collaboration with the National Physical Research Laboratory a method has been developed for the determination of trace and ultra-trace quantities of rare earth elements in rocks.

Platinum metals

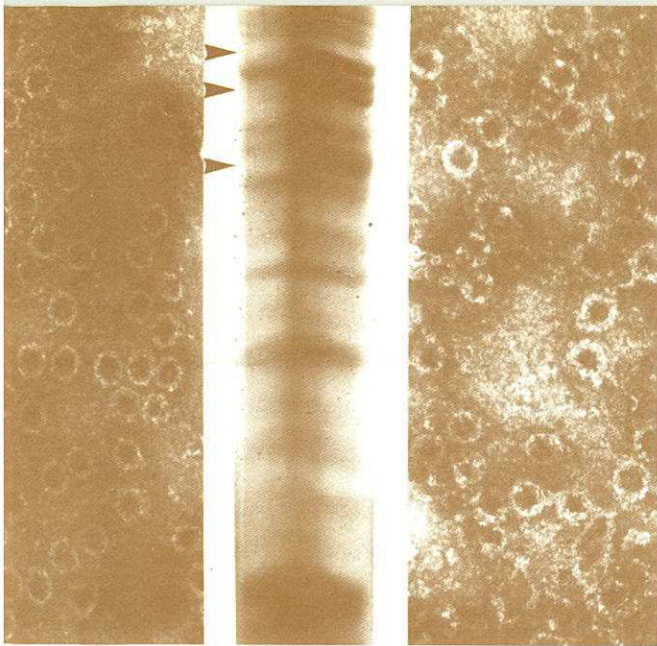
Good progress has been made with the study of reaction kinetics of organo-metallic complexes particularly after the acquisition of a new stopped-flow spectrometer which speeded up the work considerably. Of great scientific interest are the indications of the existence of an intermediate five-coordinate complex observed during fast reactions of rhodium(I) systems.

New organo-metallic compounds of rhodium and iridium have been prepared and X-ray crystallography has been used for structure determinations in collaboration with the University of Natal in Durban.

Corrosion

The Corrosion Group has during the past years been engaged mainly in short-term investigations and advisory services for industry, the public service and other public bodies because of the great demand for such services. As it is in the national interest, however, that long-term research on corrosion should not be neglected, the Group is being reorganized as a research division which will in future confine its advisory activities to problems related to its research programme.

The South African Defence Force gave permission to publish in pamphlet form the results of the four-year programme of exposure tests on metals and metal coatings. The information on corrosion rates of most metals at various places in the Republic is of great value to architects and engineers.



Nuclear membranes from transplanted rat liver tumour (left) and from normal rat liver (right) shown by electron microscope. The circles are the membrane pores allowing chemical messages to pass from the nucleus to the cytoplasm. Although there is apparently little difference electrophoretic separation of the membrane proteins shows considerable decline of the three main components in the tumour membrane (centre).

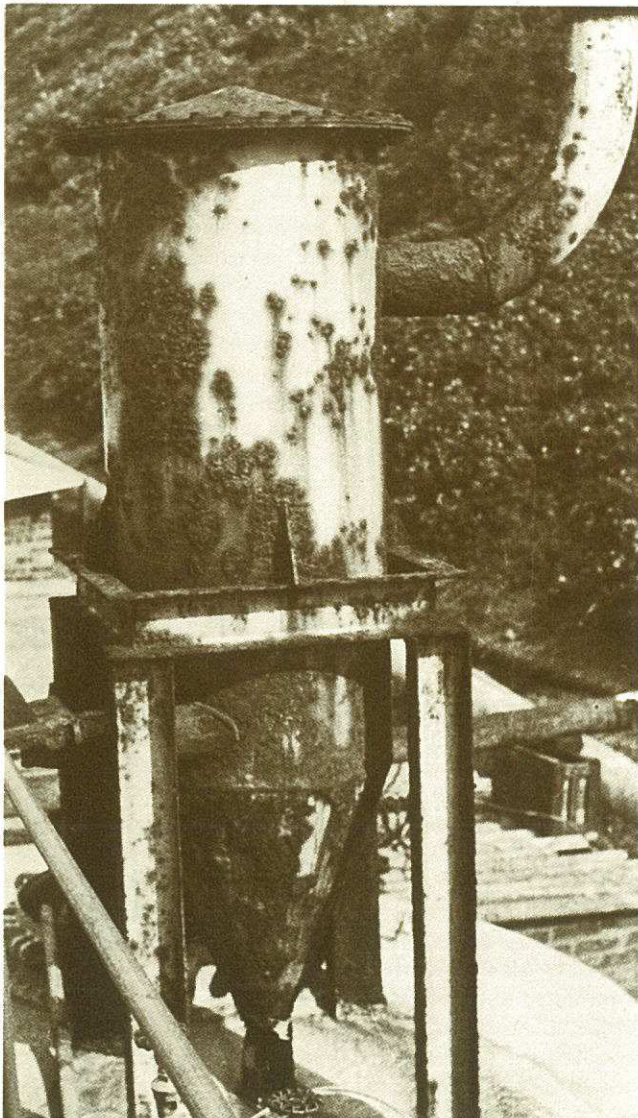
Valuable information has been obtained from a study of the heat resistance of paints using thermogravimetric methods and differential thermal analysis.

The results of an extensive investigation of bacteriological corrosion of ferrous metals will be published soon.

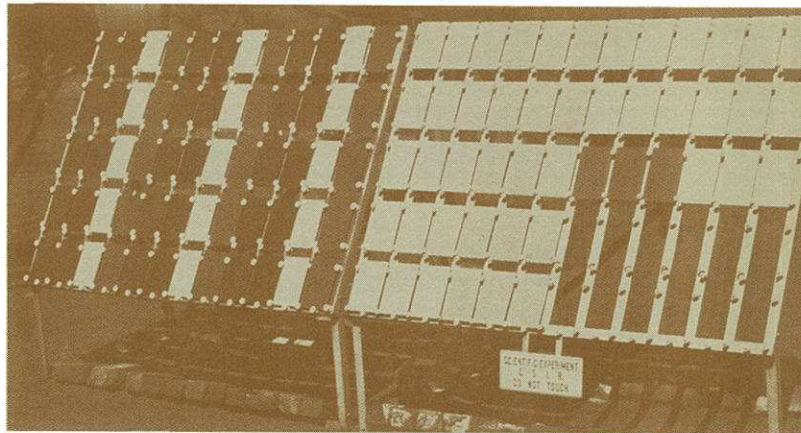
Bantu beer

The first students to qualify for the National Diploma in Brewing Technology are now employed in industry and a second intake of students has started at the Pretoria College for Advanced Technical Education. Staff members of the Bantu Beer Unit give specialist lectures at the College.

Corrosion of a steam condenser at a factory at the coast, Durban.



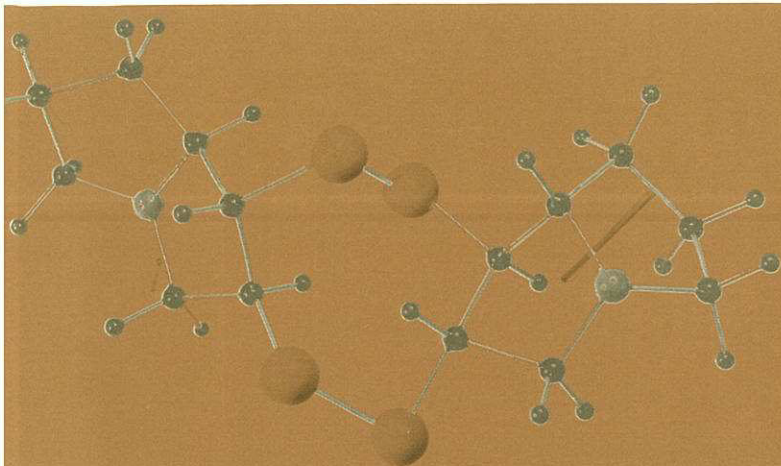
Atmospheric exposure of specimens during corrosion experiment.



The Unit has members serving on the Tender Committee and the Bantu Beer Committee which advise the Department of Bantu Administration and Development and the Deputy Minister concerned with the bantu beer industry.

The running of the bantu beer industry has now passed from the hands of the local authorities (municipalities, etc.) into those of the newly created Bantu Affairs Administration Boards. These boards deal with much larger areas than the municipalities (a board may embrace five or six municipalities) and this move should promote rationalisation. The Bantu Beer Unit is studying the effects of this development and will also advise the new Boards.

Work for the Maize Board has revealed that certain new hybrid sorghums are totally unsuited for bantu beer brewing. The reasons for this are being investigated and the phenomena involved appear to be genetically determined.



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 the Republic through research aimed at the adaptation of existing knowledge as well as 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 standards of physical measurement for mass, length, electricity, radiation, etc.

The present facilities of the NPRL cater for most of the important needs of the Republic in the sphere of physical science. Within the NPRL there are groups of research workers in the following fields: optics, nuclear physics, solid state physics, acoustics, spectrochemistry, electron microscopy, geophysics, geochronology, oceanography, high pressure physics and natural isotopes.

Physics of materials

It is essential that the Republic's rich resources in mineral and ore deposits should be processed locally as far as possible before being sold overseas. The study and determination of the physical properties of such materials is the task of the National Physical Research Laboratory and for this purpose the Physics of Materials Division has been established. Close co-operation will be maintained between this Division and the more basic Divisions such as X-ray Diffraction, Electron Microscopy and High Pressure Physics in order to build up knowledge and to determine the needs of South African industry.

National standards

During the year two Acts which are of special significance to the NPRL were promulgated. The first of these is the *Measuring Units and National Measuring Standards Act* whereby the CSIR is nominated as the authority responsible for maintaining the national measuring standards. The second refers to *Regulations Regarding the Control of Electronic Products*. This makes provision for the safe operation and control of accelerators and X-ray apparatus with the NPRL responsible for the standards set up to calibrate instruments which measure the dose of radiation.

Gold analysis

An improved technique which makes it possible to determine the concentrations of more than ten elements in a

gold sample in less than three minutes has been developed by the NPRL.

Gold produced by the South African mining industry contains relatively large amounts of silver, copper, lead and other minerals, but the assaying methods which are at present being used to determine the silver content, for example, are time-consuming. The new system which is based on the emission of light and its measurement by means of a direct reading spectrometer has been developed for the Chamber of Mines of South Africa. It can also be used to analyse refined gold with an accuracy comparable to that of the fire assay technique.

The Chamber of Mines has already acquired the necessary equipment and will soon be using the technique on a full-time basis.

New experimental complex for nuclear physics

A new experimental complex, incorporating a control room for the operation of the cyclotron as well as all on-line experiments, was taken into use during the past year by the Nuclear Physics and Radio-activity Division. The complex also houses a mini-computer for data-acquisition and data-reduction purposes and facilities for conducting biological experiments involving cyclotron irradiation and the measurement of short-lived radio-activity.

Hail research

A fundamental investigation was made of so-called spongy ice produced in laboratory-grown hailstones. This ice comprises a fine mesh of ice crystals with water in the interstices. Spongy growth allows hailstones to form much more rapidly than was for many years thought to be possible.

Measurement of the deuterium content of different parts of large, multi-layer hailstones showed that practically all growth had occurred while they were moving upwards in the cloud. Previously, workers elsewhere had concluded from radar observations of the structure of severe storms that large hailstones would grow mostly during the downward trajectory.

Data on hail were supplied to insurance assessors, architects, consulting engineers and manufacturers of bricks, tiles and aluminium products. The information included the fallspeed of large hailstones, the maximum amount of hail per unit area, and the occurrence of hail at specific points on certain days.

Age determinations with apatite

Age determinations of rocks remain necessary for a more refined compilation of the stratigraphic column of the Republic of South Africa.

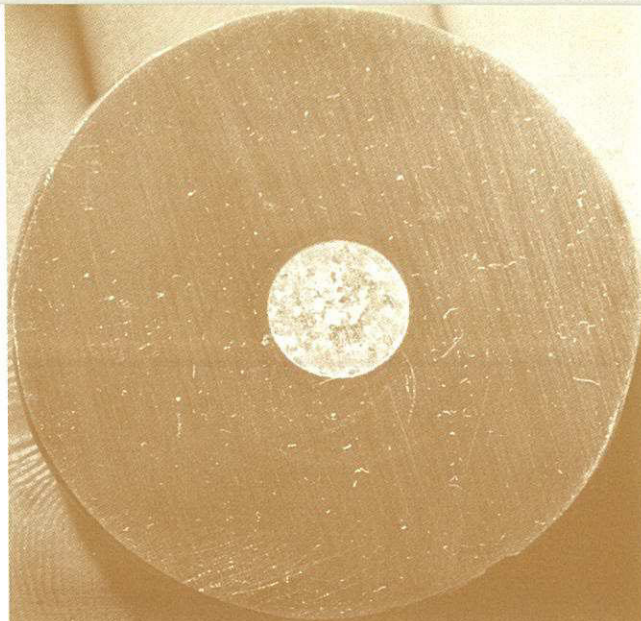
Geochronological data obtained from granitic rocks surrounding the Barberton Mountain Land not only demonstrated that the common accessory mineral, apatite, is suitable for age measurements by the uranium-lead-isotope method, but that it may in many cases be a more reliable age indicator than the co-existing zircon. This is the first time that uranium-lead ages for apatite have been successfully determined and published.

Participation in ERTS programme

The interpretation of ERTS photographs in collaboration with the Soil and Irrigation Research Institute and the Botanical Research Institute, both of the Department of Agricultural Technical Services, the Geological Survey of the Department of Mines, and the Department of Planning and the Environment has led to a first evaluation of data obtained from a satellite over the surface area of the Republic of South Africa.

The following significant deductions could be made from the ERTS photos:

- They are eminently suitable for the compilation of a 1:1 500 000 scale geomorphological map of South Africa and may contribute significantly toward soil mapping.
- The encroachment of the Karoo at the expense of grassland in the southern Free State as well as the encroachment of thornveld could be detected.
- In rugged areas the ERTS photographs can significantly contribute toward lowering of the cost and acceleration of complete mapping of indigenous forests.
- The monitoring of the occurrence, extent and time of veld fires can be done on a national basis for the first time.

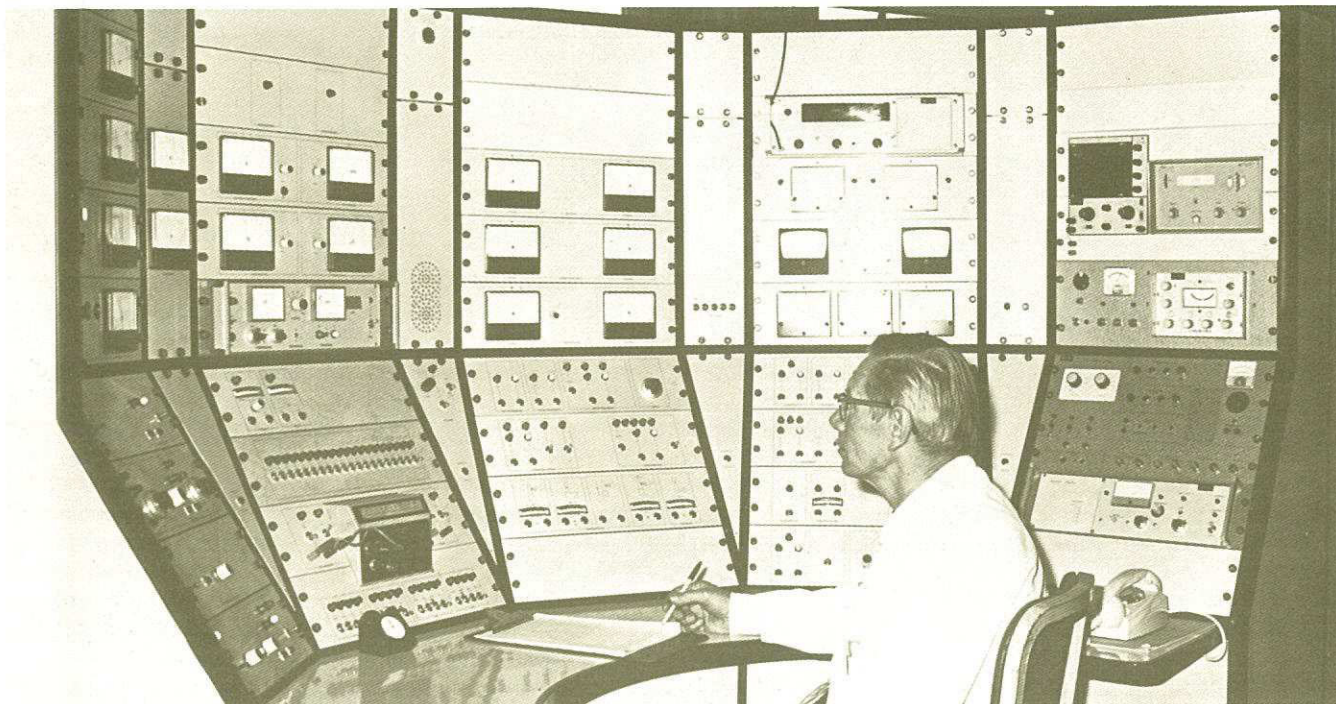


A gold sample which had been subjected to analysis. Note burn mark.

- Large scale geologic features are more clearly discernible on satellite photographs than with any conventional method. This information is particularly suitable for the compilation of a tectonic map of South Africa.
- Mapping of land use on a regional or national scale can be completed at a lower cost and faster rate by means of such photographs.

A new co-ordinated proposal from South Africa has been submitted to NASA for the programme of ERTS-B, the second satellite in the present series.

The new control panel for the NPRL cyclotron which was built locally and came into operation recently.



Smoke sampling in the atmosphere.



Oceanography

The results of a special study undertaken for the Department of Town and Regional Planning of Natal confirmed the formation of eddy currents in the vicinity of Richards Bay. These eddy currents are responsible for the reversals of the coastal currents and are definitely not wind-driven.

Analysis of some of the data from the routine East Coast Survey has led to the production of a simple empirical model of sea surface temperature, which is accurate to within 1 °C over 60 per cent of the area of the survey. Anomalous areas where the model does not reflect the true situation are highlighted as areas for special investigation in the future.

Analysis of rare earths

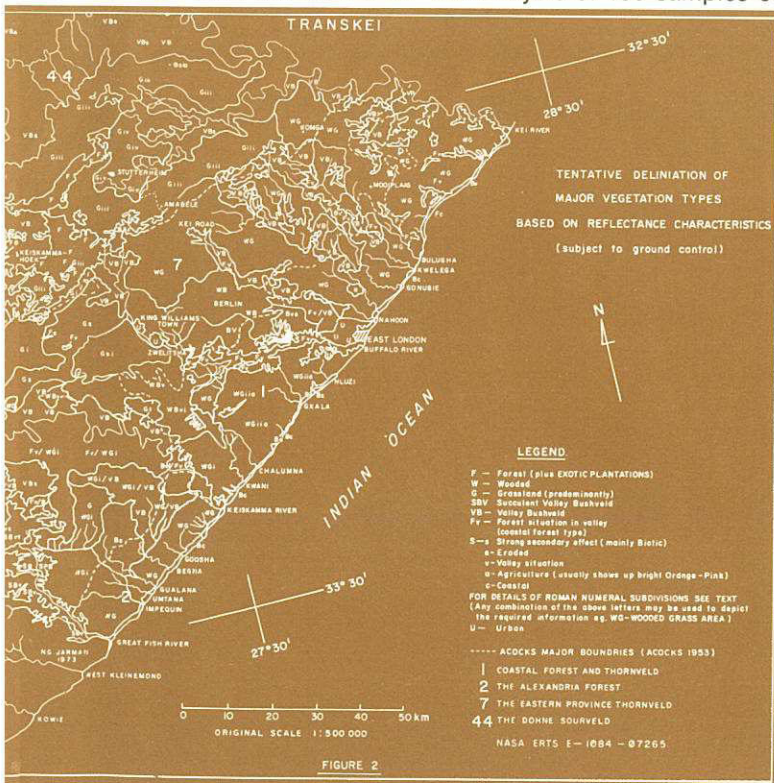
The development of a method for the determination of rare earth elements in silicate rocks has been completed. This development work was carried out in collaboration with the National Chemical Research Laboratory. A contract has been concluded for the analysis of 150 samples of

calcium fluoride on behalf of the National Institute for Metallurgy and the Geological Survey of the Department of Mines.

Isotopic composition of rain, river and groundwater in South Africa

A country-wide survey of the oxygen-18 content of precipitation (20 stations) and run-off (6 rivers) has been completed, and an overall outline of the variations that occur in the country is now available for application to groundwater problems.

The use of the stable isotopes oxygen-18 and deuterium for identification of different groundwater bodies has been successfully demonstrated in two areas. By means of radio-active tritium occurring in precipitation, the rate of infiltration through the soil could be determined quantitatively in a number of instances. The application of this technique can be of considerable practical value for determining the safe yield of underground water reservoirs.



Delineation of major vegetation types as deduced from ERTS photographs (NASA Document NASA-CR-133589 interpreted by the Botanical Research Institute).

Right: The NPRL's new single crystal diffractometer used for crystallographic data collection.

Air pollution studies

Theories concerning the dispersion of air pollutants in the atmosphere have been used to provide estimates of the ability of the air above certain regions of the Republic to disperse any pollutants emitted in those regions. A study on these lines was carried out in Marburg, Natal, and recommendations were made in regard to the possible establishment of industries.

The air of Pretoria was sampled with a four-stage cascade impactor. Provisional results indicated that the percentage of particles larger than ten microns is larger than in American and English towns.

High pressure physics

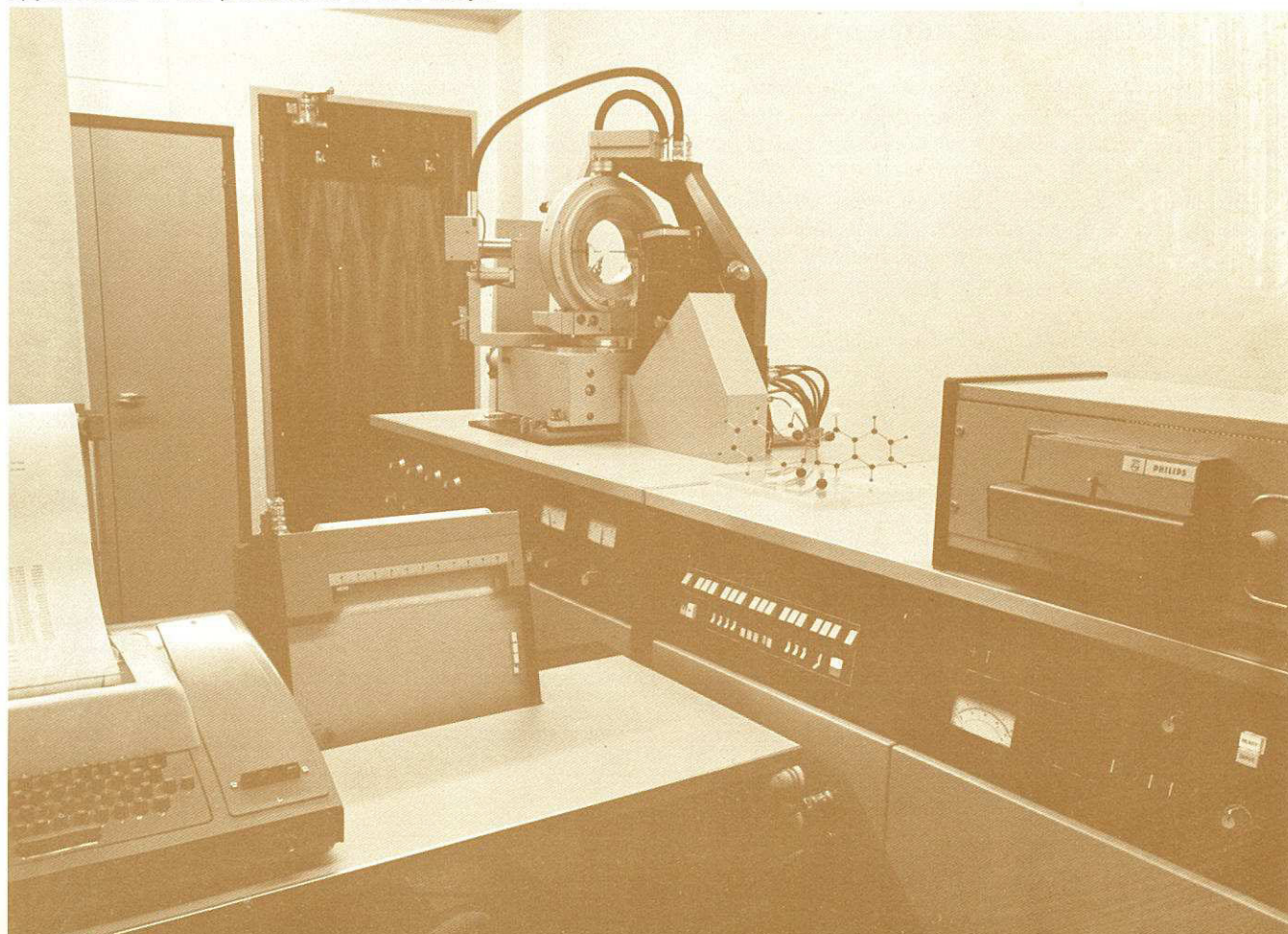
Studies of the phase behaviour of binary alloy systems at pressures up to 4 GPa were started. Interesting results have already been obtained for two systems. Although extremely complex, this type of study has practical applications in the production of new alloys.

Requests for fundamental research services have been received from several institutions in the USA, UK, Israel and South Africa.

Crystallography

The Crystallography Division has increased its data collecting ability by purchasing a second automatic diffractometer. The advanced programme, which controls the diffractometer via a small computer, allows rapid determination of the crystal orientation and initiation of data collection. It is thus possible to collect data for university crystallographers on a routine service basis without interfering with the activities of the Division.

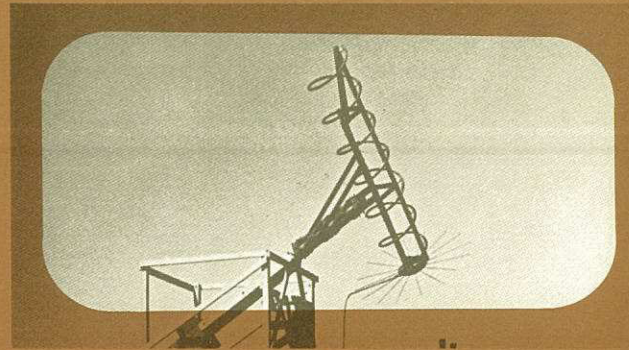
The demand for this data collection service has been beyond expectation and thirty sets of data have been collected for outside interests in the past nine months.



GEOMAGNETISM

MAGNETIC OBSERVATORY

Head
A.M. VAN WIJK



The functions and current programme of the Magnetic Observatory at Hermanus, C.P., include the continuous monitoring of geomagnetic and related geophysical elements, the determination of the configuration and variations of the magnetic field in Southern Africa, the maintenance of magnetic standards, the analysis and dissemination of the data, and co-operation in both national and international geophysical programmes. Although the activities of the Observatory have, from their very nature, an international character, due attention is given to the needs of local research workers and national organizations. The Observatory's own research programme is concerned mainly with the analysis and interpretation of time variations in the geophysical elements.

Geomagnetism

The elements of the earth's magnetic field are recorded continuously at the Observatory at Hermanus, at Tsumeb in South-West Africa and at Hartebeesthoek in the Transvaal.

The recording station at Tsumeb is situated in the grounds of the Ionospheric Research Station of the Max Planck Institut für Aeronomie and is operated by the staff of the research station.

The station at Hartebeesthoek was established towards the end of 1972. The recording equipment at this station was designed and constructed at the Magnetic Observatory and is operated by the staff of the STDN station.

The Department of Physics at Rhodes University has undertaken to operate the proposed recording station at Grahamstown. The necessary buildings have been erected.

The fluxmeter at Hermanus is used for recording geomagnetic pulsations in the frequency range 0,2 to 0,003 Hz. The pulsations are reported in the Observatory's monthly magnetic bulletin. Also included in the bulletin are the Hermanus K indices of magnetic activity and the onset times of sudden storm commencements (ssc's), sudden impulses, solar flare effects and magnetic bays.

Secular variation field stations were established at Mossel Bay and Humansdorp. The network of 'repeat stations' in the Republic and South West Africa now comprises some 60 permanently marked points. The Botswana authorities have reacted favourably to a



Aerial view of the Magnetic Observatory at Hermanus.

suggestion by the Observatory that similar observation points be established in that country to fill the gap in the overall network of repeat stations in Southern Africa.

The results of the regional magnetic survey in South West Africa have confirmed the suspected southward shift of the isoporic focus (region of rapid change in magnetic declination) over central and southern Africa.

The 'significant breakthrough' in time series analysis of geophysical data referred to in the previous annual report has been followed by a steady flow of research papers from the Observatory. Among the many significant findings reported in these papers may be mentioned evidence for a 54-day line in geomagnetic power spectra; fundamental lines at 21-22 and 10-11 years, and a series of harmonics of both fundamental cycles down to at least 2 years; six out of the ten lunar tide components predicted on theoretical grounds; and a band centred at about 58 years. It is also shown that the sunspot spectrum from 50 days to six months is not a continuum but has a line structure; that the '27-day peak' is in reality a broad 24 to 31-day band; and that the purported fundamental solar variation of 26 months corresponds to the fourth harmonic of the solar cycle.



Installing a magnetometer sensor at the Hartebeesthoek recording station.

Cosmic rays

Operation of the Chalk River Type 12-NM-64 neutron monitor at Hermanus continued with only minor interruptions. The average counting rate during 1973 was $4,4 \times 10^5$ per hour with a theoretical standard deviation of 0,16 per cent.

Cosmic ray intensity shows a strong negative correlation with solar and geomagnetic activity and is expected to reach a maximum in 1975-76.

With the steady accumulation of data from the enlarged monitor, the way is being paved for more intensive studies on the transient variations in cosmic ray intensity.

The cosmic ray programme at Hermanus is conducted in co-operation with the CSIR Cosmic Ray Research Unit centred at the Potchefstroom University. The routine data are processed on the computer in Potchefstroom and published by the Observatory.

Ionospheric observations

A 30 MHz riometer is used to measure changes in the ionospheric absorption of extra-terrestrial radio noise. The changes in absorption are related to variations in

electron density within the ionosphere. The Observatory uses the instrument *inter alia* for the detection of sudden ionospheric disturbances.

The riometer data for June-July 1973 are currently being examined for possible evidence of an acoustic wave during the solar eclipse of June 30, 1973.

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 observations and the VLF recordings together provided immediate confirmation of the solar flare effects recorded on the magnetograms.

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

Seismology

The seismological programme is conducted as a side-line but the records are nevertheless useful for distinguishing between pulsations of magnetic and seismic origin. As one recorder is sufficient for the identification of pulsations, it was decided to discontinue operation of the older of the two Milne-Shaw seismographs. This historic instrument is destined to become one of the Observatory's treasured museum exhibits.

Of the 118 earthquakes recorded during the period July 1972 to June 1973, 58 showed well-defined phases.

Ozone observations

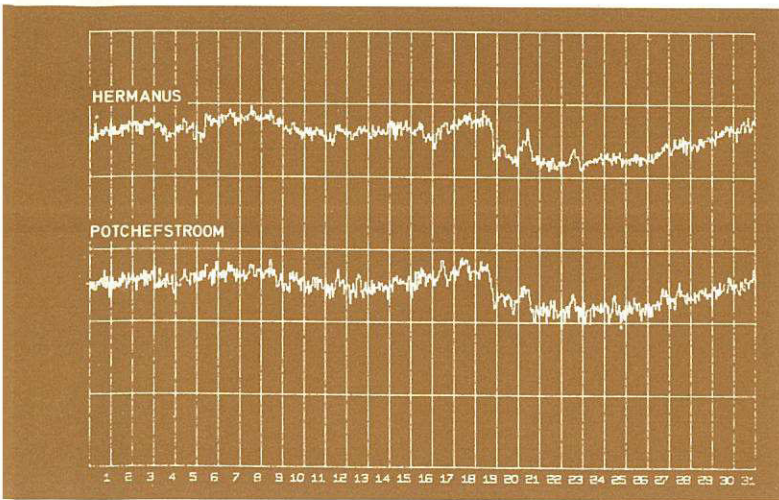
The Observatory operates an ozone recorder for the Max Planck Institut für Stratosphärenphysik (MPI). The chain of stations established by the MPI in 1970 extends from the north of Norway to the southern tip of Africa.

Geophysical alerts

Geophysical research units and other interested organizations in the Republic 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 Observatory 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



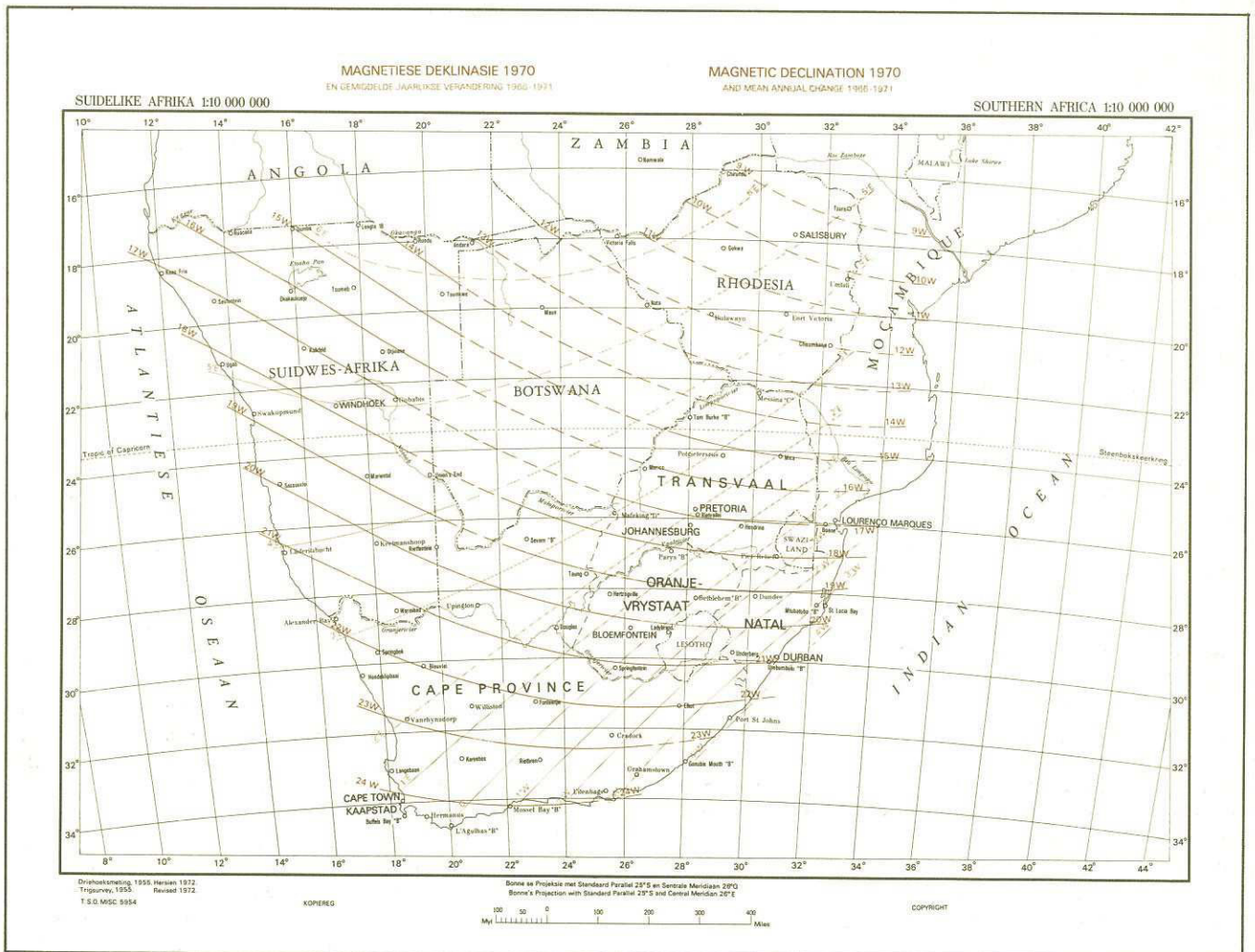
Variations in cosmic ray intensity as recorded at Hermanus and Potchefstroom, January 1973.

Ks. The monthly tabulations of Hermanus data are supplied to the relevant international centres as soon as possible after processing.

Antarctic research

The Observatory provides laboratory and other facilities for the geophysicist from Potchefstroom University who organizes the Antarctic programmes for geomagnetism and aurora. The geophysicist is stationed at Hermanus and is assisted on a full-time basis by a research officer of the Observatory.

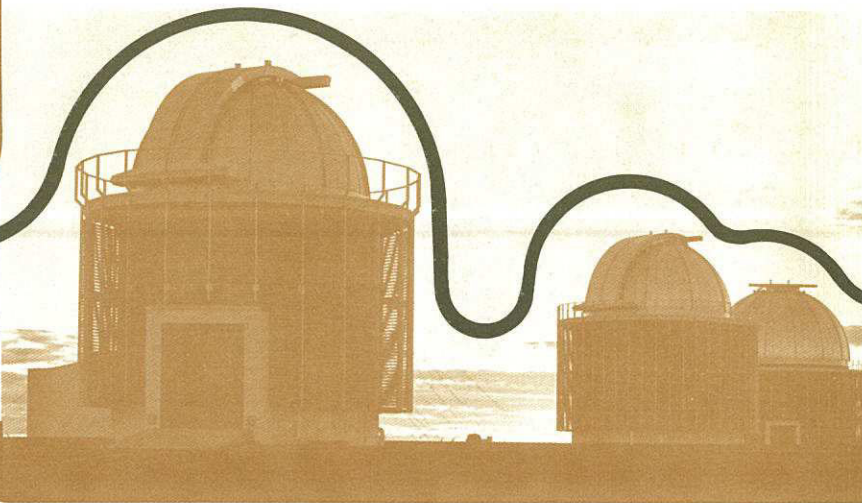
Isogonic chart (magnetic declination) of South Africa for the epoch 1970.0. (Published in CSIR Report MAG C5, 1972.)



ASTRONOMY

SOUTH AFRICAN ASTRONOMICAL OBSERVATORY

Director
SIR RICHARD VAN DER RIET WOOLLEY



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. Instrumentation from the former Republic Observatory in Johannesburg and the former Royal Observatory in Cape Town has been transferred to the new observatory. The headquarters of 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').

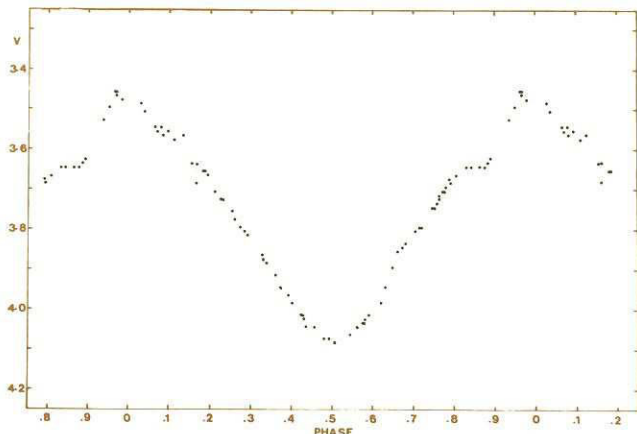
Observing station at Sutherland

The observing station at Sutherland was formally opened by the Hon. the Prime Minister, Mr B J Vorster, on March 15, 1973 in the presence of a distinguished gathering, including members of the Cabinet, the Right Honourable Mrs M Thatcher, United Kingdom Secretary of State for Education and Science, the President and Council members of the CSIR, the Board of the SAAO itself and a number of eminent overseas astronomers. Very successful meetings were held at Stellenbosch and in Cape Town at which astrophysical papers were read.

During the year the improved road to the Observatory (from the public Sutherland-Fraserburg road) has been completed and sealed, and the ESCOM electricity supply has been connected. Work has been commenced on the new observers' accommodation. Hitherto the four existing observers' chalets and two of the three technicians' houses have been used as living quarters.

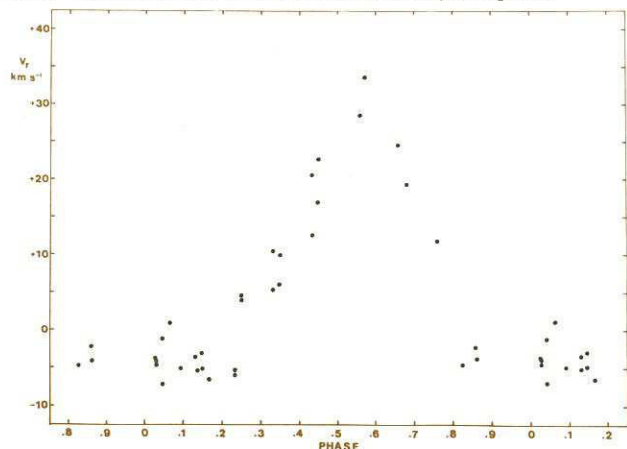
Observing activities and equipment

The 100-cm and 50-cm telescopes have been running throughout the year. The former telescope has been equipped with a spectrograph borrowed from the Royal Greenwich Observatory, with which several hundred spectrograms have already been taken. These are mainly spectra of pulsating variable stars and the programme is arranged so that simultaneous observations of the light curve are obtained with the 50-cm telescope. It is expected that a number of determinations of stellar radius by the Baade-Wesselink method will be completed and prepared for publication during next year.



Light curve of B Doradus determined at SAAO.

Bottom: Velocity curve of B Doradus from SAAO spectrograms.

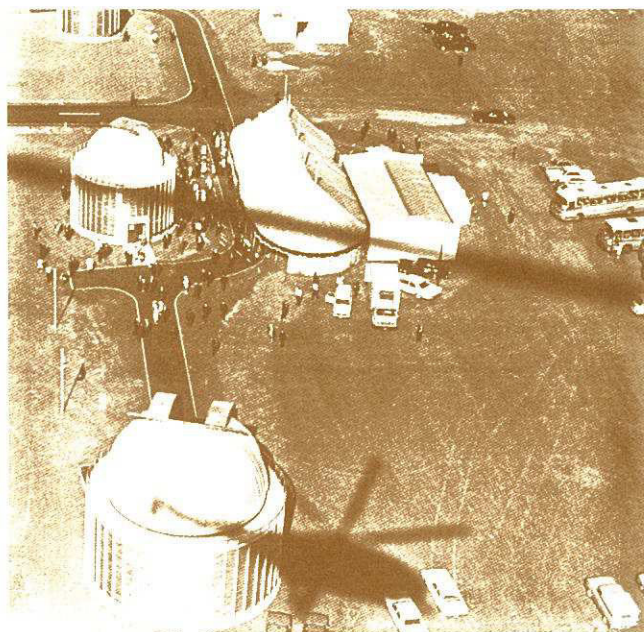


The 100-cm telescope has also been used for direct photoelectric work on faint variable stars and other faint objects of galactic (and extragalactic) significance. The telescope was also put into the mode appropriate to direct photography over a comparatively large field, namely with its reflector corrector system. This promises to yield very useful results.

The 50-cm telescope has been employed exclusively on photoelectric work. The average performance of the night sky at Sutherland has remained very constant, and just over one half of the night hours so far encountered have been suitable for first class photometry.

OFFICIAL OPENING OF THE SAAO OBSERVING STATION

(PHOTOS: CAPE TIMES)



Top: The observing station at Sutherland on the opening day.

The Prime Minister, the Hon. B J Vorster, addressing the guests.

The University of Cape Town has continued to send parties to Sutherland regularly. These parties are assigned one week in the month on one telescope, alternating between the larger and the smaller of the two reflectors.

Progress has been made with commissioning the Multiple Refractor Mounting and programmes have been planned with this instrument. It is hoped to organise co-operative programmes both with the Royal Greenwich Observatory and with the Royal Observatory at Edinburgh, making use of the high speed automatic plate measuring machines at these institutions.

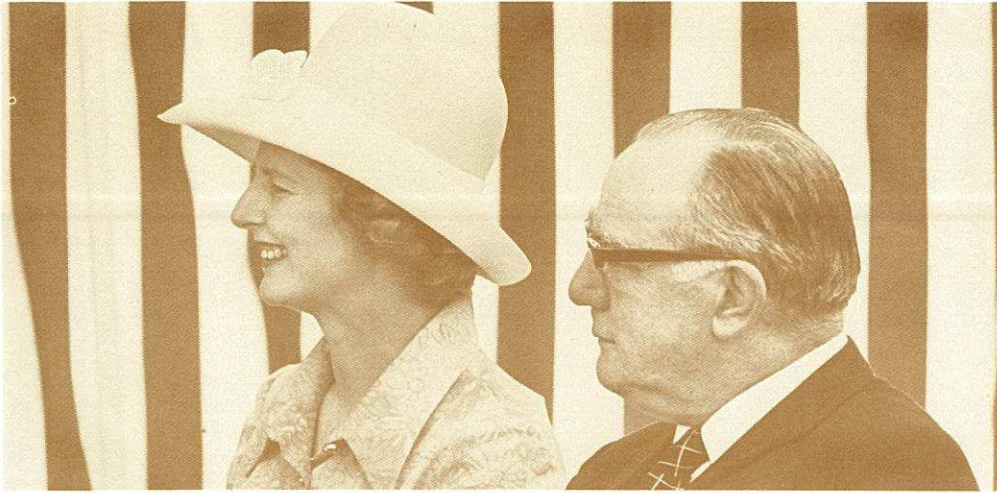
Two automatic guiders, built to a design made at the Royal Observatory, Edinburgh, have been purchased and used successfully with the Victoria refracting telescope at the headquarters of the observatory in Cape Town. These will ultimately be attached to telescopes at Sutherland.

During the year the CSIR purchased the 74-inch reflecting telescope at the Radcliffe Observatory, Pretoria, from the Radcliffe Trustees. The sale will be effective on 1st April 1974. Plans have been made to move the instrument to Sutherland, and work has already commenced on the foundations for the support of the instrument, and on building the wall on which the turret will rotate.

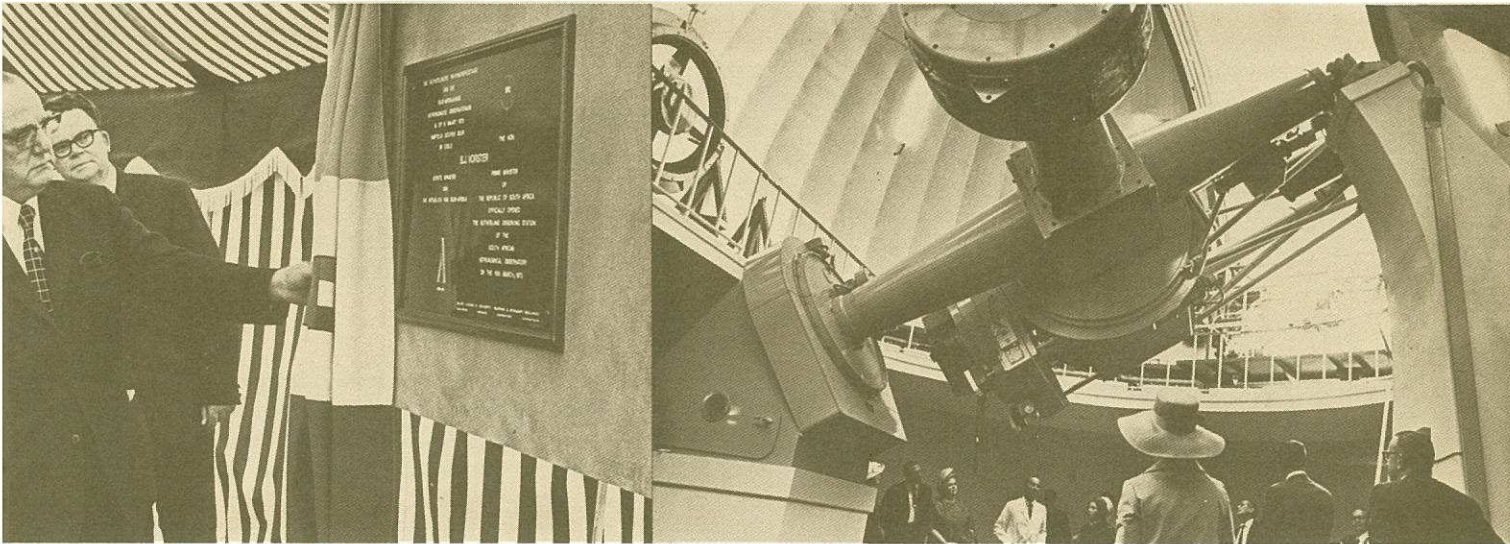
Light and colour curves have already been obtained for nine pulsating variable stars, and work is in progress on others. The fainter stars are being observed in visual and blue light, the brighter ones often in ultraviolet and infrared light as well. The colour changes are an indication of temperature changes, and these, taken in conjunction with changes of brightness, make it possible for the absolute magnitudes to be estimated and distances to be determined by comparing the apparent and absolute brightnesses. Pulsating variable stars are of special value for estimating the vast distances in interstellar space.

A limited amount of photometry has been done on other stars, including measurements in the far infrared that have revealed the presence of low temperature matter surrounding certain stars.





The Rt. Hon. Mrs Margaret Thatcher and the Hon. B J Vorster.



Unveiling of the plaque by the Hon. B J Vorster, with Dr C v d M Brink, President of the CSIR.

Viewing one of the domes.

Spectroscopic programme

The SAAO has acquired the use of the Yapp grating spectrograph, formerly used at the Royal Greenwich Observatory. This spectrograph is capable of dispersions of 31, 42, 64 and 86 Å/mm and is being used at the Cassegrain focus of the 40-inch telescope. The instrument was commissioned in January 1973, and by the end of September more than 600 spectra had been taken.

The main programme on which the spectroscopic section is working is the study of pulsating stars such as Cepheids, W Virginis and RR Lyrae stars. There exists a well-known method, first proposed by Baade and extended by Wesselink, by which the radii of these stars may be determined from the radial velocity and light curves. The change in radius between two phases is found by integrating the velocity curve, and the fractional change in luminosity over the corresponding time is

estimated from the light curve. Provided that the surface temperature of the star is the same at the two phases the radius may then be easily calculated. The method assumes that the temperatures of the star at the two phases are equal if the colour indices are equal.

Special attention is given to investigating the radii of W Virginis stars, a class of variable whose radii appear smaller than most of the classical cepheids. At the same time the radii of classical cepheids and RR Lyraes are also being determined for comparison with the W Virginis stars.

If the radius of a star is known, then its luminosity may be inferred from the surface temperature. It is believed that a period-luminosity relationship for the W Virginis stars which can be used to determine the luminosity of similar stars in the galactic centre will enable us to give a new estimate for the distance to the galactic centre.

Left: The Hon. J J Loots, Minister of Planning and the Environment, delivering his address.

MATHEMATICAL SCIENCES

NATIONAL RESEARCH INSTITUTE FOR MATHEMATICAL SCIENCES

Director
PROF. C. JACOBSZ

The National Research Institute for Mathematical Sciences (NRIMS) consists of divisions for mathematical analysis, statistics, computer science and operations research. Activities cover the various branches of mathematics and their application to research. Typical fields of study are theoretical fluid dynamics, statistical decision techniques and design of experiments, and numerical and non-numerical computation on digital computers.

Weather prediction

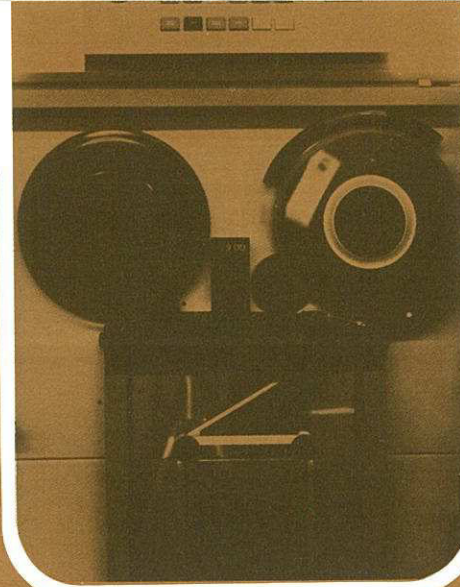
Methods of numerical weather prediction were further investigated in collaboration with the Weather Bureau. The previously developed forecasting model, which used data at three levels in the atmosphere, was modified, and predictions made with the aid of this program showed clearly that the new model was an improvement on the previous one based on only two levels. When improved computing facilities become available at the Weather Bureau in the near future, however, the program will be run on a semi-operational basis so that its capabilities may be properly evaluated.

It is anticipated that additional upper air data will shortly be available from satellites, and to make use of this information a five-level forecasting model is being developed. In this model the lowest co-ordinate level will be the actual surface of the earth.

Road traffic problems

A member of staff was on a visit to the Transport and Road Research Laboratory in England from March 1972 to February 1973. One of the projects in which he took part while there dealt with the 'moving observer' method of determining average travelling speed on highways. The theoretical study undertaken suggests that this method is preferable to the usual one where traffic volume is of average or more than average density.

In addition, a comprehensive contingency table of accidents involving injury which occurred in Great Britain during 1969 and 1970 was studied with a view to determining those environmental variables which are most closely related to serious and fatal accidents. Mathematical-statistical analysis indicated very strong associations with visibility and speed limit.



Enrichment experiment

In collaboration with the National Research Institute for Nutritional Diseases an experiment was planned to determine the influence on certain biochemical variables, observed in the blood of a group of test subjects, of the addition of certain vitamins to maize meal.

The general conclusion after statistical analysis was that the vitamin levels of the experimental group were significantly higher after the additions to the maize-meal had been made, and that they had no inhibiting effect on the protein level.

Forecast of maize yield in Rhodesia

A method to forecast the yield of maize in various regions was developed for the Rhodesian Department of Agriculture. Data on the maize yield in these regions, and also on two variables based on rainfall figures, were available. The aim of the undertaking was to be able to forecast the yield at a stage when the harvest has not yet been gathered but rainfall figures are already known.

After the necessary analytical work had been done, the computer programs were written and supplied to the Rhodesian Department to be adapted for a local computer.

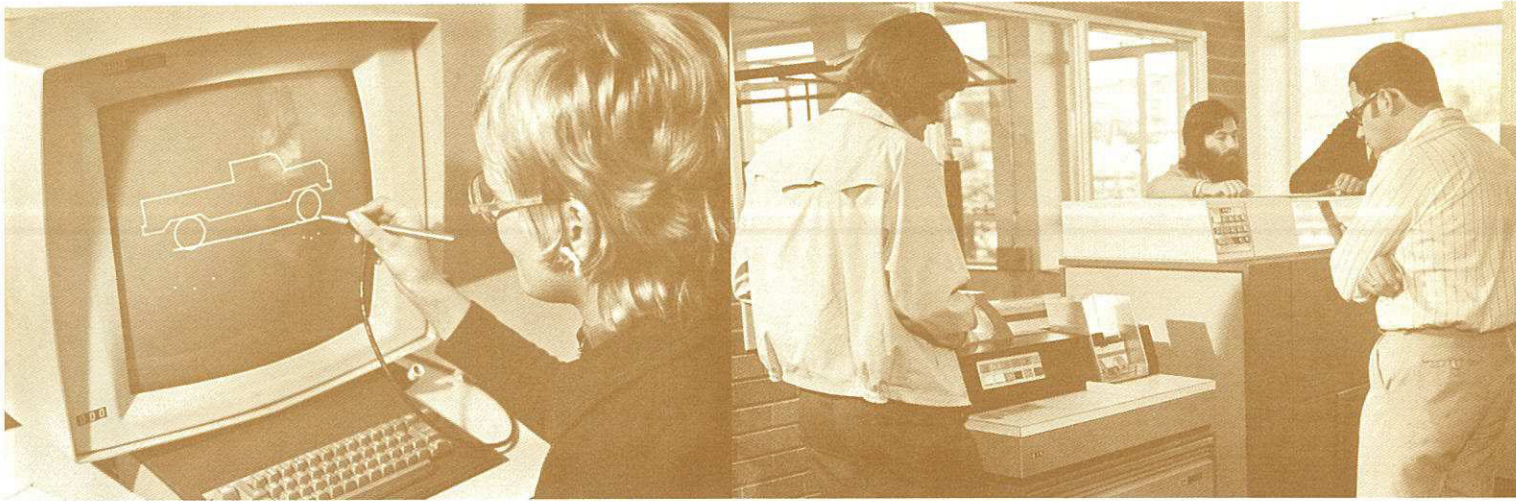
Aging of paper

An experimental design was recommended to a research worker of the CSIR's Timber Research Unit for determining the aging of paper under given circumstances. A number of variables were measured under given manufacturing conditions; the sheets of paper were then aged under accelerated circumstances, the temperature and humidity being controlled. A mathematical model was fitted to the data, making possible extrapolation far beyond the experimental range.

Computing centre

During the past year as in previous years the computing centre provided services to clients within and outside the CSIR. Saturation point has almost been reached on the day shift since clients have practically immediate access to the computer either through terminals or by making use of the self-service facilities.

A minicomputer was acquired to take over the operation of slow peripheral equipment from the central computer.



Kinematic computer graphics

A program was developed to simulate and depict on a graphic display unit the movement of a vehicle on a road. The program was successfully tested using information supplied by the National Institute for Road Research, and was so written that the vehicle appears to be stationary while the road profile changes.

Numerically controlled machine tools

In collaboration with the CSIR's Technical Services Department, another course was organized covering the application in industry of numerically controlled machine tools and numerical techniques generally.

Service programming

Programs were developed for investigations into aircraft noise disturbances in the vicinity of airports, variations in electric field intensity and the potentials generated during lightning discharges from clouds, and eclipses of binary stars. Regular use has been made of programs for the analysis of data gathered in connection with air pollution, hail research, geomagnetism, the seasonal adjustment of economic time series and other projects.

Data processing

As in previous years there has been a steady flow of mass data processing work. This included the evaluation of weather and weather services in South Africa, the analysis of beach and surf conditions at points on the Natal South Coast, water resources and the water table in South West Africa, and tabulations of road accident data, taking into account various factors such as speed and visibility, together with the driver's age, his vigilance, skill and misjudgement.

Equilibrium equation for thin films

The technique of thin films plays an important part in modern technology and its industrial applications. Micro-miniature circuits in electronic equipment are an important example.

To learn something about the characteristics of such thin films a system of partial differential equations was investigated, describing the equilibrium condition of a thin film. A study was carried out to determine those characteristics of the above-mentioned equations which are important for applications.

This study led to the identification of certain boundary conditions which have to be imposed for the

By means of this computer terminal, users have almost immediate access to the IBM/360 model 65 computer of the NRIMS.

Left: A graphic display unit being used to represent the computer-simulated movement of a vehicle on a road.

equations to be solved meaningfully. In addition it was found that if the film is sufficiently thick in relation to the area it occupies, only one equilibrium condition is possible. If the film becomes thinner, various equilibrium conditions exist. These findings indicate that the proposed equations describe well the actual behaviour of thin films.

Perturbation theory of differential equations in Banach spaces

The study of perturbation theory for first order differential equations in Banach spaces was extended to cover the case of equations the solutions of which converge to a stationary state. The continuity characteristics of fractional powers of closed linear operators were also investigated. The results obtained are applicable to partial differential equations of parabolic type, and to certain initial value problems of second order.

Scheduling of production

An algorithm was developed for the scheduling of the production of a number of product lines on a number of non-identical facilities, each of which is subject to capacity constraints such that total inventory and production costs (which may be non-linear) are approximately minimized. Computation time using this algorithm is several orders of magnitude less than that using rigorous, generalized methods.

Transportation problem

Contract work in the field of operations research included modifications to a program developed previously for the solution of a transportation problem of the Maize Board.

The original program computed a minimum cost solution to the problem of supplying maize from various points of origin to the points of usage, but this solution is not unique since various alternatives are possible, each having the same total cost, but differing in costs to individual users.

The extension now incorporated seeks to identify a solution from amongst these many alternative minimum total cost solutions which is in a sense the most fair to all the individual users.

TELECOMMUNICATIONS RESEARCH

NATIONAL INSTITUTE FOR TELECOMMUNICATIONS RESEARCH

Director
R.W. VICE

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 and radar systems for specialized applications. The Institute operates the Radio Space Research Station at Hartebeesthoek near Johannesburg on behalf of the United States' National Aeronautics and Space Administration.



The ionospheric observing station on Marion Island.

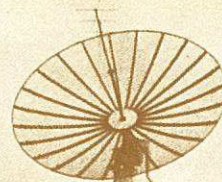
Ionospheric research

The Institute carries out research into the ionosphere and its influence on the propagation of radio waves. Routine ionospheric observations are made near Johannesburg, at Hermanus and at the recently established station on Marion Island. Observations of airglow are made near Pretoria and at Sutherland. Bulletins of ionospheric data and predictions of the optimum frequencies for use in short-wave radio communications are issued monthly.

The Institute co-operates with numerous overseas organizations by exchanging data and taking part in joint experiments.

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, specially designed for the measurement of rain, has been used together with a system of rain gauges in comparative experiments designed to establish the essential parameters of the radar measuring process. A system for processing and recording the radar data has been developed in order to make it possible to measure rainfall over a wide area.



A number of storms have been studied with the aid of an 8-mm Doppler radar. This system was designed to measure the motions of raindrops, from which the sizes of the drops can be derived.

Significant departures from the generally assumed distribution of drop sizes have been found, and this has an important bearing on the relationship between the measured echo intensity and the rainfall rate in a radar system of rainfall measurement.

Lightning research

The Institute uses a system of spaced VHF receivers to obtain synchronized records of the radio noise radiated by lightning; from these records the development of the noise sources in space and time can be derived with great accuracy.

These observations are supplemented by radar observations of precipitation in order to investigate the relation between the paths of lightning discharges and the precipitation. Balloon-borne radiosondes are being developed in order to measure the electric fields in storms.

Over 200 lightning flashes were observed during the summer of 1972-73, and a selected number of these are being analysed in detail.

Distance measurement

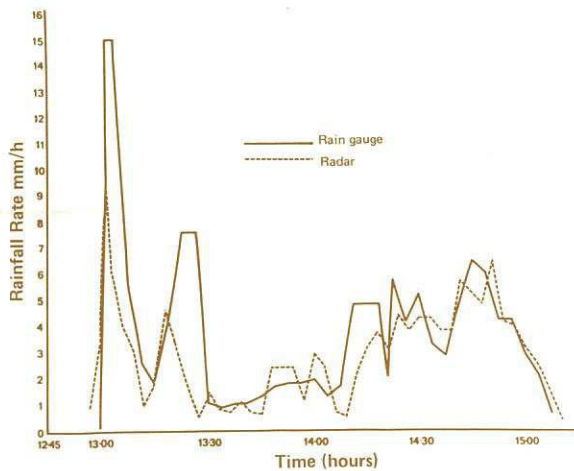
An important aspect of the Institute's work is the development of electromagnetic systems for the measurement of distance. As a result of continued research and development since the invention of the 'Tellurometer' system of distance measurement in 1955, South Africa has maintained its lead in the production of such equipment.

In 1972 the Institute developed a new, automatic version of the 'Tellurometer' system with the assistance of the South African producers of this type of equipment. After the successful demonstration of the system the Institute co-operated with the firm in the design of a pre-production model.

In the new system the antenna unit can be separated from the instrument and elevated on a light mast to obtain a clear line of sight over obstructions. After the instruments have been set up a digital presentation of the distance is obtained automatically in about twelve seconds.

Space research

The Institute operates the Radio Space Research Station at Hartebeesthoek on behalf of the United States' National



Comparison of rainfall measurement by radar and by rain gauges.

Aeronautics and Space Administration (NASA). This station actually comprises two tracking stations, the Deep Space Instrumentation Facility (DSIF) and a station of the Spaceflight Tracking and Data Network (STDN).

The DSIF uses a 26-m parabolic antenna to track and communicate with space probes to the moon and the planets and in interplanetary space. During the past year the station has been engaged mainly in tracking the space probe Pioneer 9 orbiting around the sun, and Pioneer 11, the second of the space probes bound for Jupiter.

The STDN station is one of the world-wide network of stations established by NASA to track and communicate with scientific earth satellites.

In July NASA announced that for technical reasons the DSIF would cease operations in July 1974, and the STDN station probably a year or two later. The tracking activity will remain at a high level until closure.

During the year the CSIR and the French Centre National d'Etudes Spatiales (CNES) concluded an agreement in terms of which the Institute will operate the French satellite tracking station at Paardefontein, near Pretoria. Some CSIR staff have already assumed duty at the station, and it is intended that the CSIR will assume full responsibility for the operation of the station on behalf of CNES early next year.

Radio astronomy

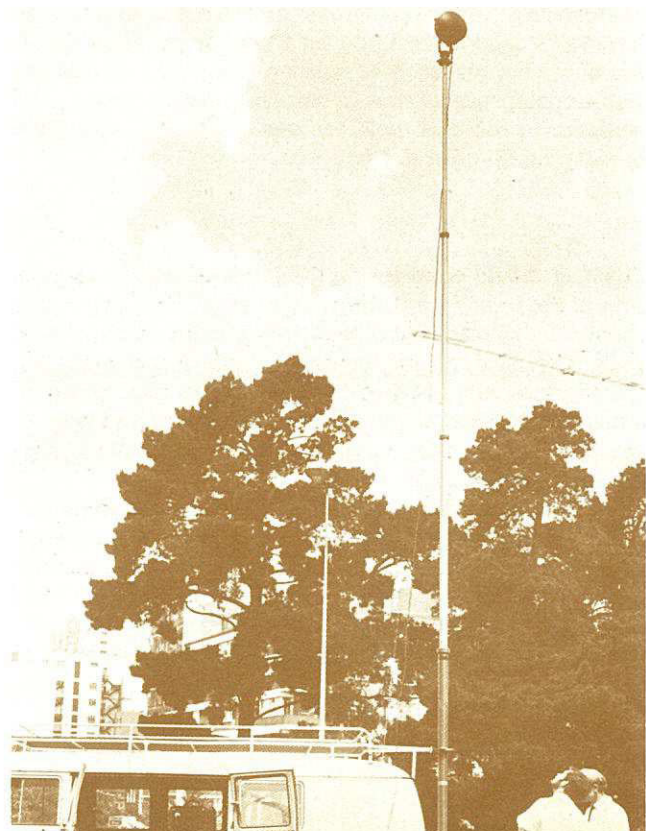
When the 26-m antenna at Hartebeesthoek is not required for tracking operations it is used in a programme of radio astronomy. The necessary ancillary equipment has been designed and built by the Institute. One radiometer operates at the normal operational frequency of the station (2295 MHz). A second radiometer, operating at 4200 MHz, was completed during the year.

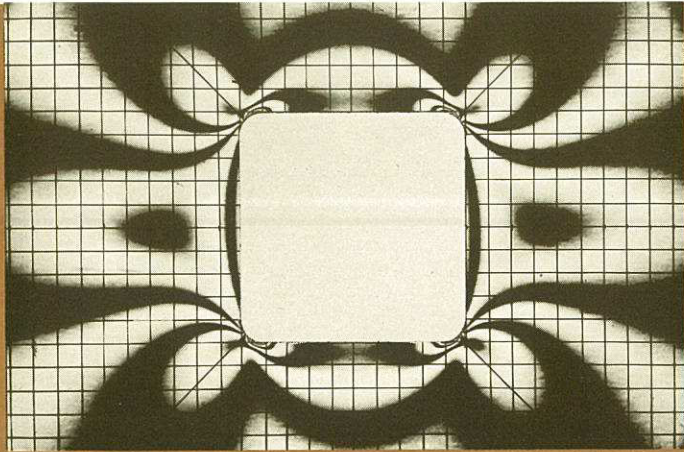
The main continuing programme over the past six years has been the study of variable radio sources, and 90 such sources are currently being observed. Observations with intercontinental interferometers have continued, using baselines extending from South Africa to Australia and to West Germany.

Work has continued on a survey of radio sources in the southern sky; the zone covering declinations -20° to -36° has been completed and a survey of the zone from -5° to -15° is in progress.



Prototype automatic 'Tellurometer' distance measuring equipment. Below, tests are being conducted with the antenna unit elevated on a mast.





MECHANICAL ENGINEERING

NATIONAL MECHANICAL ENGINEERING RESEARCH INSTITUTE

Director
DR H.G. DENKHAUS

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. The Institute is also active in fields such as geomechanics in relation to both mining and civil engineering. The Institute has testing equipment, machines, instruments and qualified personnel for research in the fields of metallurgy, strength of structures, process development, geomechanics, hydromechanics, (including harbour and river engineering), heat mechanics (including air conditioning and refrigeration) and aeronautics.

The NMERI consists of six research divisions, namely Strength Mechanics, Metal Mechanics, Geomechanics, Process Mechanics, Fluid Mechanics and Heat Mechanics, as well as three research units, namely Hydraulics, Mine Equipment and Aeronautics.

The six divisions and the Aeronautics Research Unit are in Pretoria, the Mine Equipment Research Unit is in Johannesburg and the Hydraulics Research Unit is on the campus of the University of Stellenbosch. The three units are integral parts of the NMERI and are responsible to the Director of the Institute. (As from 1 February 1974 the facilities and activities of the Hydraulics Research Unit in Stellenbosch will be taken over by the newly established National Research Institute for Oceanology of the CSIR, but hydraulic research activities not related to the ocean or the coast, such as river hydraulics, dam hydraulics and irrigation problems will be dealt with by the Fluid Mechanics Division in Pretoria).

Effect of mould coatings on the finish of metal castings

One of the most troublesome defects in metal castings is caused by molten metal penetrating voids in the mould wall. The size of the voids, metallic-static pressure, temperature and surface tension are all factors which influence the rate of penetration into the mould wall. In practice, coatings are applied to the mould walls to alleviate this type of defect.

The National Mechanical Engineering Research Institute is doing research to develop the best coating material. Slurries using silica flour, zircon flour, chromite flour and graphite as base materials, bentonite as a binder and water and alcohol have so far been tested. Steel, cast iron, brass and tin have so far been used as the casting metals.

Mechanics of jointed rock masses

A geomechanics classification of jointed rock masses was proposed by the Institute. It has proved very useful in several practical examples of tunnelling problems in civil and mining engineering and has been received with great interest both in South Africa and abroad.

A study of the geological descriptions of *in situ* rock masses was undertaken. This included a literature survey on the identification and description of those geological parameters that influence the behaviour of rock masses and which are important in civil and mining engineering. Existing field and laboratory techniques which give quantitative descriptions of these parameters were also studied to develop tests which would produce results more useful in engineering design than those used at present.

Lightweight aggregates

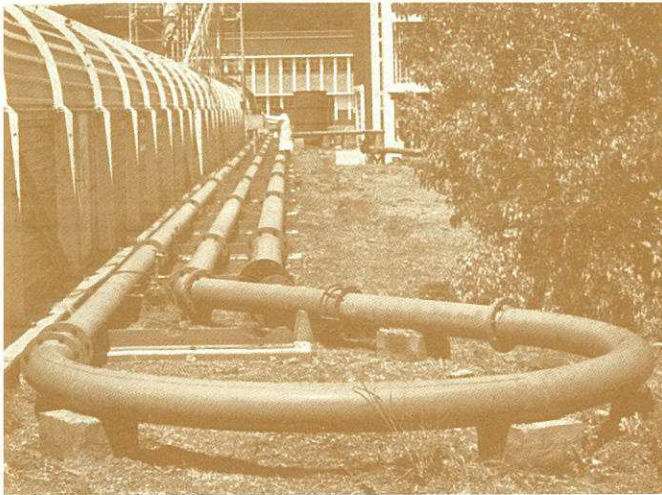
Lightweight aggregates (sometimes having a relative density of less than unity) are being produced overseas from expandable clay and, to a lesser extent, from fly ash. Their main advantage over conventional aggregates is that the overall dead-weight of concrete structures is considerably reduced.

The Institute is investigating the feasibility of using fly ash, a waste material from power stations, for the profitable production of lightweight aggregates in South Africa. Pellets of fly ash have been prepared, and various ingredients have been added to increase their strength and to improve their expanding qualities. Research is being done to develop a suitable fluidized bed reactor in which the pellets can be turned into acceptable aggregate material.

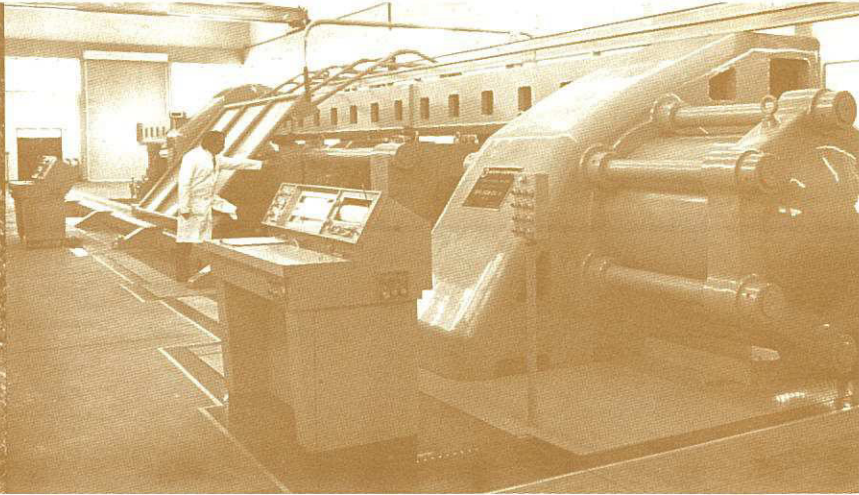
Hydraulic transportation of solids

A hydraulic pipeline test circuit with pipe diameters of 200 mm and 250 mm has been completed for tests to determine the pressure gradients and power required for the hydraulic transportation of solid materials in pipelines. Previously a capillary tube viscometer and a pipeline test circuit in which the pipe diameter was only 50 mm was used for this purpose.

As the larger pipe sizes correspond to those commonly used in actual hydraulic transportation pipelines it is now possible to determine the best operational conditions for any type of slurry, material grain size, slurry



A 200-mm and 250-mm pipe diameter test circuit for research into the hydraulic transportation of solid materials in pipelines.



The new 10 000-kN wire rope testing machine at the Mine Equipment Research Unit.

concentration and slurry velocity under almost full scale test conditions.

Some years ago a literature survey revealed that little was known about the wear of the pipes in pipelines used for the hydraulic transportation of solids and that no test apparatus existed for measuring the wear of pipes in such circumstances. The Institute has designed and built a simple test apparatus which can simulate actual conditions in pipelines and in which the various wear parameters can be studied simultaneously.

Chilling of meat

Basic studies into the effect of environmental conditions on the chilling of meat are being undertaken in conjunction with the Livestock and Meat Industries Control Board and the Division of Veterinary Services of the Department of Agricultural Technical Services. These investigations are carried out in experimental cold rooms specially designed for this purpose and include a study of bacteriological spoilage of meat, moisture losses and the phenomenon of 'cold shortening' or toughening of meat.

Wire rope testing

The new mine rope testing laboratory of the Mine Equipment Research Unit at Cottesloe came into operation towards the end of 1973. The approximate costs of the buildings and ancillary equipment amounted to R300 000 and those of the new 10 000 kN wire rope testing machine to an additional R300 000. This facility is probably one of the finest to be found anywhere and will enable the Unit to provide even more extensive services than with the old equipment which was in use for nearly forty years.

Harbour research

Good progress was made with the Richards Bay harbour project, while the field work and model studies in connection with the proposed harbour at Saldanha Bay were completed. The Hydraulics Research Unit was also consulted in connection with coastal research necessary

for the establishment of a nuclear power station near Cape Town.

Umgeni estuary study

The tidal exchange rates in the Umgeni estuary are being studied to determine the feasibility of a scheme aimed at producing a self-scouring estuary mouth in which there would be sufficient water exchange for self-purification.

The extensive field data programme required for the hydraulic model studies was completed. This included beach and bathymetric surveys, estuary and river surveys and routine collection of wave, wind, tide and river flow data. Mathematical as well as physical model studies are being undertaken to find a practical means of increasing the scouring effect of the tidal flow in the estuary and reducing the movement of longshore sand into it.

Swakopmund beach development

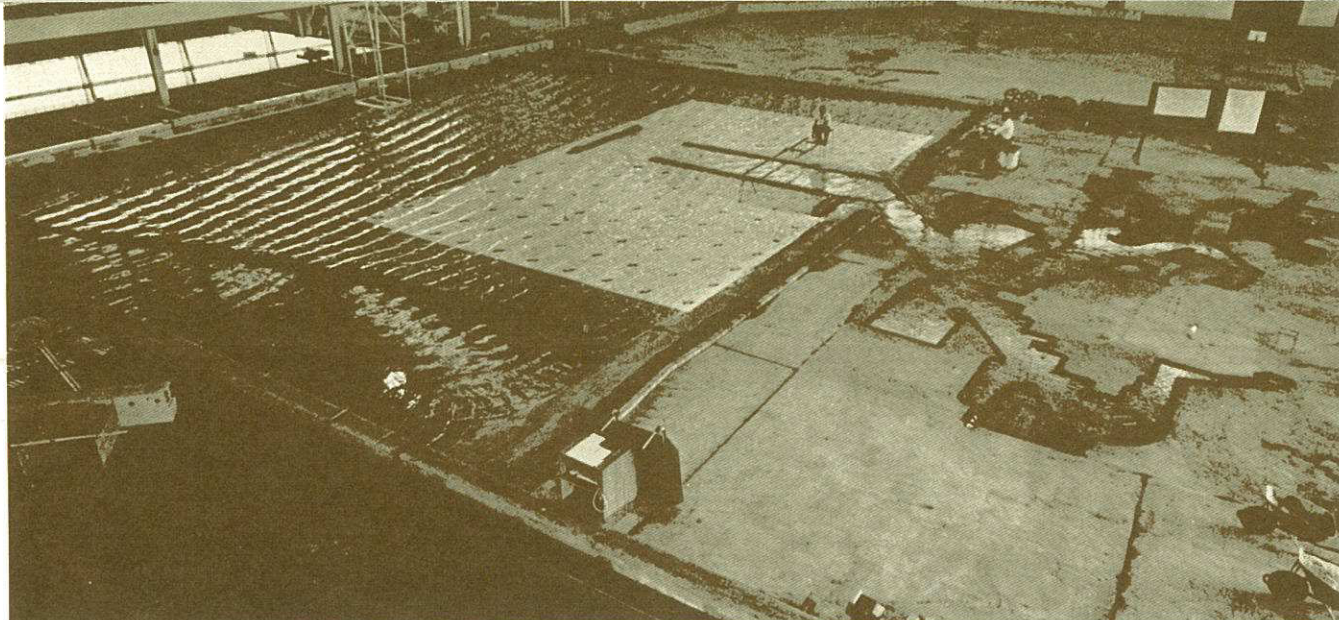
The South West Africa Administration commissioned the CSIR in 1970 to undertake a study of the beaches of Swakopmund with the object of recommending beach improvement and protection schemes which would provide safe bathing conditions at this important coastal resort.

A field data collection programme which was started at the end of 1970 and included hydrographic and sub-bottom surveys as well as wave recordings has been completed. A hydraulic model using data to simulate sea conditions observed in nature, will now be built to establish the best means of improving the beaches.

Knysna marina

The question of whether the development of a marina in the Knysna lagoon will have any undesirable effects on the existing regime of the lagoon, is being investigated at the request of the Department of Agricultural Credit and Land Tenure.

Field studies as well as the construction and calibration of a hydraulic model to be used in this investigation, has been completed. Alternative schemes will be studied in the model, including an open marina with full tidal



Tests in progress with the hydraulic model of the Muizenberg Marina.

Right: A radio controlled scale model of an ore carrier entering a model of Richards Bay Harbour at the Hydraulics Research Unit.

action in the channels and a closed or locked marina with no tidal action in the channels.

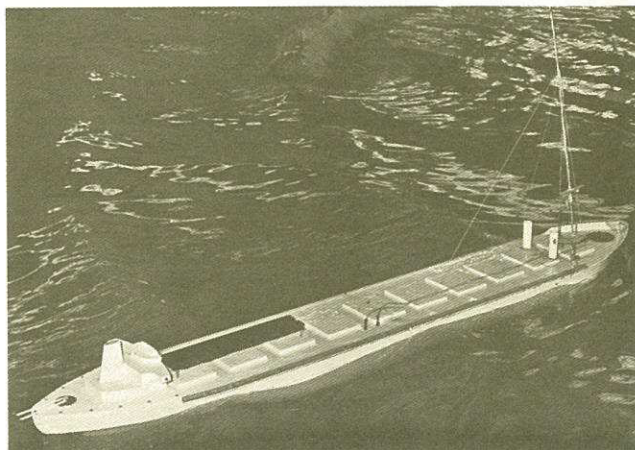
Aircraft noise

Continued participation in the work of the International Organisation for Standardisation (ISO) involved further consideration of procedures for the assessment of noise produced by light aircraft and helicopters and of the subjective effects of noise variability. The Institute's earlier work on the effects of noise variability aroused much interest in several other countries.

Autogyro

Following its successful maiden flight in December 1972, the prototype autogyro developed by the Institute was publicly demonstrated and much favourable comment was received. The aircraft was subsequently fitted with extensive data recording equipment, and its flight testing programme initiated.

Apart from a preliminary study of general handling characteristics, the tests have thus far been concerned mainly with take-off performance. It was found that the aircraft became airborne at unexpectedly low rotor speeds, owing to the presence of ground effect. While this should have resulted in even shorter take-off runs than had been anticipated, the rate of decay of the rotor speed during the ground roll prior to lift-off proved to be unacceptably high, thus spoiling the short take-off potential. A modified rotor head system has been devised to solve the problem of rapid rotor speed decay. This should make shorter take-off runs possible while still meeting the important requirements of mechanical simplicity.

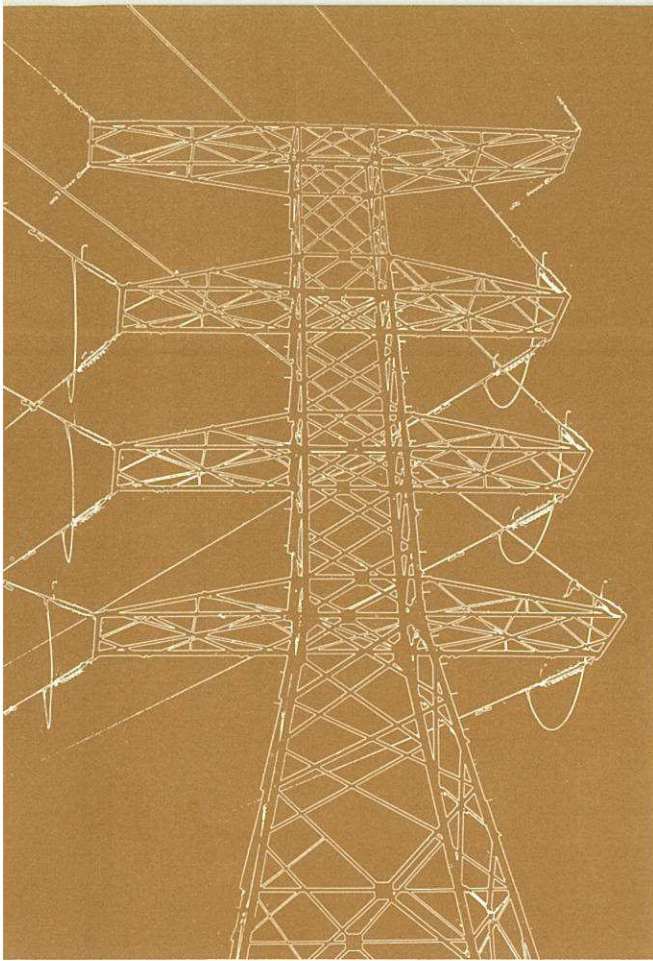


The prototype autogyro on landing approach after a test flight.

ELECTRICAL ENGINEERING

NATIONAL ELECTRICAL ENGINEERING RESEARCH INSTITUTE

Director
J.D.N. VAN WYK



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 signal processing, automation, applied electronics, solid state electronics, electronic instrumentation, training and information, and power electrical engineering. 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, thin film and semi-conductor technology and its applications to electronic circuit systems and micro-miniaturization, and the investigation of problems peculiar to the Republic in heavy-current applications.

Lightning research

The most important objective of the lightning research programme in the Institute is the determination of the density of lightning discharges between cloud and earth. This factor is of importance in the design of lightning protection for power transmission and distribution systems and also communications lines.

Lightning counters are being tested at four automatic recording stations in the Pretoria-Johannesburg area. During the past season the average number of recordings made at the four stations by the counter which is used as reference was 47 000, compared with 24 000 for the previous season.

An important parameter in regard to lightning counters is the correction factor that is used to compensate for the number of intercloud discharges which are also registered. During the recent season this parameter was determined for the first time for three types of lightning counter and made it possible to calculate the ground flash density in the test area for the season: the value obtained was about 10 discharges per square kilometre per year. Further recordings are necessary to obtain more reliable results.

As the protective measures used at present are largely based on measurements of lightning parameters made in more temperate regions of the world it is important to investigate the characteristics of lightning in South Africa. With this aim in view a 60-metre mast was erected at a prominent point on the CSIR site for the direct measurement of lightning parameters. This mast has been mounted on high voltage insulators and is supported by insulating stay wires, and this is the first time this approach has been used anywhere for such measurements. Owing to damage to the mast during a storm, the complete series of measurements could not be carried out as planned, but a number of indirect measurements of lightning parameters were nevertheless made.

Surges and corona on transmission and distribution lines

A knowledge of the excess voltage surges in transmission and distribution networks is necessary to improve the design of such systems and for a more realistic appraisal to be made of the degree of protection required.

Automatic stations in which surges are continuously registered are in operation at a 400-kV ESCOM distribution station and at an electrified system of the South African Railways.

These surge recording stations have already produced important volumes of data and many of the surges could also be correlated with lightning discharges which occurred nearby.

In addition, the University of Pretoria is collaborating with the CSIR in the measurement of radio interference voltages produced on the line by corona.

Insulation research

The Institute actively participated in the work done in the field of insulation by the two working groups of the Coordinating Committee for High Voltage Research and Testing Facilities.

Agreements were also entered into with two organizations in order to develop insulation evaluation procedures for large high-voltage motors.

Process control

A project on process control in a sugar factory is being undertaken in conjunction with a sugar company. The aim is to establish a mathematical model of a cane sugar factory and thus discover guidelines for optimum operation of the factory.

A member of the CSIR's Research Group for Chemical Engineering is collaborating in the project and the

Sugar Manufacturing Research Institute will in future also take a more active part — in particular by acquiring the necessary special sensors and also by assisting with the interpretation of results.

A second project on the optimization of a gold recovery filter is being undertaken together with a mining company. Preliminary experiments on a mine filter have been carried out. A computer will be temporarily installed in the reduction plant of the mine to gather data during further experiments to test the proposed model of the process.

Data-acquisition systems

As part of research projects being undertaken in collaboration with industrial organizations two computer-controlled data-acquisition systems have been installed and the necessary programs developed.

At the Apollo switching station of ESCOM a mini-computer system is used to gather in real-time high voltage transmission line current, voltage and corona data and also meteorological information.

An out-of-contact current measuring system has been developed as an alternative to current transformers for certain applications such as protection, where high accuracy is not of decisive importance. It is expected that such a system will be able to compete favourably with existing measuring systems in view of the lower cost of the equipment. An out-of-contact voltage measuring system has also been developed, and in both cases antennae are mounted on the towers opposite each set of phase conductors, and just beyond the minimum safe distance from these.

A data-acquisition system has also been put into operation at a sugar factory. Here data on the milling section of the factory are being gathered.

Hybrid computer

A typical problem investigated with the aid of the NEERI's hybrid computer was one involving the behaviour of a jet plane and which was referred to NEERI by the National Mechanical Engineering Research Institute.

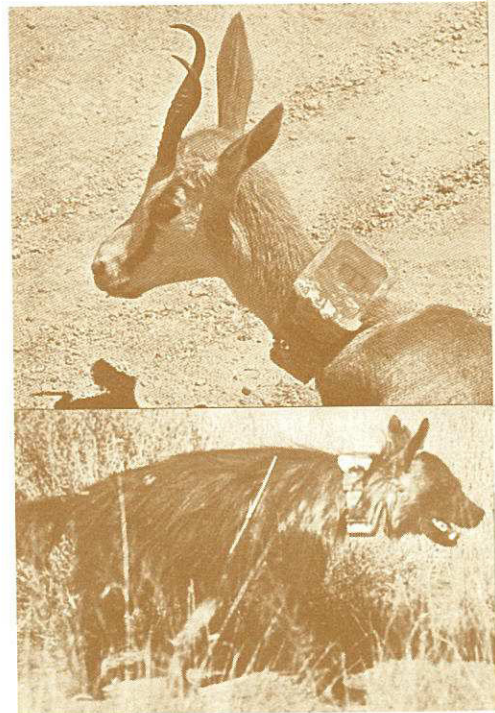
A combination of low pressure and high temperatures, for instance on the Transvaal highveld, reduces the lift of the wings and consequently long runways are necessary to enable the take-off speed to be attained. It has been found that wetting of the runway improves conditions, and the aerodynamic properties of an aircraft have been simulated on the hybrid computer in order to



Direct lightning discharge on the mast on the CSIR site.

Right: The 60-m mast mounted on an insulated base.

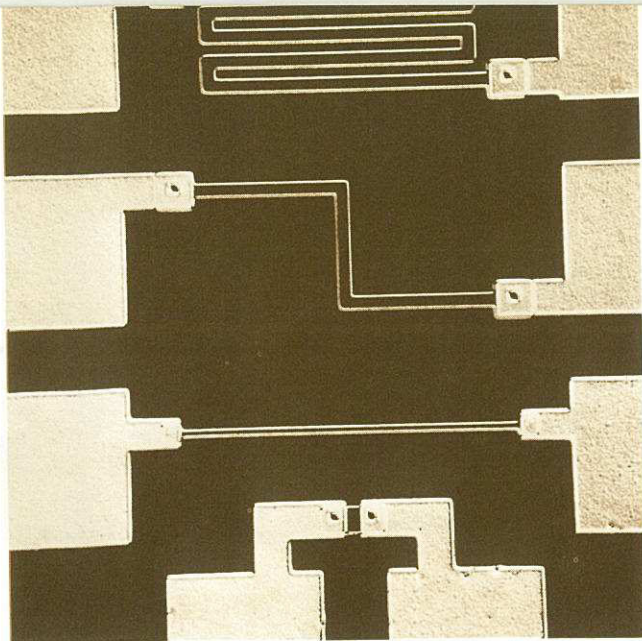
Springbok and (bottom) hyena carrying radio transmitters in animal tracking projects.



obtain quantitative evaluations of the efficiency of the method.

Microcircuits

The research programme dealing with thin-film integrated circuits has now been successfully completed and a small-scale production unit is available for clients.



Monolithic resistances of various widths. The light-coloured surfaces are aluminium contact plates for attaching conductors for testing purposes.

With a view to the fabrication of the first monolithic bipolar circuit, attention has been devoted to the development of transistors and resistances, and an integrated circuit which will be used for testing purposes has already been designed.

To speed up the production of masks for micro-circuits and printed circuits and reduce the likelihood of errors due to human fallibility, a computer-aided graphic design system has been acquired. During the design stage the pattern is displayed on a cathode ray tube, and at any point a permanent copy can be produced on request by a graph plotter. When the design has been completed a punched paper tape is produced containing all the instructions necessary for an accurate draughting table on which the final masks are drawn.

Liquid crystals

The object of the Institute's work on liquid crystals is to develop an image converter which will transform an ultrasonic holographic field suitable for visual display. The line of research being followed is to modify the transparency of a liquid crystal cell between two crossed polarizers by means of ultrasonic (mechanical) energy.

Ultrasonic surface waves

Ultrasonic surface waves are being increasingly utilized in signal processing and communication engineering. Research in this Institute on the influence of evaporated metal films on the propagation parameters of surface waves has been concluded. Applications in the microwave region are being further investigated in conjunction with the National Institute for Telecommunications Research.

Optical signal processing

Optical signal processing with the aid of computers is being applied in a wide field which includes automatic pattern recognition. The optical processing embraces techniques such as compensation for shadows, varia-

tions in contrasts and improvement of the definition of outlines.

A start has been made by studying the possibilities of various techniques, and the fast special-purpose computer for signal processing will be used for this purpose. The system can handle signals in real time with frequency components of tens of kilohertz.

Animal tracking

The past year was devoted mainly to the investigation of problems which arose in connection with radio transmitters for fairly large animals. Additional equipment was also supplied for the tracking of baboons, and new equipment for hyena, nyala, springbok, bushbuck and kudu.

About half the transmitters supplied gave satisfactory service. Upon investigation it was concluded that the following factors, singly or in combination, were responsible for the problems encountered; factors such as the effect of the animal on the larger type of loop antenna which had to be used, the artificial resin with which the antenna was being stiffened and the transmitters encapsulated, and failure of components. The figure of 50 per cent utilization, however, is of the same order of magnitude as that recorded in the literature for several overseas projects.

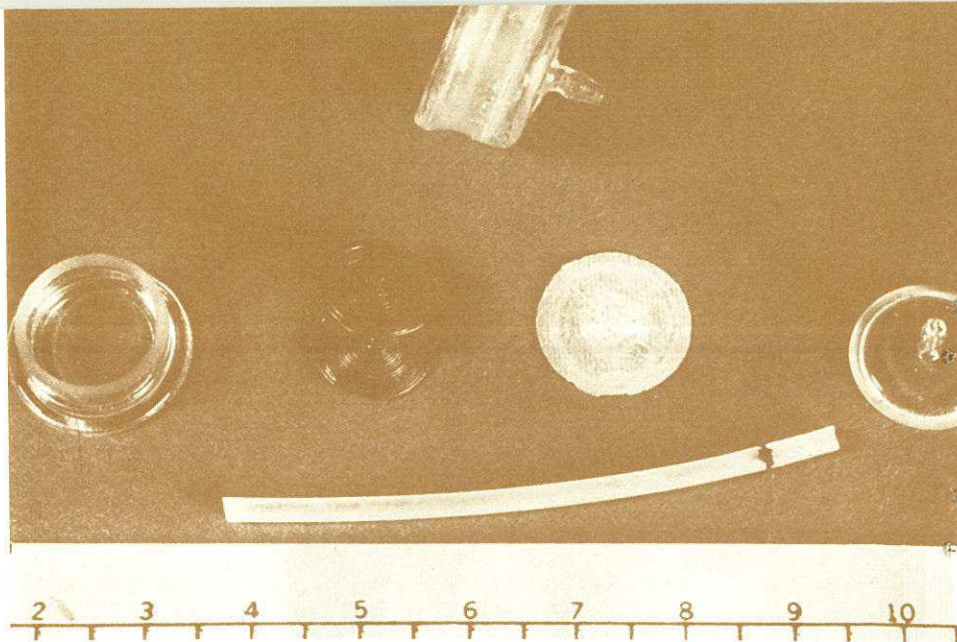
Instrumentation information service

The Institute offers an information service covering technical details of electronic equipment, manufacturers of such equipment and their local representatives, and also the interpretation or evaluation of specifications for equipment for specific applications.

Small-scale automation

On request of the South African Council for Automation and Computation, and the Institute of Production Engineers, the CSIR has inaugurated a special new service for industry: a Service for Automation and Production Technology. It consists of consultation facilities in regard to the technology of automation and production, and the development of prototype equipment where necessary to help solve problems of this nature in industry.

The National Electrical Engineering Research Institute will deal mainly with projects involving electronics as applied to small-scale automation. A number of projects have either been completed or are still continuing. A few examples are given here.



A capsule developed for measuring cerebro-spinal fluid pressure. Complete capsule is shown at top, with various components below.

For a manufacturer of copper pipes an automatic control unit was designed which is being mounted on existing equipment. Predetermined lengths of pipe are sawn off and lengths with defects discarded.

A power consumption recorder was developed for ESCOM. Pulses from existing kilowatt-hour meters are received by the unit and added; the total for every half-hour is recorded on punched paper tape.

For the South African Bureau of Standards a data acquisition system is being designed to measure the body temperature of up to 60 experimental animals at regular intervals, and to process the data according to a predetermined programme. A minicomputer will be used as central control unit to store and process the readings.

Calibration and maintenance of electronic instruments

About 150 electronic instruments were calibrated during the year, about 17 per cent of them for external organizations; some were received from instrument suppliers who had their laboratory standards tested.

Altogether 241 instruments were serviced, 136 of them for other CSIR Institutes and 17 for external organizations.

Training

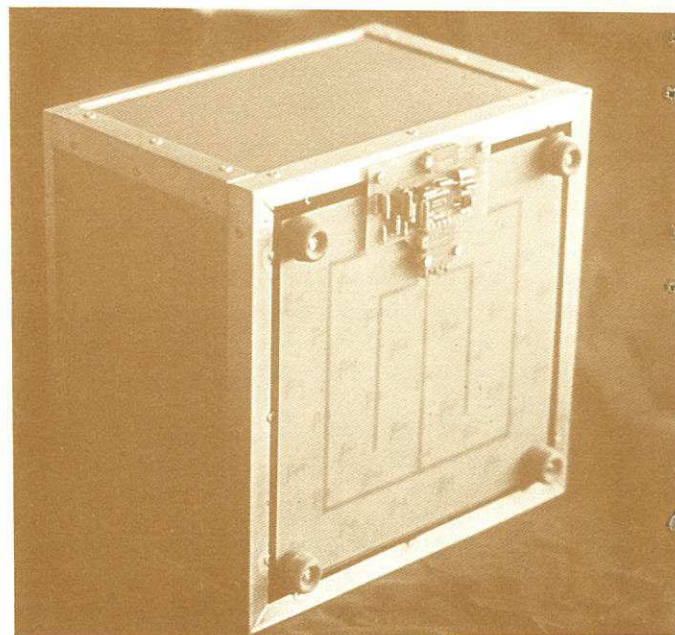
The Institute is responsible for the practical training of the CSIR's electronic technicians who take the four-year sandwich course at the Pretoria College for Advanced Technical Education. This scheme has now been in operation for ten years and caters for a group of 26 students.

Medical electronics

During the past year a radio-telemetric link, developed to transmit physiological data such as the electrocardiogram (ECG) from active patients, was used on an experimental basis in various centres.

A telemetering project for studying electroencephalograms (EEG) is being undertaken at a hospital in Pretoria with the support of the Medical Research Council.

At the Military Medical Institute a large centrifuge is being used to study various physiological data, especially on pilots. With the telemetering system it is possible in



The antenna system and sensor at bottom of cage used to determine activity of experimental animals (rats and mice) quantitatively by electronic means.

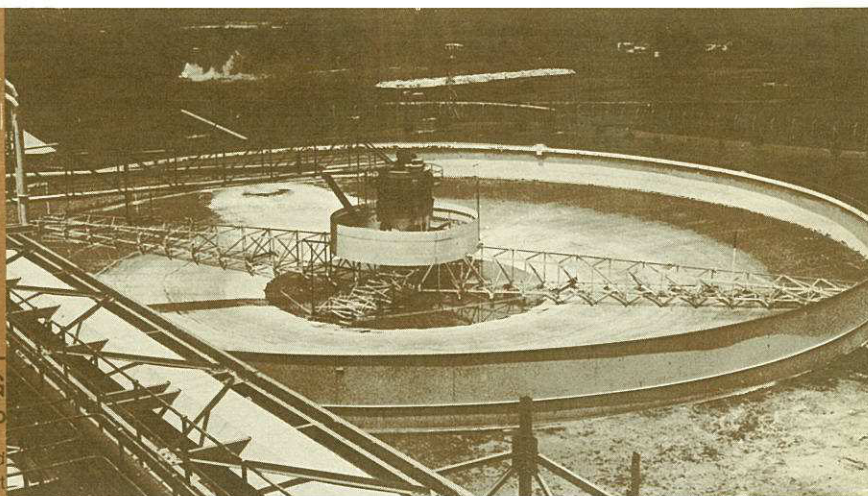
spite of the generally unfavourable circumstances to transmit useful ECG and EEG signals from the test cabin.

An electronic method has been developed to determine quantitatively the general activity of experimental animals, such as mice and rats, used for the quality control of pharmaceutical products. The method has been used with great success at a South African university.

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 organisations.

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 research.

Services to industry

The Group's semi-technical scale equipment for drying, mixing, extracting, etc. is available to industry for long-term and short-term investigations. This service meets the needs particularly of the smaller industries which do not have their own research and development facilities.

The Group also maintains a well-equipped laboratory for particle size analysis. The analysis of samples submitted by industry often leads to further advice on related process problems.

Prevention of air pollution

The process industry's measures for preventing air pollution are often based on emission measurements. Routine sampling of stack gas is carried out at the request of industry. In addition, CERG sampling staff are available for assisting industry in training their own sampling teams. When required, sampling equipment is manufactured for industry at cost. Thus a set of sampling probes and filters and several 'isokinetic slide rules' were recently supplied and detailed information given to several enquirers on the selection of sampling equipment.

Comprehensive scanning and indexing of the technical literature relating to all aspects of pollution control likely to be encountered in this country has provided an extensive 'library' of control measures and techniques. Industry and control authorities are invited to utilize this source of information, through which full use can be made

of air pollution control experience elsewhere. A comprehensive bibliography on stack sampling has been issued and is being updated annually.

Computer programming

In an environment with limited trained manpower certain repetitive tasks should be taken over by the computer. The development of the required computer programs has become an important function of the Group; these programs are made available to industry.

Program development was speeded up by the acquisition of a computer terminal giving direct access to the CSIR's central computer. Much attention was given to a unified approach for writing user-oriented computer programs and a number of guides on this subject have been issued.

Heat exchangers

The Group's service on computer-designed heat exchangers (particularly air-cooled units) was further extended to cover a wider range of process conditions.

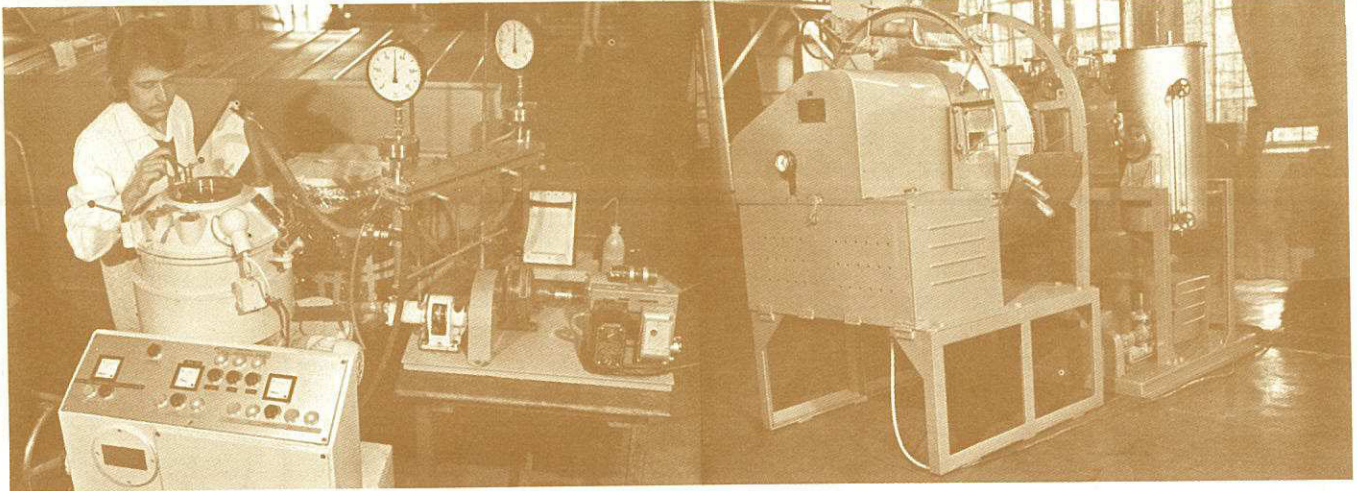
The most important development was a design program for single phase air-cooled heat exchangers and single vapour condensers including desuperheating and subcooling. This work was supported financially by the Heat Transfer and Fluid Flow Service of AERE at Harwell, England.

Programming was backed up by the further development of rapid calculation methods for pressure drop and mean heat transfer coefficient to allow for cross-flow and other flow arrangements. An experimental study of the true mean temperature difference in cross-flow fin-tube bundles was completed successfully.

Thickening of mineral slurries

Thickeners are used by the mining industry to concentrate dilute mineral slurries. This is a continuous process and direct control of underflow density in the thickeners proved possible on a specific ore because compaction by solids pressure in the thickener was negligible.

Re-examination of the 'mud' zones observed at several mines indicated that compaction is generally absent, contrary to common belief; the automatic control strategy can therefore be applied with various gold ores. Results of the work were presented at local symposia and an international particle technology conference.



A test rig for viscosity measurements on cooked maize grits (used in the brewing of Bantu beer) in a single channel of a plate heat exchanger.

A pilot scale rotary vacuum filter.

The strategy worked out for the control of the overflow of a thickener is that carry-over of fines is prevented by control of feed flow rate and/or addition of secondary flocculant.

Filtration of mineral slurries

A literature survey was prepared in which the problems of slurry filtration were identified and recommendations for further work were listed.

The differences between the gold and uranium filtration circuits were analysed to find out why soluble uranium is more difficult to recover than gold. A pilot rotary vacuum drum filter was operated in parallel with industrial filters in the uranium circuit at a gold mine. This work showed that pilot-scale filtration correlates well with full-scale filtration and also that certain changes are likely to move the filtration system closer to optimum conditions. A recommendation on the elimination of excess filter wash has been implemented on the plant and plant records confirm the expected improvement.

Flocculation of suspended particles

The experimental work on slurries is supported by basic laboratory investigations. To relate filtration to the primary slurry properties through the properties of the flocs formed by primary particles requires an understanding of the surface phenomena at the solid-liquid interface on these particles.

As a starting point the coagulation and flocculation of aqueous quartz suspensions at various pH and in the presence of small concentrations of polyvalent ions and neutral and cationic flocculants were investigated. For the first time all the major variables were measured on one system and considered together (with additional published facts) to explain the observations and to demonstrate conclusively some relations which had not been discussed previously.

Manganese dioxide for dry cells

Manganese ore is widely distributed in South Africa and a regular supply of manganese dioxide is being submitted for evaluation of dry cell activity. The 'active' form of manganese dioxide is suitable for the production of electricity in the small batteries (dry cells) widely used for

transistor radios, flash lights, etc. A report has been issued which discusses the background of the Pulse Galvanostatic Analyzer, an apparatus developed by the Group for evaluation of the suitability of manganese dioxide for use in dry cells. Methods for upgrading of manganese ore are currently investigated.

Bantu beer

The Group worked on beer brewing technology at the request of the CSIR's Bantu Beer Unit. A sampling device was developed for taking representative local samples in a slurry tank and two samplers were supplied for testing under practical conditions in industry.

Another investigation, concerned with process improvements, revealed that a plate heat exchanger is suitable for the cooling of Bantu beer 'cook'. Use of this type of cooler should lead to better heat economics.

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, *inter alia*, investigation of the purification of water prior to use, the treatment of water 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 personnel of 158 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, physico-chemical treatment processes and desalination. There is also a group which deals with technical enquiries.

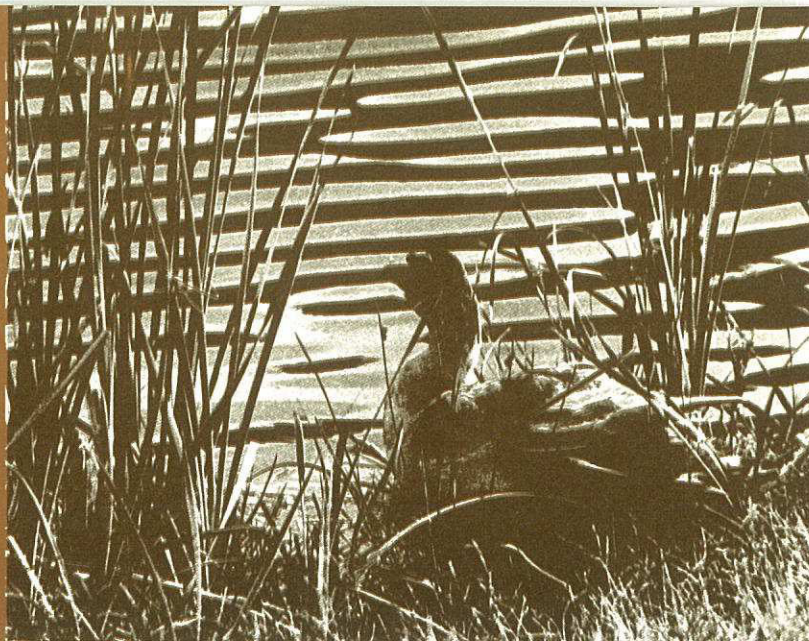
Cholnoky room in Albany Museum

Dr B J Cholnoky, former Chief Research Officer at the NIWR and a world-renowned expert on the diatoms (microscopic freshwater plants) of Africa, died early in 1972. He left an extensive collection of diatom slides and a card index which are of great value to research workers in this field. After discussions between the Institute and the Albany Museum, Grahamstown, it was decided to house this collection in a Cholnoky Room at the Museum.

The microscope, centrifuge, desk, chair, attache case and filing cabinets used by Dr Cholnoky are exhibited in this room. To these will be added samples containing diatoms, diatom slides, the original of Dr Cholnoky's index and scanning electromicrographs of diatoms. The room and collection, a tribute to Dr Cholnoky's life-work, will be available to research workers.

Training of water purification technologists

Water pollution remains a serious threat to modern civilization since pollutants from the air and soil find their way to the water environment, and the extent of water pollution increases steadily. Consequently, improved and more complicated water purification processes are required to ensure a good quality drinking water.



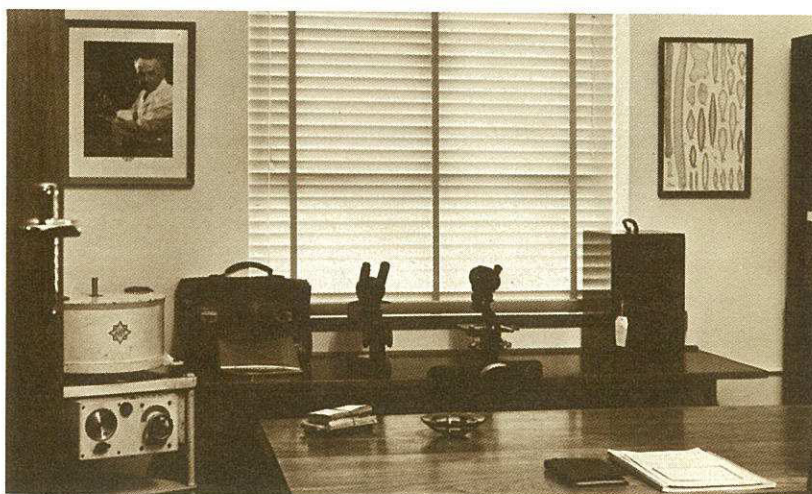
Scientific and technological development can cope with the requirements for sophisticated and efficient systems of water supply. The application of such systems often fails owing to inadequate training of operators and technicians. Current water purification techniques require experienced operators who are well-versed in the basic principles of the processes utilized. The NIWR, in collaboration with the Institute for Water Pollution Control, Department of Water Affairs, colleges for advanced technical education and other bodies concerned, has accordingly developed syllabuses for the training of maintenance workers, operators and technicians.

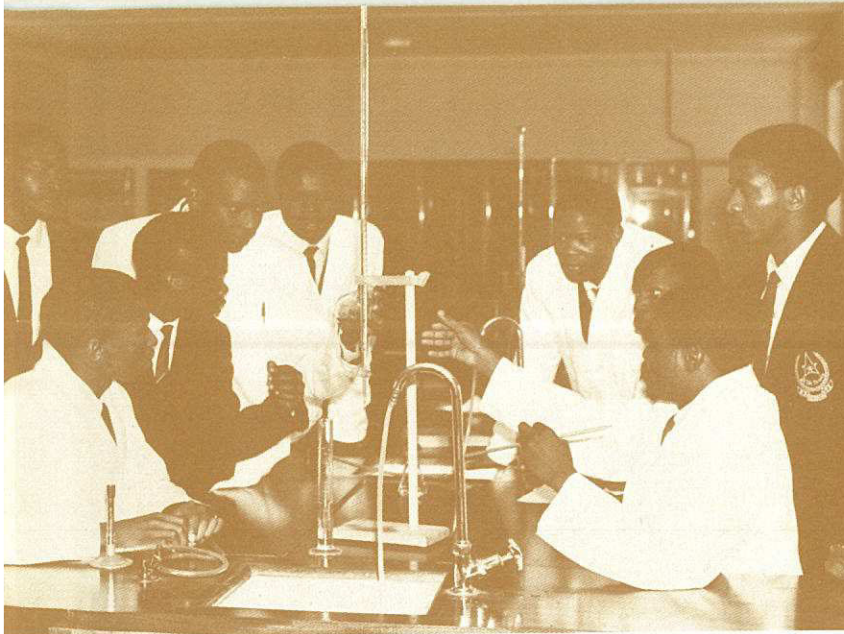
Various technical colleges and colleges for advanced technical education have offered some of these courses since January 1973. The courses are the first in the Republic which incorporate both water purification and effluent treatment and are especially applicable to South African conditions, where the same personnel often has to control both processes.

Desalination of brackish water

South Africa has considerable underground sources of brackish water which cannot be fully utilized. Some of these sources may also contain harmful salts such as fluorides and nitrates.

The B J Cholnoky room at the Albany Museum.





Student operators in the laboratory of the Mmadikoti Technical College, near Pietersburg, Transvaal.



A vapour compression evaporation unit with ion exchange pretreatment unit.

Investigations on the desalination of brackish water have been limited to particular areas where freshwater supplies are in short supply or non-existent, and consisted mainly of *ad hoc* evaluations of commercially available desalination apparatus for local conditions. The results of these investigations will accordingly have only limited application for the country as a whole.

An extensive programme has now been initiated to investigate thoroughly desalination techniques and their general application. It is anticipated that this work will provide data for the application of specific techniques under local conditions.

The NIWR has at its disposal a vapour compression evaporation unit, which can produce approximately 1 000 litres fresh water per hour. This unit, which is mounted on a trailer, will shortly be utilized to conduct field trials at Beaufort West.

Removal of plant nutrients

Conventional activated sludge plants remove nearly 98 per cent of all organic carbon present in raw or settled sewage, while nitrogenous compounds are almost completely oxidized to nitrates, and organic phosphates are converted to orthophosphates. The nitrates and phosphates remain in solution in the effluent and may enrich a receiving body of water, such as the Hartbeespoort Dam, to such an extent to cause growth of undesirable quantities of algae and other water plants.

It was found that, if the activated sludge process was modified by enlarging the aeration tank, nitrates were removed from the water without addition of any chemicals. Simultaneously a significant reduction of phosphate levels occurred through precipitation. Experiments showed that more than 90 per cent of the nitrates and between 90 and 95 per cent of phosphates can be removed. The mechanism of phosphate removal has not yet been fully investigated and the factors which influence its efficiency must still be determined.

The modified activated sludge process is registered in the major industrial countries of the world. It is anticipated that the Israeli Government will sign an agreement for the large-scale development of the process. The City Council of Johannesburg is already constructing a sewage treat-

ment plant based on the principle. The results of the practical application of this process will therefore be available in the near future.

Should the removal of 90 per cent of plant nutrients from effluents be made compulsory, and should this process be equally effective in practice as in the pilot plant, it is estimated that for a city of the size of Johannesburg an amount of approximately R2 000 000 per year could be saved in comparison with treatment processes requiring the addition of chemicals.

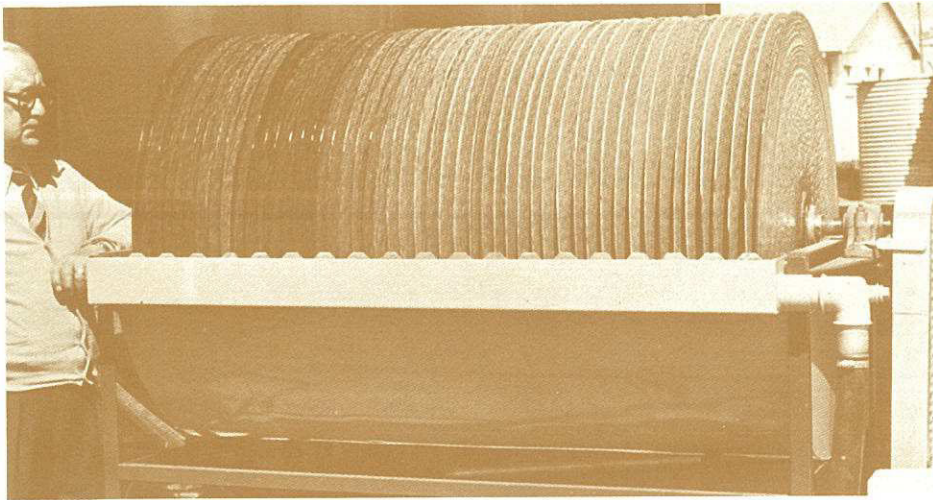
Quality of underground water in South West Africa

The Regional Laboratory of the NIWR in South West Africa has for a number of years conducted a systematic survey of the chemical quality of the underground water in South West Africa. Initially sporadic water samples from all over the area were analysed chemically. From these results the regions experiencing particular problems with water quality could be identified.

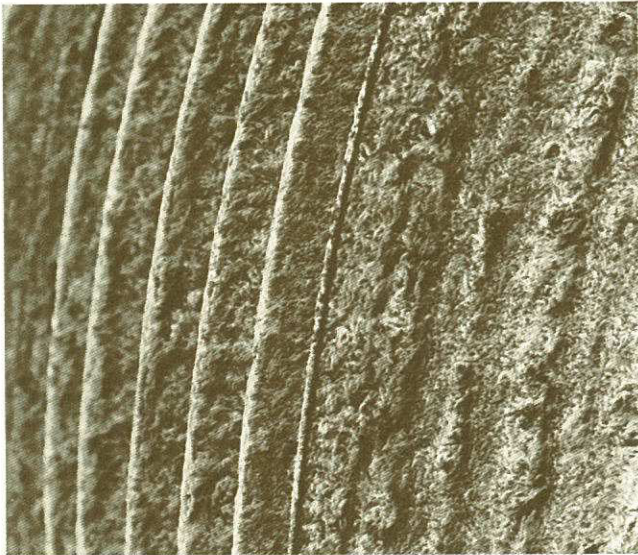
Since 1967, intensive surveys of specific areas have been made. These surveys entail the collection and chemical analysis of water samples, and the collection of information on rate of production and of water utilization for each borehole within a particular area. Such surveys have already been completed for the so-called Salt Block around Gochas and Koës, the Kalkrand basaltic area, the Warmbad area, the Aroab area between Keetmanshoop and Karasburg, and Namaland. The results of a similar survey, undertaken in the Otjiwarongo area, are at present being processed. A less intensive investigation of the Karibib area has also been completed.

Approximately 8 500 boreholes have already been investigated. The analyses are conducted at the NIWR Regional Laboratory and in a mobile laboratory, which is moved from area to area. The results of the analyses are processed with the aid of the CSIR computer. It is accordingly possible to prepare water quality maps as well as recommendations for specific uses. The results are already being used successfully by several interested bodies.

These results indicate clearly which water sources do not comply with the locally accepted standards for human consumption or stock watering or the general require-



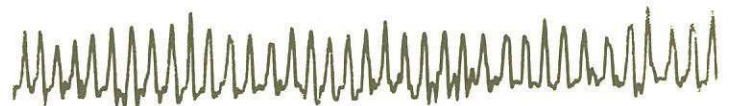
An experimental rotating disc unit for applying biological processes in effluent treatment.



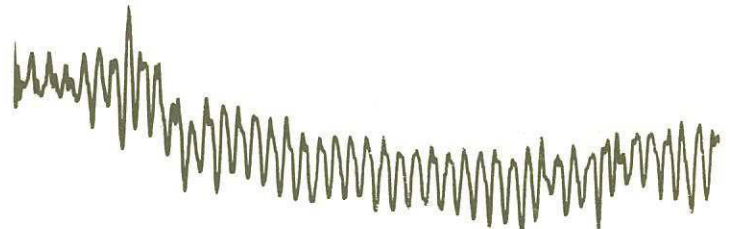
A close-up view of microbial growth on a disc in the rotating unit.

ments of irrigation. In some areas it was found that the water in up to 66 per cent of the boreholes was unfit for human consumption. In addition it was found that, although water from a large number of sources throughout the given area may not comply with standards for stock watering, in many cases such water is utilized for stock without any apparent harmful effects. Negotiations are at present being conducted with the Department of Agricultural Technical Services with a view to investigating the acquisition of more realistic quality standards.

1 minute



natural breathing rate



breathing rate after 4 hours



breathing rate 10 hours before death

A graphic illustration of changes in breathing rate in fish exposed to toxic substances.

FOOD RESEARCH

NATIONAL FOOD RESEARCH INSTITUTE

Director
J.P. DE WIT



The National Food Research Institute (NFRI) does research aimed at advancing the food industry and improving the nutritional status of the South African population.

The Institute consists of three research divisions: Food Technology, Food Chemistry and Biological Evaluation. It also administers and is closely associated with the Microbiology Research Group of the CSIR.

Typical fields of activity are food processing, cereal technology, food packaging and storage, flavour chemistry, food microbiology, food analysis and food chemistry. Biological studies of the utilization of nutrients in foods and diets are also undertaken.

Determination of aroma components

A method for measuring the permeability of aroma components through plastic material has been developed, which makes it possible to predict how much aroma will be lost through a plastic packaging material in a given time under prevailing temperature conditions. Similarly an indication of retention of original flavour during storage of packaged foodstuffs can be obtained. It is also possible to establish whether unwanted flavours will be able to permeate a specific packaging material.

Research into the characterization and identification of aroma components of marula and guavas was continued and research on the flavour components of Bantu beer was initiated.

Fatty acids in seeds of wild fruits

Research workers in the USA found a very sweet component in the fruit of the climber *Dioscoreophyllum cumminsii*. The fruits were obtained from Nigeria. In fruits obtained from plants in Mozambique and Rhodesia this sweet component could not be found. Another group of research workers established that the oil of the seeds of the Nigerian fruits contained an isomer of oleic acid with a double bond in position 5. Investigation of seed oil of the fruits obtained from Mozambique and Rhodesia revealed that the fatty acid composition was identical to that of the Nigerian fruits. This lends support to the classification of these plants in Mozambique and Rhodesia as identical to those occurring in Nigeria but leaves the absence of the sweet substance still unexplained.

The 'sandappel' (*Parinari capense*) and 'grysappel' (*P. curatellifolia*) belong to a family where it is known that the seed oils contain unusual conjugated fatty acids. It was established that the seed oil of both the 'sandappel'

and the 'grysappel' contain a high percentage of α -eleostearic acid. Oils containing a high percentage of this fatty acid are of importance to the paint industry because of their good drying qualities. An additional property which favours use in the paint industry is the low tocopherol content.

Marula processing

Although the study of South African veld food plants was initiated mainly for the purpose of determining their nutritional values, the possibility of commercial exploitation is also always borne in mind.

In the previous Annual Report the possible utilization of the mangetti and marula nuts was mentioned. In some rural areas the marula fruit is often used for the preparation of home-made jelly and fruit rolls and some Bantu groups use it to brew an alcoholic beverage.

The overseas market for natural fruit juices is expanding rapidly and is favourable for the introduction of a new product. The possibility of producing fruit juice from the marula was examined. Laboratory experiments have shown that a product with an attractive and characteristic flavour can be prepared and reasonably good yields are obtained. The next step will be to study the economic feasibility of harvesting fruit from the naturally occurring stands of marula trees for processing.

Small-scale food processing

Small-scale food processing equipment is very expensive due to the small numbers produced. The Institute has over the years acquired a wide range of small-scale equipment and thus created a valuable facility for assisting individual food processing industries in their product and process development projects.

A good example is a laboratory scale extrusion-cooker acquired by the Institute. Extrusion-cooking is finding ever-increasing application in the manufacture of ready-to-eat foods and of texturized food analogues. Experimental work on industrial equipment is very expensive and thus impractical, and the availability of the experimental-scale equipment has enabled the Institute to assist industries in assessing extrusion cooking as a process and in product development at a much lower cost than if each industry would have had to acquire experimental equipment for itself.

The facilities for experimental processing are being utilized by the food industry on a steadily increasing scale.

Food packaging

The purpose of packaging of food is not only to present the product to the consumer in a convenient form and quantity — in the case of perishable foods the packaging material also has a protective function.

Properties such as moisture and oxygen permeability are important in the choice of packaging materials for certain food products. The oxygen permeability of locally available types of plastic film were investigated. Storage tests with whole milk powder — an oxygen-sensitive product — served to illustrate the effect of difference in oxygen permeability on shelf life.

Concurrent tests on whole milk powder packaged in an inert gas mixture (nitrogen and hydrogen) together with a catalyst insert, showed that in this way retained oxygen as well as oxygen penetrating the package can be effectively removed and the keeping quality of the product improved.

Nutritional value of grain sorghum

At the request of the Maize Board feeding trials were conducted with rats to investigate complaints by certain foreign buyers about the so-called growth-repressing effects of some of the South African grain sorghum cultivars. From the results it appeared that certain cultivars are indeed of inferior nutritional value, particularly the so-called bird-resistant types.

The grains of those cultivars having a low digestibility have been shown also to have high tannin contents. The role of the tannins have not been studied but these compounds may combine with the protein to form relatively indigestible compounds, or interfere with protein digestion in some other way.

The digestibility of the protein in the grain is a good index of the suitability of the seeds for use in breeding programmes directed at improvement of available cultivars.

Diet and tissue calcification

Work was continued on the effect of the high-phosphorus, low-magnesium diet on the formation of calcium structures in the tissues of the baboon. Original observations were made regarding the involvement of globule leucocytes in the kidney calcification induced by this type of diet.

Iron intake and siderosis

Siderosis of the liver (the deposition in the liver of large quantities of iron storage compounds) occurs frequently among the Bantu. As siderosis is considered to be an undesirable condition, it is of interest to know which of the iron compounds that can be present in foods as contaminants are siderotic.

In an experiment with rats various iron compounds were investigated for their siderogenicity and on the basis of the results these compounds could be ranked (in descending order) as follows: ferrous chloride; powdered steel; powdered cast-iron; ferric chloride; organic ferric salts (lactate and citrate); ferric oxide.

Nutritive value of proteins

Investigations were made into the possibility of substituting in certain special cases the conventional rat technique for determination of protein digestibility with an *in vitro* technique.

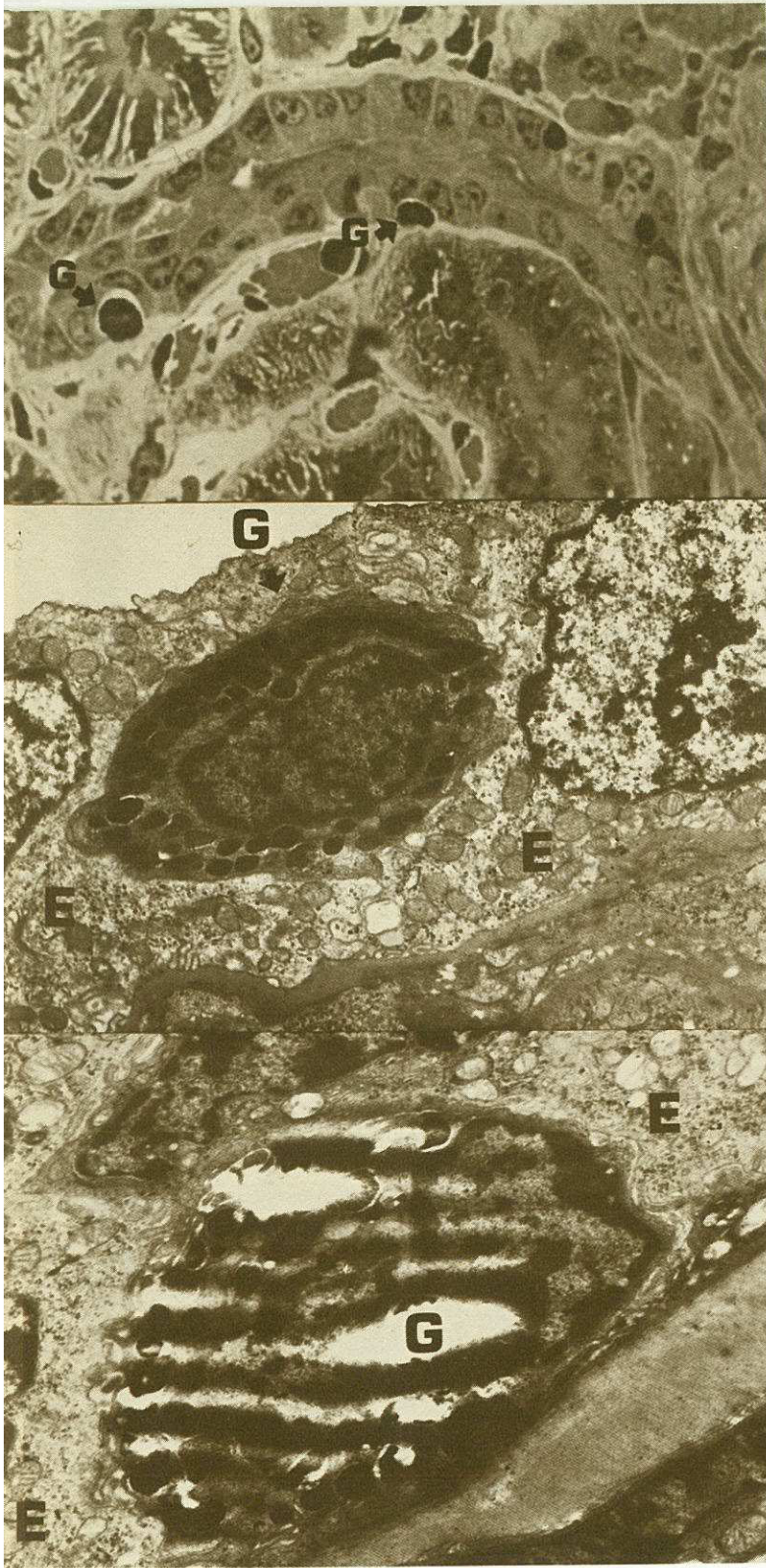
A method was developed for use in the classification of grain sorghum samples according to the digestibility of the protein component.

Contamination of biltong

The investigation of the contamination of commercial biltong by bacteria and moulds is being continued.

Where in the past attention was given to the presence of pathogenic or potentially pathogenic bacteria, recent investigations were concerned with a study of the 'normal bacterial flora' of biltong. This normal bacterial flora consists primarily of saprophytic or non-pathogenic bacteria that as a result of their resistance to high salt concentrations have the ability to develop during the salting and subsequent drying process. It has been established that this bacterial load on commercial biltong may sometimes be extremely high — even of the order of one hundred million organisms per gram of biltong. It also appears that this microflora plays no role in the development of flavour. Present investigations are concerned with classifying this normal microflora and with the sources of possible contamination by these salt-tolerant bacteria during processing of the meat.

Although visible mouldiness of biltong is not a general occurrence, moulds can nevertheless be shown to be present on this product. It has been established that some of these moulds, when grown on sterilized wet biltong, are able to form toxins that are regarded as harmful to man.



A series of photomicrographs showing the involvement of the globule leucocyte in the initiation of kidney calcification in the baboon. *Top to bottom*: View of normal globule leucocyte lodged between epithelial cells in renal collecting tube; high magnification (by electron microscope) of normal globule leucocyte; high magnification of globule leucocyte in advanced state of calcification. The calcification was induced through the feeding of a high-phosphorus, low-magnesium diet for about two months.

Production of citric acid

South Africa lags behind most other industrial countries in the development of its fermentation industry. The only products which are produced by local industries are alcoholic beverages, commercial yeast and industrial solvents.

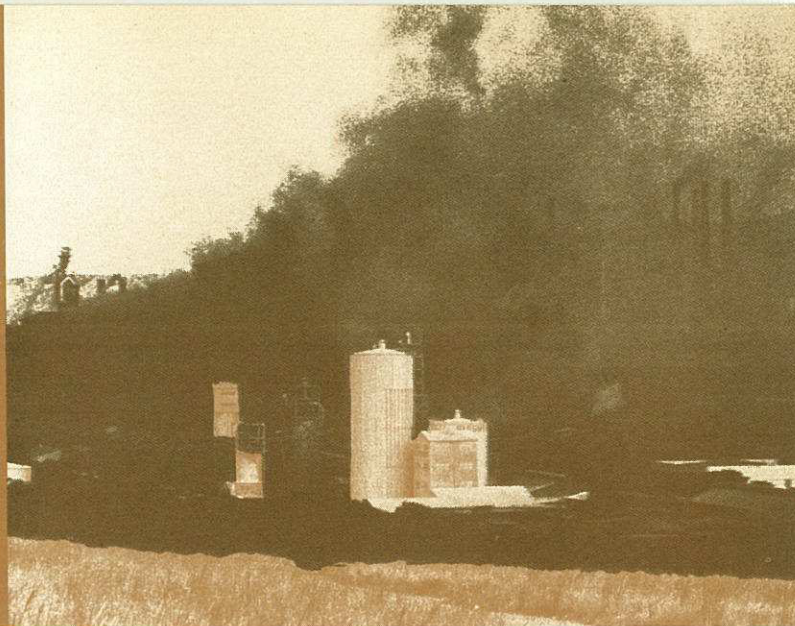
The microbial residues which are obtained from the industrial solvent fermentations are processed into an animal feed supplement. Antibiotics are produced on a limited scale under licence agreements with foreign companies which supply the necessary technical expertise. All the other microbial products which are required for medical, household and industrial uses have to be imported. For instance, 2 018 metric tons of citric acid were imported during 1972 at a cost of R1 052 416.

As the entire world supply of citric acid is at present produced by means of microbial fermentation, research has been initiated to investigate the production of citric acid by microbial fermentation employing locally available raw materials.

AIR POLLUTION RESEARCH

AIR POLLUTION RESEARCH GROUP

Head
DR E.C. HALLIDAY



Air pollution has always been a threat to health. Even vegetation, buildings and various materials are affected. In order to determine the extent of this problem in South Africa, to gain basic information of value to those concerned with the application of control measures and with combating it by effective control measures, the Air Pollution Research Group (APRG) was formed.

The Group studies the type and concentration of pollutants, the physics of dispersion processes and the effect of meteorological changes. It has an extensive collection of pamphlets which can be obtained on request by industries and organizations concerned with air pollution.

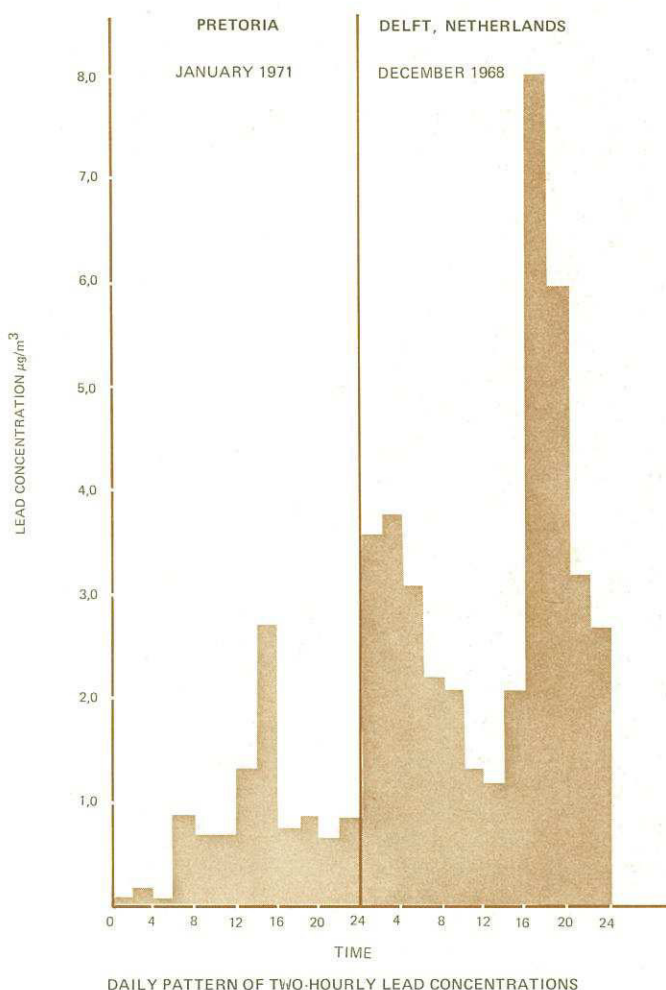
Growing public concern about the environment and the resultant formation of vigilance committees and societies have led to a considerable increase in the public relations activities of the Group. Many enquiries are received from societies, industries, schools, university departments and individuals and there is a great demand for lectures, informal talks and material for demonstrations for symposia and conferences. This work throws an increased load on the scientific staff and competes with time spent on research and investigations.

Pollutants from motor vehicles

Measurements of carbon monoxide, oxides of nitrogen, hydrocarbons and oxidants continued, using the mobile laboratory. To ensure the reliability of results a study was made of suitable techniques for calibrating the measuring instruments of the APRG. This investigation yielded valuable practical experience.

A number of modifications were introduced in the instruments in order to eliminate disturbing influences and to permit more selective measurements. A molecular sieve-type pre-column was used to eliminate completely inaccuracies due to water vapour in the carbon monoxide infra-red analyzer (spectrometer). The hydrocarbon analyzer was made selective in regard to the more reactive hydrocarbons by means of an activated carbon pre-column and the ozonometer was modified by the addition of trans-2-butane through a gas diffusion system in order to measure either total oxidants or only ozone.

Furthermore, the present measurement facilities have been expanded so that the lead emitted by motor vehicles can be determined by a simple, sensitive and accurate method which is first evaluated for typical samples of the



urban atmosphere in South Africa. A typical daily lead curve for Pretoria as well as the results obtained in Delft, Holland, are shown in the graph.

The mobile laboratory was equipped with a temperature control unit to prevent the heat build-up which occurred in earlier surveys and which resulted in problems of malfunctioning of instruments. Tests showed that the unit was perfectly adapted to its purpose and did not have any electronic interference on the measuring instruments.

Solid organic pollutants

In view of the persistent world interest in polycyclic hydrocarbons because of their carcinogenic properties, the APRG resumed its earlier investigations.

A particularly rapid and sensitive method has been developed for the identification of these hydrocarbons. It is based on the combination of one-dimensional thin-layer chromatography with two-dimensional thin-layer chromatography in order to obtain an effective separation of the polycyclic hydrocarbons. This is followed by identification of the separated components by means of Rf values and the visible ultraviolet spectra of their extracts as obtained from the thin-layer plates. The method was applied to samples taken in streets, industrial areas and residential areas of Pretoria, Durban and Johannesburg. In addition to the known group of polycyclic hydrocarbons which include benzpyrene, four other pyrene derivatives could be identified.

Smoke and sulphur dioxide measurement

The standard method of the APRG for measuring concentrations of smoke and sulphur dioxide in the atmosphere has been so effective in recent years that it is now in general use not only in South Africa but will shortly also be employed in Rhodesia.

The fact that the measurement techniques have now been standardized and comply with the required demands means that more time can be devoted to the evaluation of results. It was sought to present the results in a form that makes them easy to use by bodies applying air pollution control measures. A paper on this subject was given in October, 1973 at the Third International Conference on Clean Air in Düsseldorf, West Germany.

Solids in atmosphere

Initially a cyclone and filter paper to classify the material into two sizes were used to take samples of the solid particles in the atmosphere of Pretoria. Subsequently, a four-stage cascade impactor was used for grading the material into four sizes. The work is still in progress but provisional results indicate that the suspended material contains a greater percentage of large particles (i.e. larger than ten microns) than would be the case in American and British towns. This finding is in conformity with previous observations that the iron content of the samples is rather high and the fact that the ground in the vicinity of Pretoria consists of disintegrated ironstone.

Ventilation potential of atmosphere

Theories regarding the dispersion of pollutants in the atmosphere as a result of mechanical turbulence and thermal convection provide a basis for determining the extent to which the air above a specific region is able to disperse any pollutants emitted there. Investigations of this type involving the determination of temperature difference with change in altitude, the standard deviation of wind directions and the total wind pattern for a specific period were carried out during the year at various localities. Recommendations on possible siting of industries were made in a report to the Natal Department of Urban and Regional Planning on a similar investigation at Marburg.

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, interest 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

For some years the NIPR has been functioning on a 'programme' basis in that its research divisions have been grouped, according to their main emphasis, into 'programmes'.

Consistent with the aim of integrating programme and divisional objectives more closely, the Psychology of Learning Division has re-defined its objectives and brought its activities closer to those of the Organization and Personnel Development Programme into which it now falls. This also accords with the need to determine new training research priorities as a result of the emphasis which has recently been placed on improved industrial training facilities. Special emphasis will be placed on the educational, training and pre-induction needs of adult Bantu entering industry for the first time.



Vocational guidance counsellor with client.

Staff turnover remained relatively high and it was especially difficult to replace the accumulated losses in the more senior research ranks. In fact vacancies in the research ranks reached an all-time high point during December 1972. Several divisions were short-staffed for a considerable part of the time. Particularly noticeable also was the demand for higher levels of Bantu staff. Whereas in earlier years higher-level NIPR Bantu staff rarely received more attractive offers of employment from outside bodies, such offers have now become commonplace, especially from industrial and commercial enterprises who are acquainted with the work of the NIPR.

Manager and organization development

A project aimed at developing an integrated system of manager and organization development, and designed to meet the specific needs of a given organization, has been completed.

Based on the assumption that the development of human resources forms an integral part of the management process and that organizational effectiveness depends on the degree of human resource utilization manifested in the management system, the model was applied in three organizations.



Interviewing a machinist at a clothing factory during the study of Bantu women in industry.

Right: Subjects doing the information processing test used for research into the human factor in road safety.

Far right: Test for the selection of crane operators.

Nine groups of managers participated in Organization Development (OD) seminars. Results indicated significant improvement in team effectiveness and insight into human resource utilization. Where longer-term evaluation was possible, some authentic organizational improvement was also demonstrated.

Follow-up studies of vocational guidance

Follow-up studies were completed by the Personnel Selection and Vocational Guidance Divisions in both Johannesburg and Pretoria on the effectiveness of NIPR vocational guidance counselling.

In a follow-up study undertaken by the Pretoria division, a study was made of a group of 54 CSIR staff members who had received vocational guidance on an average of five years previously.

It is interesting to note that 82 per cent of the respondents followed the recommended course of study. Those who followed the study advice given were considerably more successful than those who did not. Where study success was expressed in terms of total number of years taken to complete a 3-year bachelor's degree, the average was 3,8 years for respondents who took the study advice given, as compared with 5,6 years for those who did not.

Productivity in men's and boys' clothing industry

A collaborative study with the National Productivity Institute of productivity in the men's and boys' clothing industry in South Africa was completed, and the NIPR's report on the utilization of manpower resources has been distributed throughout the clothing industry.

The report indicated that clothing manufacturers were to a large extent unaware of the value of scientific personnel management and administration; that recruitment and selection took place without much pre-planning; that little was done on systematically planned development and utilization of human resources; and that varying labour mobility patterns occurred in different areas (Western Cape, Transvaal and Natal) and in different worker groups (e.g. Coloured, Bantu and Indian).

Recommendations for improved practices were included in the report.

Information processing factors in driving

With the prospect of significantly increased sponsorship of road safety research by the National Road Safety Council, new projects to investigate this serious national problem are being formulated.

One of the areas of human failure which is now being recognized as among the most important for safe road usage is that of information processing and decision-making. While driving a motor vehicle, the human operator is required to process information about his own and other vehicles, as well as about the road and sundry other moving and stationary objects. He must decide on the relevance and importance of the data, determine a course of action and carry out that action. If the driver's capacity to absorb, interpret and respond to the information is exceeded, a critical situation occurs.

The Institute has now embarked on an intensive study of human information processing as related to real-world driving events. Several hypotheses are to be investigated. Some of the major ones are: poor information processing capacity is directly related to unsafe driving performance; information processing is adversely affected by the intemperate ingestion of alcohol; there is a marked decrease in information processing capacity under conditions of fatigue.

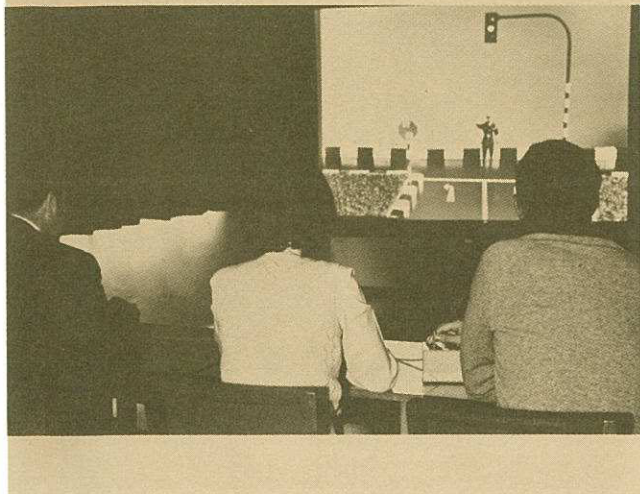
Special three-dimensional models depicting everyday traffic situations have been prepared and photographed. Three situations, in which some aspects are systematically altered, have been developed. These situations will be shown to subjects at increasing rates with a view to measuring individual differences in the rate and effectiveness of information processing. Special equipment has been acquired for the project, and pilot studies are to start soon.

Training

The NIPR is experiencing an ever-growing demand for training in various personnel practices. Since meeting this demand usually implies the application of methods and techniques developed by the Institute, these services are in fact part of research application activities.

Where they are warranted by the number of candidates, training courses are sometimes given as far afield as Natal and Swaziland.

To make the skills as widely available as possible, and to ease the training burden on staff-members, much effort has gone into the preparation of manuals for NIPR personnel practices such as test administration, job evaluation and first-line supervisory training.



South African National Programme for Environmental Sciences

The NIPR's participation in the International Biological Programme officially came to an end with the 5th General Assembly of IBP which was held at the University of Washington, Seattle, USA, and which was attended by the Director.

The Director has since been appointed Convener of the Human Adaptability Section of the South African National Programme for Environmental Sciences.

Minimal cerebral dysfunction

The concept of minimal cerebral dysfunction has been a subject of study by the Institute for three years. The most widely accepted definition of minimal cerebral dysfunction includes a variety of learning and perceptual disorders in the presence of an intelligence level that is at least average if not above average. Assessment of the relative contribution of trauma, producing irreversible brain damage, and of delayed cortical maturation, reflected in temporary deficiencies, has clear implications for the proper education and eventual optimum employment of children diagnosed as having minimal cerebral dysfunction (MCD).

A sample of children with MCD underwent electroencephalographic (EEG) examination on two occasions with an interval of eight months. Subsequently, a sample of normal children was tested twice, also with an interval of eight months.

The MCD group showed a higher incidence of EEG abnormality than the control group, confirming the results of previous investigations. In addition, and this does not appear to have been found before, the two groups showed differences in normal activity, suggesting a simpler, less organized type of electro-cortical function in the MCD group. Differences between the groups were reduced on the second occasion of testing, indicating a trend to EEG normalization in the MCD group.

The study suggests that maturation as well as specialized education may well play a part in the reduction of EEG abnormality, at least in some cases of MCD, but it seems that a somewhat similar process may operate in normal children who receive orthodox education.

Selection of crane operators

The present increasing development in heavy industry has produced a greater demand for the selection of operators for cranes and similar machines. Because the perceptual-

motor skills required in this kind of activity are not adequately sampled by conventional tests of muscular co-ordination an appropriate apparatus test has been constructed by the Institute.

It seemed more promising to devise a test situation simulating certain full-scale elements in miniature. As many of the tasks with cranes require team-work and leadership the possibility of investigating these aspects in the laboratory, albeit to a limited extent, was also a consideration in devising the apparatus.

Bantu women in industry

A fact-finding study was undertaken for the purpose of obtaining, if possible, answers to the ever-increasing number of enquiries received by the Institute in connection with the employment, industrial attitudes, job satisfaction, work motivation and productivity of Bantu women.

From literature studied it was evident that in Western industrial countries, women's patterns of industrial behaviour differed from those of men in so far as absence and turnover rates, job satisfaction and performance (manual dexterity) were concerned. It appeared, however, that no research had been carried out on either Bantu women or women of any other population group in the process of acculturation.

Preliminary findings, based on data collected during other NIPR investigations, indicated that Bantu women in industrial employment were developing patterns similar to those of industrially-employed women in Europe and America. To substantiate these findings, further investigations were planned.

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.

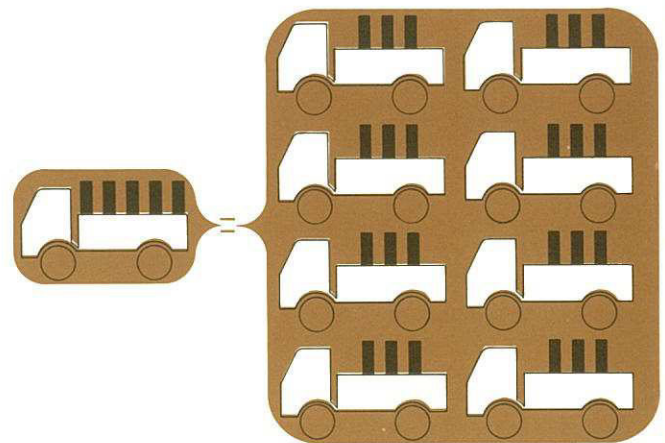
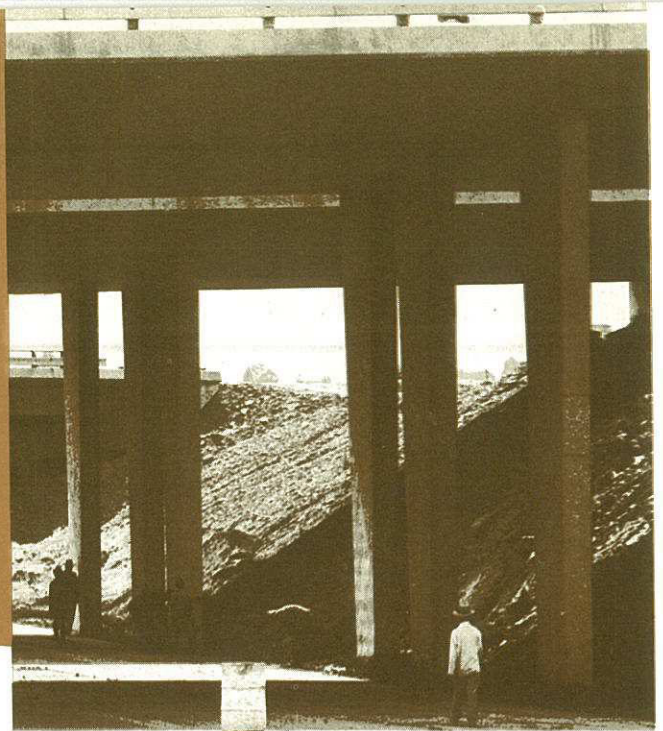
The NIRR works in close collaboration with national and provincial road authorities, the South West Africa Administration, the South African Railways, the National Road Safety Council and the road industry, which together provide most of the funds for road research. The Rhodesian Ministry of Roads and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

Limits on vehicle axle masses

Roads are designed to carry vehicles of a specific maximum axle mass for a specific period, usually 20 to 25 years. Overloading of vehicles beyond the legal limit drastically reduces the life of a road and limitations imposed on vehicle axle masses are designed to protect roads against damage through indiscriminate use.

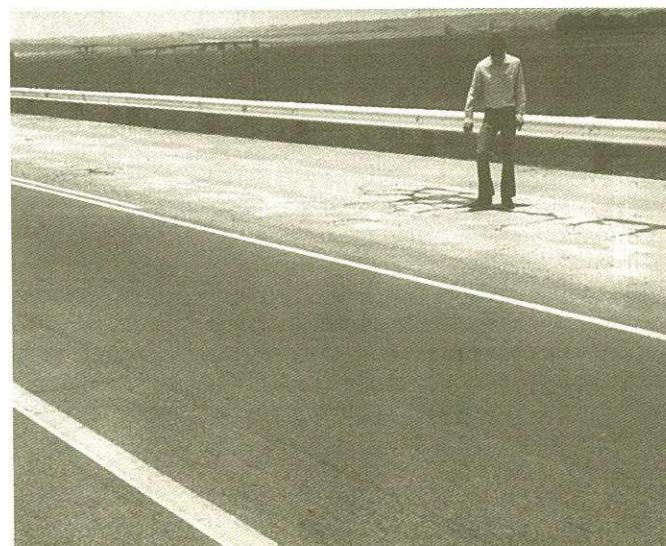
Unfortunately misunderstanding exists in South Africa on the effect which overloading can have on a road structure. For example, it is not generally realised that doubling an axle mass leads to a twentyfold increase in damage to the road. This relative effect can be illustrated in another way. If a road structure, designed to carry legally loaded vehicles for 20 years, were in fact to carry vehicles that were 50 per cent overloaded its life would be reduced to four years. If all the vehicles it carried were 100 per cent overloaded the road would have to be rebuilt after one year. It is even possible for one very heavily loaded vehicle to cause failure in a road pavement.

The Institute has played a leading role in the study of the technical background to the problem and in formulating regulations for practical application. A publication which was widely distributed amongst the authorities and the road transport industry explains in non-technical language the need for regulations in connection with axle masses. It also explains how it is possible to convey very



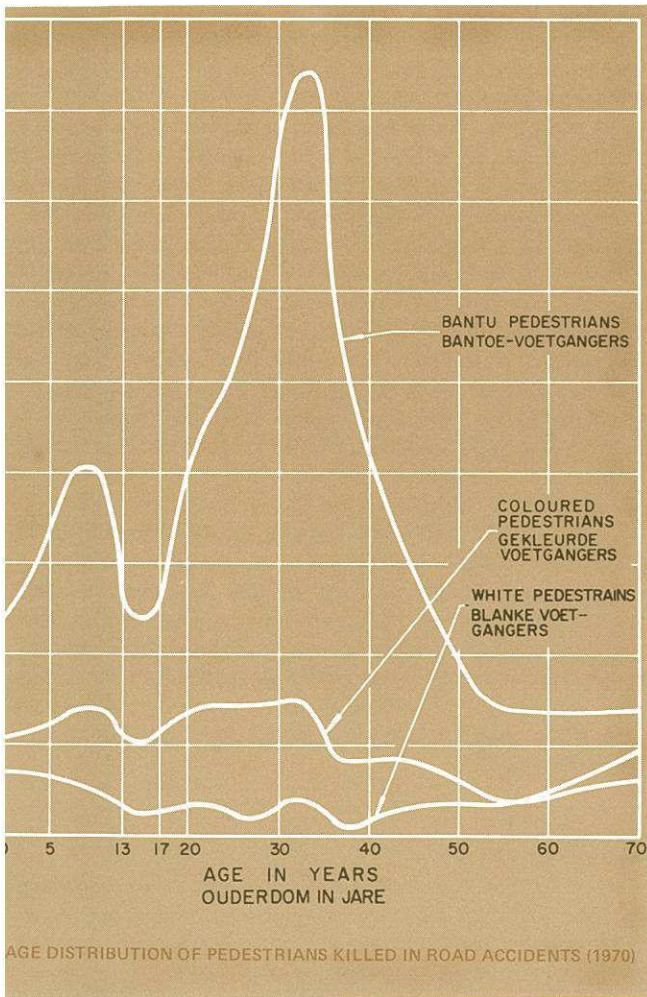
Graphic presentation of relative damage: One vehicle with an axle mass of five units causes just as much damage to a road as eight vehicles, each with an axle mass of three units.

Bottom: The effect of overloading. The far lane carries loaded coal trucks; its white appearance is due to fine material pumped from the subbase through extensive cracking. The near lane exhibits transverse and longitudinal shrinkage cracks which do not deteriorate further under normal traffic.





A hazardous crossing point for pedestrians.



is lowered by the action of traffic which polishes the aggregate and also causes the texture to become smooth. Hence road surfaces need to be maintained from time to time to restore adequate skid-resistance.

An experiment has been in progress on the N4 freeway between Pretoria and Bronkhorstspuit to investigate different methods of maintaining the skid-resistance of a freeway. A total of 18 different sections was laid, each 150 m long and covering the full width of a carriageway.

Skid-resistance measurements and observations of the durability of the different sections will be made from time to time to establish the most effective and economical method of maintaining skid-resistance under the traffic and environmental conditions of this site. A wide range of surface textures and of different stone types, having varying susceptibilities to polishing, were included in the experiment so that useful information will be obtained on the effect of various factors on skid-resistance.

Pedestrian accidents

A sine que non of any effective campaign to reduce the number of road accidents is the collection and analysis of reliable accident statistics. Without this information it is impossible to make a sound and unemotional assessment of the accident situation, of the relative toll taken by different types of accidents, of the priorities that should be accorded to different countermeasures and of the effectiveness of such measures.

A detailed study by the NIRR of pedestrian accident statistics reveals the high incidence of these accidents in South Africa and also their tendency to cluster at certain locations in the street network. The latter finding will greatly assist traffic authorities in planning remedial action.

The analysis has shown that the majority of casualties on our roads in urban areas result from accidents involving pedestrians. An alarming 47 per cent of all road accident fatalities in the Republic are pedestrians. Approximately 90 per cent of all pedestrian casualties are Non-Whites and 74 per cent of these are males. The majority of Non-Whites involved are between the ages of 17 and 50. This age distribution pattern differs appreciably from that for White pedestrian casualties which, as in overseas countries, have a high frequency in the younger

heavy loads without damage to the road, simply by distributing the load over a sufficient number of axles.

Maintaining skid-resistance of freeways

The skid-resistance of a dry road surface is generally sufficient to allow vehicles to travel with safety. When a surface is wet, skid-resistance decreases with increasing vehicle speed and this decrease is greater for smooth-textured than for rough-textured surfaces. Reasonably rough-textured surfacings should therefore be provided for roads that carry high-speed traffic. There is a limit to the roughness of texture, however, because it increases tyre wear and can cause excessive noise. Skid-resistance

and older age groups. These figures clearly indicate that measures for the improvement of pedestrian safety should principally be aimed at the adult, Non-White working man.

Cement-treated crushed-rock bases

Cement-treated crushed-rock bases (CTB) have been extensively used in the construction of major roads in South Africa and it is expected that they will continue to play an important role in roads built to carry heavy traffic loads.

However, on certain roads, mainly in the Transvaal, difficulties have been experienced with CTB because of initial shrinkage and thermally induced cracking which, on heavily overloaded roads, may develop into more extensive traffic-induced cracking. If this happens the performance of the pavement may be seriously impaired.

The NIRR thoroughly investigated the properties of the materials used in both the field and the laboratory and, jointly with the Portland Cement Institute, organized a symposium on the subject. The symposium attracted 120 delegates, representing all branches of the road industry in Southern Africa, as well as four leading specialists from the USA and the UK. The following points concerning the use of CTB have emerged from this research and from the symposium.

- Initial drying shrinkage and thermally induced cracking are unavoidable under certain climatic conditions but their effects on road performance can be minimized by effective control during construction, the use of appropriate mixtures and adequate thicknesses of base and surfacing.
- Though primary transverse cracking is unavoidable, secondary cracking caused by the combined effect of wheel-loading and temperature is a condition which can and should be designed against. In this connection the importance of adequate base thickness and sufficient sub-base support have become apparent.
- The critical effect of overloading on CTB is now realised and cannot be over-emphasized. Initial shrinkage cracks do not propagate further in structurally adequate pavements under normal loading but secondary, traffic-induced cracking, which allows the ingress of water to an unacceptable degree, will develop in pavements which are normally adequate but which are severely overloaded.

National Data Bank for Roads

During the year the techniques for data input and retrieval were improved considerably and the Bank is now geared to handle large quantities of data.

A simplified index has been prepared which enables clients to see at a glance exactly what information is available for any particular land pattern. This index will be up-dated annually. There has been some improvement in the quality of data submitted but the main barrier to the efficient storage of data, and hence efficient retrieval, is still the fact that much of the information received does not comply with the Bank's requirements. To improve the situation, soil engineering maps, commissioned by the road authorities, are now checked by the Data Bank and, when necessary, discussions are held with the consultants or mappers to obtain agreement on the method of presentation of data.

A pressing need is more rapid accumulation of data. One fruitful and readily available source of information is the test results in the old files of the road authorities. An investigation of the records of the Transvaal Roads Department showed that about two-thirds of old test results could immediately be processed and stored. Assuming the same re-use potential for the records of the other provinces, there exists an enormous reservoir of potentially useful information available to the Data Bank from this source.

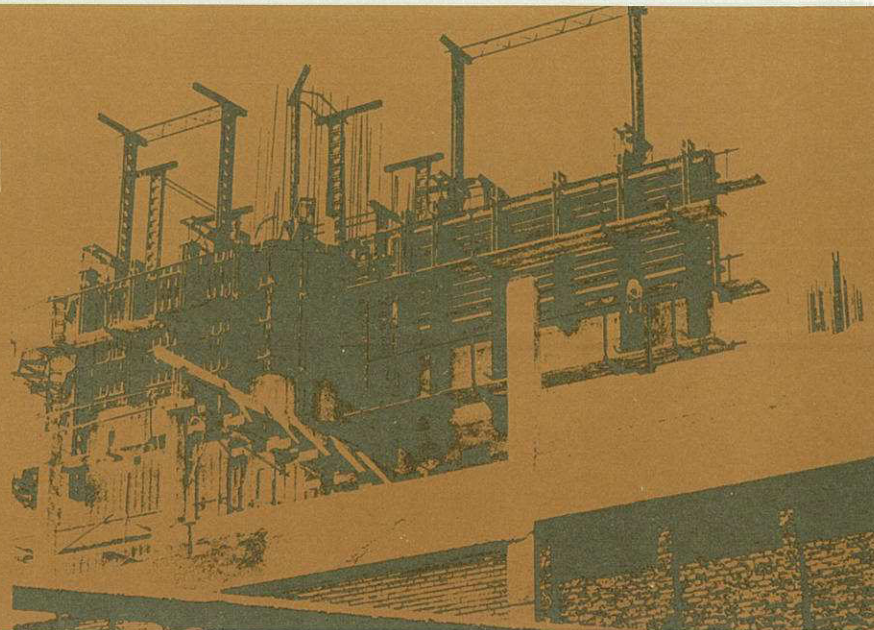
Information Centre

The services offered by the NIRR's Information Centre to the road industry, both in answering technical enquiries and in conducting literature searches, are becoming more widely known outside the Institute.

During the year there was a marked increase in the number of enquiries from the National Road Safety Council and this valuable exchange of information with the Council is expected to continue to increase in future.

The Institute's publications are an important channel for the dissemination of research findings to the road industry. During 1973 the Information Centre issued almost 10 000 copies of NIRR publications, including 2 200 copies of *VIA*. *VIA* is issued twice a year and contains summaries of all reports, publications and papers printed during the preceding six months. It is estimated that some 5 000 publications were ordered as a result of the publicity given them in *VIA* and this is considered a satisfactory response.

BUILDING RESEARCH



NATIONAL BUILDING RESEARCH INSTITUTE

Director
DR T.L. WEBB

The National Building Research Institute (NBRI) is essentially an applied research organization. It works very closely with the building and construction industry, associated professions and related organizations in the public and private sectors. The Institute seeks solutions to long-term problems of national interest concerned with organization and management in the industry, short-term transitional problems arising from rapid development in the industry and *ad hoc*, day-to-day problems which existing knowledge is used to solve.

The work of the NBRI covers a wide field because numerous scientific disciplines and technologies are involved in building and construction. Research is done on construction in general, on housing, schools and hospitals for the various population groups, on factory and office structures and industrialized building. This involves investigation into design and services, structural and foundation engineering, acoustics, lighting, development of building materials, management, organization and industrialization. International liaison takes place through formal and informal exchange of research reports, information and new techniques.

The cooperation of the entire building industry and associated professions, which is so essential to the planning of building research projects, is achieved largely through the agency of the Institute's Building Research Advisory Committee (BRAC). The Committee consists of about 40 leading local and overseas representatives of all sections of the industry and its influence extends far beyond the field of research.

During 1972-1973 about R2 200 million was invested in the South African building and construction industry. The Institute's budget for this period was about R2 million of which nearly 60 per cent was obtained from Parliamentary funds and the balance earned by the NBRI itself, mostly from Government sources.

Building and Construction Advisory Council

At the request of the Building and Construction Advisory Council (BCAC) an investigation was carried out to determine the housing requirements of the Coloured population in South Africa. The resultant report was referred by the BCAC to the Department of Community Development.

The BCAC supported a recommendation by the Building Research Advisory Committee that the Institute compile a basic guide or model on the preparation of maintenance and user manuals for design teams.

The increasing use of flammable fabrics (particularly synthetic materials) for finishes in buildings, is causing concern as serious fires and deaths have occurred in a number of countries following their use. The BCAC requested the Institute to submit a memorandum recommending what research should be done and possible national legislation to control the use of highly flammable materials.

Regional offices

Local sub-committees of the Building Research Advisory Committee guide the work of the NBRI regional offices in Durban, Cape Town and Windhoek and channel their work to solve problems of local importance. Thus the Institute remains in touch with developments and problems in areas far from Pretoria.

Committees, congresses and symposia

During the year under review NBRI staff served on or contributed to the work of 144 committees which promote the interests of the building and construction industry, both locally and internationally. Staff members delivered 30 lectures and participated in 27 local and overseas conferences, presenting 12 papers. Eleven radio talks were also prepared and broadcast.

The quarterly lectures held in Cape Town, Durban, Windhoek and also in Rhodesia have been extended to include regional seminars.

Films and exhibitions

A film on paint is nearly completed and has been accepted for screening at cinemas throughout the Republic. Work has also started on three other films dealing with mortar, fire research and the system of precooked frozen food.

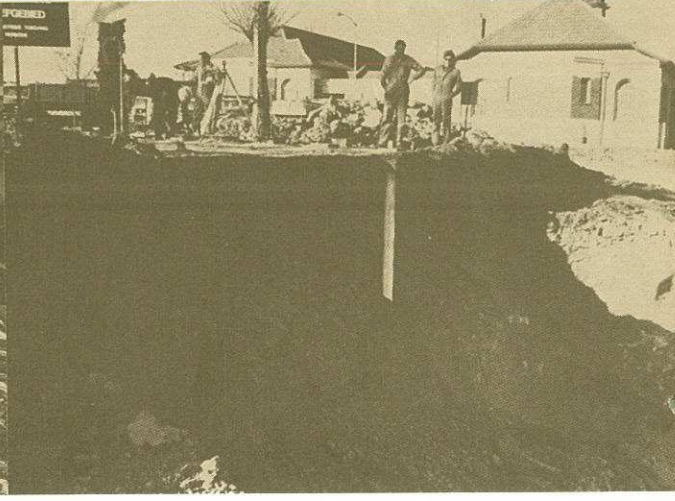
During the year the Institute participated in various exhibitions, including one in Australia and one in Swaziland.

School buildings

The Schools Building Committee requested that research be undertaken immediately on the planning of primary schools and the design of suitable furniture to meet the needs of differentiated education.

Reflective insulation

A major cause of serious thermal discomfort in factories is the heat radiated down from the unprotected roof. One of the simplest and cheapest ways of insulating



sheet-type roofs is by installing reflective insulation below the roof sheets. At this stage, however, it is not known how dust and staining of the reflective surfaces will affect the long-term insulation efficiency when this method of insulation is used in this country.

Experiments conducted in collaboration with Austrian authorities reveal that the emissivity of the underside increases with time because of dust and dirt which collect on the material. From observations it is estimated that even if the material were completely covered with dust, it would be reasonably effective because the overall thermal transmittance value would still be 35 per cent lower than that of an uninsulated galvanized steel roof.

Fissured clay

Various theories as well as laboratory and field tests have been developed to provide design data and methods of dealing with fissured clay in engineering applications such as stability of excavations, cuts for road and rail construction, and foundations.

A suitable opportunity was sought, however, for carrying out a comprehensive field experiment, which could even involve deliberate collapsing of the soil, to validate or, if necessary, modify the theories and methods. A local authority in the Transvaal has consented to such tests being done at the site of a new civic centre.

Clay bricks

The Institute has published a research report recommending steps in the design of brickwork and use of bricks to allow for long-term moisture expansion which causes serious problems in practice.

Extensive laboratory tests on the unrestricted moisture expansion of bricks produced at different brick-making works, as well as investigations to determine the structural implications of expanding brickwork, are continuing.

Popular booklets

In line with its policy to serve the general public, the Institute is publishing a series of popular booklets for the layman on building research subjects. Three booklets, dealing with fire, acoustics and foundations, have already been issued.

Information on building for the Bantu

Information on building is now made available in different Bantu languages. A magazine widely read by Bantu

At a building site forced collapse of the soil was brought about to obtain valuable data to validate or modify the theories and tests developed by the NBRI on the use of fissured clay.

Left: The subject of an interesting research project being carried out by the NBRI is the use of metal foil for thermal insulation in factory buildings and the effect of dust and dirt on its performance.

regularly publishes articles compiled by the Institute, and negotiations are in progress with Radio Bantu with a view to using this medium as well to disseminate such information.

Investment in the building industry

Information is being collected and analysed for an estimate of the total output of the building and construction industry, including repairs, renovations, maintenance and new capital, to gain a better understanding of the industry and its role in the South African economy.

This is the first time that the total output of the industry in South Africa is being estimated on a scientifically organized basis and it is expected to provide valuable data for planning purposes.

Child care centre

The planning of a 24-hour child care centre for children of mothers doing shiftwork was investigated. Two reports were submitted to the sponsors and the necessary documentation and sketch plans are now being prepared. The research information will later be made available to other interested organizations.

Deterioration of plastics

A large-scale, long-term investigation has been undertaken to determine the degree of deterioration of plastic building materials exposed to various climatic conditions. Samples of plastics as well as information on their composition and processing are being supplied by local manufacturers.

Agrément Board

The NBRI acts as the evaluating agency for the Agrément Board. Seven reports were completed for the Board by various divisions of the Institute and evaluations were requested on eight new projects.

Work done on behalf of the Board also includes research on, for example, the water-proofness of conventional and concrete roofs, the sound-insulating properties of classroom partition walls, techniques for



An example of the serious damage moisture expansion can cause in clay brickwork.

During the next few years research workers at the NBRI will investigate various aspects of high density housing.

measuring the smoke density when certain materials burn and the spacing of unconventionally built structures where flammable materials are used. A furnace was completed to determine the behaviour of carpets in fire for Agrément evaluations of soft finishes.

Computerized capital works programming

Various public institutions are collaborating with the NBRI in implementing the computerized capital works programming and control system being developed by the Institute. It is thought that the programs will have a wide field of application and could be used successfully by the public sector.

Housing requirements

In addition to the report on the housing needs of the Coloured population in South Africa (mentioned earlier in this report) the Institute prepared a memorandum on the assessment of the housing needs of Whites on a regional basis. Determination of housing needs in the Pretoria district will proceed as soon as essential statistical data from the 1970 census become available.

Sea sand

The need for good building sand in Durban has led to considerable research on the use of sea sand.

At present about 300 m³ of sea sand is being recovered daily near Durban. It is washed and then mixed with the correct amount of gravel chips to produce a good quality building sand.

Hospitals

The development work done by the NBRI on clean operating enclosures is now paying dividends. Various hospitals have installed units while several others are considering their use.

Space and cost norms have been determined for teaching and routine hospitals.

Work on the precooked frozen food project is proceeding at an increasing rate. The pilot kitchen at the H.F.

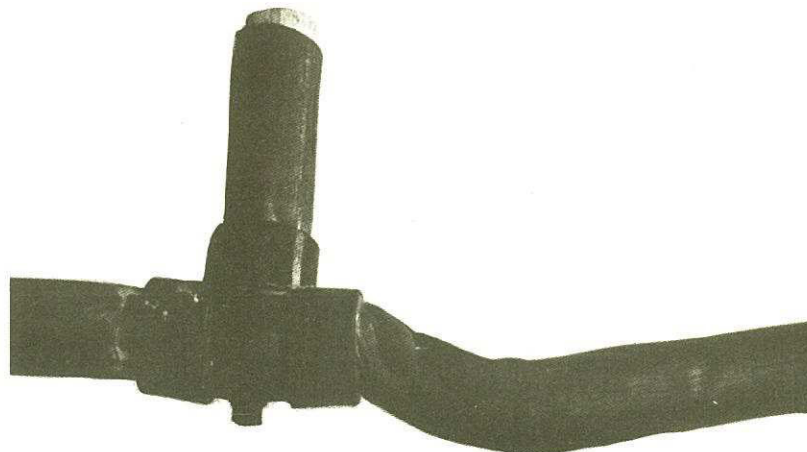
Verwoerd Hospital is being expanded and other institutions, such as universities, have consulted the NBRI on the establishment of similar facilities.

International co-operation

The NBRI is a member of 24 international organizations concerned with building research and takes part in the activities of a number of working groups and study committees. The Institute's Director is a member of the Board of the international policy-making body for building research, Conseil International du Bâtiment, and is also South Africa's representative on the Permanent Committee of RILEM.

The Director visited Argentina and Israel at the invitation of their governments for discussions on housing. He also visited Iran where he was consulted on the establishment of a building research centre in that country.

Damage to a plastic water pipe. The advantages and disadvantages of using plastic in the building industry are the subject of extensive research.





TIMBER RESEARCH

TIMBER RESEARCH UNIT

Head
DR D.L. BOSMAN

The Timber Research Unit (TRU) was established in 1960 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 oriented organization the Unit offers a wide variety of specialized research services to both producers and consumers of forest products. Timber 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, systems development, techno-economics and information and special 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

Our Green Heritage

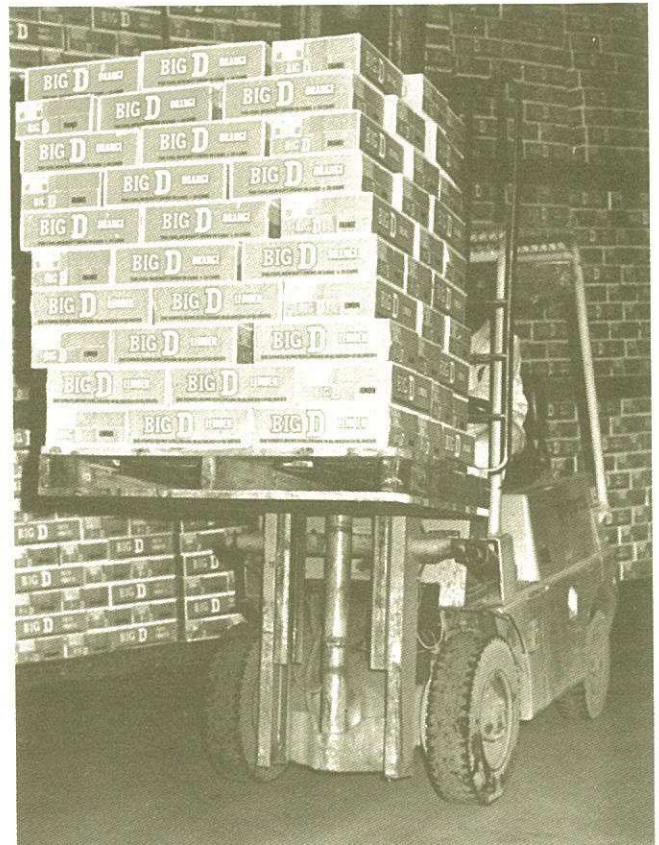
The Timber Research Unit was involved in the planning and many of the activities of the national campaign to promote forestry and timber. This included the production of a special brochure on the Unit's research work entitled *Serving the Timber Industry*.

The TRU stand in the timber pavilion at the National Trade Fair held at Milner Park, Johannesburg, attracted many visitors.

Timber technology

A timber technology course, the first of its kind in South Africa, was arranged by the TRU to cater for the needs and interests of technicians, foremen and middle management personnel at sawmills and wood processing plants. Similar courses, tailored to the specific needs of the various sectors of the timber industry, are being planned for the future.

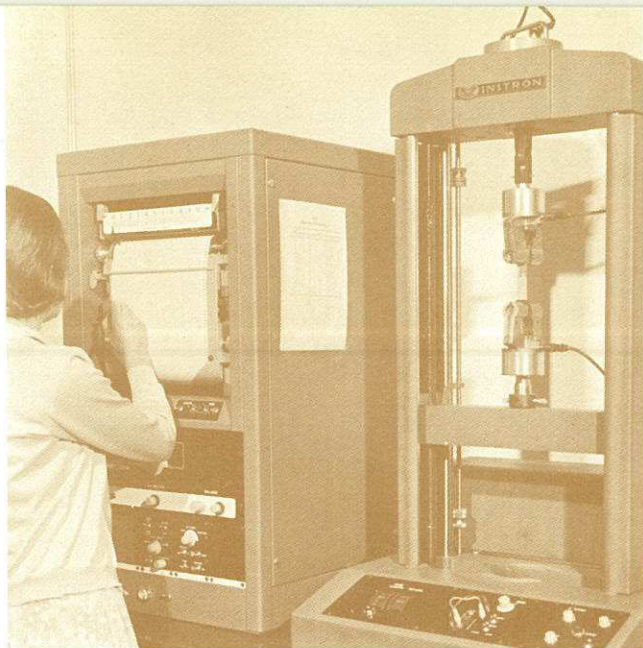
The possibility is being investigated of establishing a diploma course in timber technology at colleges of advanced technical education.



The use of pallets reduces handling costs and time and offers an outlet for short-length timber.

Bottom: Some of the many documents published by the TRU for the timber industry.





Universal testing equipment being used to test the rheological properties of paper.

Techno-economics studies

An analysis of timber supply and demand up to the year 2000, which was first made in 1968, has been revised. A detailed study of the supply of timber appears to confirm the earlier projections, and the indications are that shortages of certain timbers could start to occur as early as in 1980.

In view of these predictions attention has been given to the economics of supplementary fibres such as bagasse and waste paper which are used as a raw material for the pulp and paper industry. The collection and utilization of waste paper is being studied in detail.

A trend analysis of the short-term supply and demand of sawn timber is undertaken on a continuous basis. The predicted short-term oversupply in the latter part of 1972 was confirmed and the latest indications are that the short-term demand for sawn timber is rapidly increasing.

Timber drying

The efficiency of seasoning operations at several sawmills was determined by a method developed by the Timber Research Unit. Investigations of compartment as well as progressive kilns revealed considerable differences in efficiency and indicated the causes where efficiency was poor. Recommendations from earlier laboratory work to reduce warp of seasoned timber by the weighting of stacks and by drying at a high temperature were successfully applied.

Veneer lamination

Structural timber manufactured by peeling logs into veneer and laminating it compares favourably with sawn timber regarding yield and strength. These factors would off-set the higher manufacturing cost of 'veneerlam'.

Durability of adhesives

It was found that glued joints made with urea formaldehyde adhesives lost 15 per cent of their original strength when aged for five years in the roof spaces of buildings. It appears that these adhesives are unsuitable for timber products intended for roof structures.

Durability of board products

Short-term tests developed to assess the durability of board products in severe environments (for instance with outdoor exposure) were found to provide a reliable indication of the behaviour of particle boards in actual use.

Delamination in glulam

The influence of delamination on the strength of glulam (glue laminated timber) was studied to provide information for assessing the effect of this phenomenon in practice. This work showed that delamination is not always critical and that much depends on the degree of delamination and on the quality of the gluelines that remain intact.

Stress grading

Re-processing by computer of all data on stiffness/strength ratio collected so far from a nationwide sample has not only saved time but also made possible considerable increases in the design values for some strength properties. These increases in design values have made machine stress grading more acceptable, as adequate roof trusses can be constructed using even the lowest machine grade.

Many manufacturers are using the grading machine developed by the TRU to stress-grade the timber for their prefabricated trusses. Overseas interest in the machine has been encouraging and machines have been sold in the UK and Australia.

Stock glulam

Strength studies of stock laminated timber have led to the design of a reliable mathematical model which can be used to predict the strength of laminated beams made from any combination of mechanical stress grades of timber. This has aroused considerable interest in the mechanical stress grading of the outer laminations which enables stock glulam of a specified strength to be made using a lower proportion of graded material than is necessary with visual grading.

A plant to produce laminated timber has been installed at the Timber Research Unit and this plant has already produced a large number of beams for research purposes. This work is part of a long-term research project for the stock glulam industry, and information thus obtained is being incorporated in the relevant SABS specification.

Roof trusses

Data obtained from a series of tests made on trusses with calibrated members have helped to provide the information required to refine design parameters for semi-rigid joints. The use of these data with a computer design

program developed by the Unit has proved a very useful design aid in the nail plate truss industry.

The TRU has continued work on the properties of and design data for the various proprietary truss connector plates used in industry.

Structural timber

The Timber Engineering Division has continued to undertake site investigations and advise on many timber engineering projects. A questionnaire on structural timber from South African pine, sent to some 2 000 architects, has yielded useful results.

A two-day symposium — the fourth in a series on the utilization of sawn timber to be presented by the TRU — was attended by delegates from Rhodesia, Malawi, Swaziland, Brazil and from many parts of the Republic. The fifteen papers presented generated much interest and comment.

Sugar-cane bagasse

A study to determine the influence of certain variables on the quality of bagasse pulp for papermaking is in progress, while a preliminary study of the efficiency of various methods of storing bagasse in bulk prior to pulping is nearing completion.

An investigation on the suitability of sugar-cane bagasse for the manufacture of dissolving pulp has progressed to the stage where optimum conditions for removal of hemicellulose have been established.

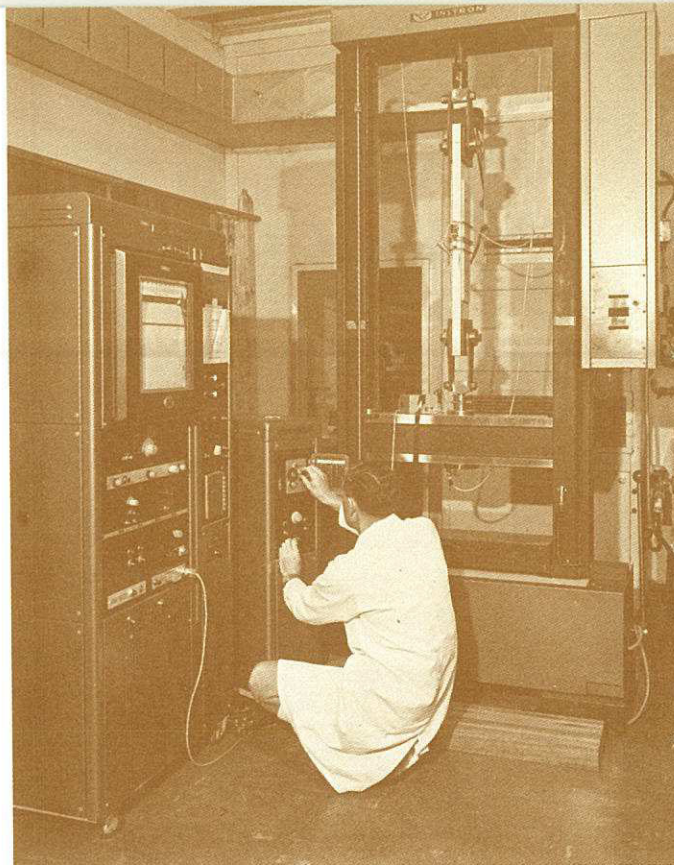
A preliminary techno-economic survey indicated that theoretically enough bagasse to double the present pulping capacity can be made available in South Africa.

Aging and preservation of paper

A study of the influence of fibre type and consumption on paper permanence has been completed. It was found that rag pulp is chemically no more stable than wood pulp.

Physical and chemical requirements of pulpwood

The Timber Research Unit is conducting research aimed at establishing criteria for assessing the quality of South African grown pulpwood. These criteria will be applied by the Department of Forestry in their tree breeding programmes for both pine and eucalyptus species.



Determining the strength and stiffness of a nailed plywood gusset joint in tension.

TEXTILE
RESEARCH

SOUTH AFRICAN WOOL AND TEXTILE RESEARCH INSTITUTE

Director
DR D.P. VELDSMAN

The South African Wool and Textile Research Institute (SAWTRI) in Port Elizabeth is committed to research on all textile fibres. Since its inception as a national institute of the CSIR in April 1971, the Institute has made steady progress towards carrying out its extended terms of reference. Previously research was done into the processing of wool and mohair but large-scale research into cotton processing will be undertaken soon. The use of man-made fibres in blends containing natural animal fibres or cotton as a major component is already being studied in depth with a view to imparting certain qualities to textile fibres to meet the requirements and dictates of a consumer public which has become very selective in its choice of fabrics especially as regards articles with easy-care qualities. This new direction has in no way distracted from the importance of SAWTRI's traditional work on the natural animal fibres. On the contrary, efforts to improve the behaviour of these fibres during processing have continued unabated and wool and mohair research still occupies an important position in SAWTRI's research programme.

Objective measurement of wool clip

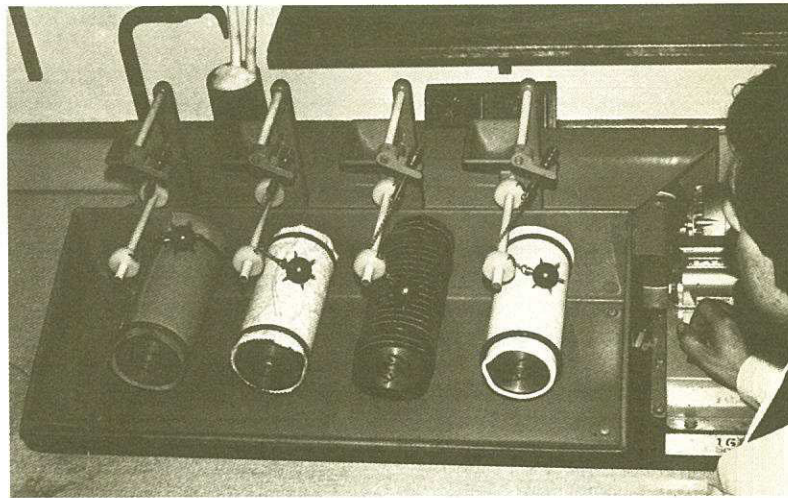
The new marketing system of the South African Wool Board has necessitated the application of objective measurement to the South African wool clip. In accordance with this procedure the clean yield and diameter of wool lots are no longer assessed subjectively but by means of representative core samples in a laboratory.

To ensure that representative samples from different lots are obtained by core testing it is of paramount importance to determine the within-bale and between-bale variation in respect of clean yield and diameter. The greater this variation, the greater must be the number of core samples per bale taken. The South African Wool and Textile Research Institute has investigated this aspect. Representative samples of the entire clip have not yet been taken but it has already become clear from the values obtained that these differ significantly from those published some time ago for the South African wool clip by the American Society for Testing and Materials.

From these values a statistical calculation can be made of the minimum number of core samples per bale and per lot that are required to achieve the desired accuracy for clean yield and for diameter.

Unconventional scouring

Some time ago the Institute succeeded in efficiently scouring grease wool in a mixture of sunflower oil, water and detergent in only two bowls of a commercial scouring installation. Normally these installations have four to five



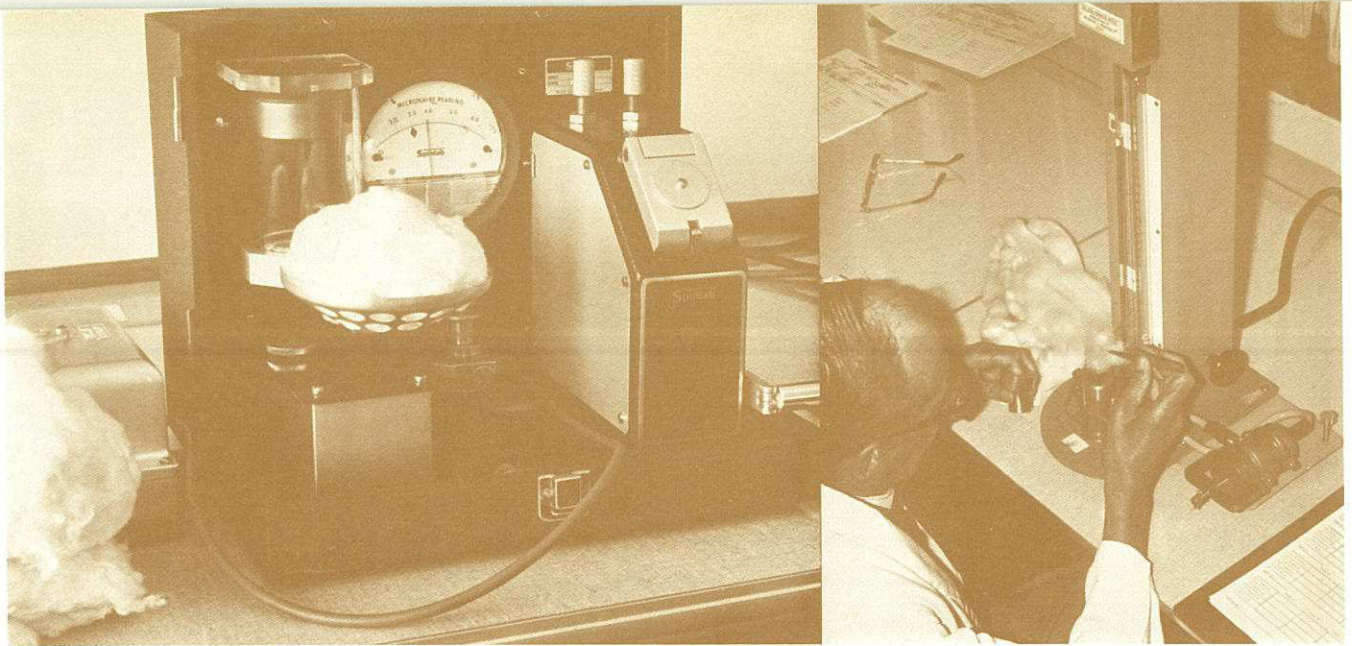
A mace snag tester which is used to determine the tendency of fabrics to snag, especially those made from filament bulk yarns.

bowls. Unfortunately this procedure presented problems in the separation of the wool grease removed and of the sunflower oil and consequently had to be abandoned in favour of a recently discovered method involving the scouring of grease wool in a mixture of wool grease, water and detergent (the wool grease forming 5 to 20 per cent of the scouring solution). It was found that this technique too could be applied with the use of only two or three bowls.

Important advantages of this unconventional scouring procedure are a saving of 50 per cent in water consumption, a saving in the floor space required for the machines as only two or three bowls are necessary, more uniform control of the residual grease on the scoured wool and greatly increased efficiency of wool grease recovery in the disc separator.

Grease recovery

In the previous annual report reference was made to a technique developed at SAWTRI by which one per cent by volume of an organic solvent such as petroleum spirit may be added to scouring effluent from wool washeries before pumping through a disc separator which removes all the



The Spinlab apparatus used to determine the micronaire values of cotton.

With the aid of this airflow meter the average fibre diameter of a wool sample can be accurately determined.

wool grease from the effluent. This degreased effluent can then be re-used for scouring in the first bowl of the scouring machine.

The next problem that had to be solved was to separate the recovered wool grease from the solvent. After testing several techniques it was found that with the aid of a rising-and-falling film evaporator a very efficient recovery process could be developed to separate these two components.

A commercial installation for one of South Africa's largest wool washeries is now being constructed.

Processing of seedy mohair

The Mohair Board is perturbed by the fact that the current mohair clip is severely contaminated with seed (as a result of the good rains) and SAWTRI has been urgently requested to establish the most economical and effective methods of removing seed from mohair.

Two methods were experimentally applied, viz first to carbonize the mohair and then either card and comb it and, alternatively, merely to scour the mohair and card and comb without carbonizing beforehand. The results have clearly shown that as much as 15 per cent of the seed can be effectively removed from the mohair and a seed-free top obtained if a French comb is used in the process. It has also been found that a considerable amount of seed can be removed in an early stage by preprocessing the seedy mohair in an opener.

Continuous shrinkproofing of wool

One of the most effective methods of shrinkproofing wool top is to make use of resins after pretreating the top with about one per cent active chlorine (on the mass of the wool). The chlorine ensures that the critical surface tension of the wool is increased to such an extent that the resin can be evenly spread over the surface of the wool fibres.

Thus far a major problem has been to ensure that this quick treatment with chlorine proceeds evenly. If the treatment is uneven the resin uptake is also uneven, resulting in localised patches of inadequately treated wool fibres in the fabric. Serious problems are also encountered during eventual dyeing of wool thus treated because of the uneven uptake of dye.

The Institute has now developed a technique by which this prechlorination of wool top can be achieved on a continuous basis and with even application. After the pretreatment an aminoplast resin can be padded onto the wool which can then be dried. The resultant yarn and the woven or knitted end-commodity is completely machine washable.

Solvent dyeing

For the last two years SAWTRI has been concentrating on the development of dyeing techniques for wool, cotton, polyester and polyacrylics in a drycleaning agent, and considerable progress has already been made with the use of perchloroethylene.

Although no techno-economic study has yet been conducted to determine whether this new technique will be more economical than conventional techniques using water, it will obviously save water and help to combat pollution.

As the processes involved are dry-to-dry, the new techniques will also expedite dyeing in the factory.

Liquid ammonia mercerization of cotton

Mercerization is an important aspect of the finishing of cotton and cotton-blend fabrics. Unfortunately, conventional mercerizing processes demand a high capital outlay because concentrated caustic soda is used.

The discovery overseas of a new mercerization technique using liquid ammonia has revolutionized this process. Not only is the penetration of the fibres by liquid ammonia more efficient than that of caustic soda, but the whole process is simpler and faster.

Many technical problems remain to be solved, however, and SAWTRI has built a small-scale installation for experimental mercerization of yarn and woven fabric. A fundamental study is also being made of the reaction to mercerization of different locally produced cotton cultivars.

Techno-economic survey of the textile industry

Senior staff members of the Institute have co-operated with the Techno-Economics Division of the CSIR in a survey aimed at identifying the most important technological problems of the South African textile industry.

Apart from identifying the technological problems which beset the textile industry, this survey has clearly shown up the lack of textile training in the Republic of South Africa — a problem which will now be tackled on a national basis under the guidance of the National Productivity Institute.

Productivity in the textile industry

In collaboration with the National Productivity Institute, SAWTRI completed two important productivity studies in the weaving and spinning industries. For the purpose of these studies the industries concerned were subdivided into the cotton, worsted and woollen sectors.

In the weaving industry productivity was assessed in terms of the ratio between labour utilization and fabric production as measured by the number of weft insertions or the length of weft inserted. To compare these values, obtained from individual factories, certain adjustments had to be made to the width of various looms and machine speeds. Thus a comparable index, termed the Overall Mill Productivity Index (OMPI), was arrived at.

For the three sectors mentioned, the National Productivity Institute was able to set realistic and achievable targets in terms of the OMPI indices. The cotton industry was found to be highly efficient and the productivity improvement potential was of the order of only 15 per cent. In the worsted sector, however, it was of the order of 38 per cent. The woollen industry on the other hand was found to be far behind with a productivity improvement potential as high as 480 per cent.

The same three sectors were studied in the spinning industry and weighted averages for count of yarn produced were determined for each factory participating in the survey. Productivity indices were subsequently calculated in terms of the number of operative hours required to produce a unit amount of product (OHP). In terms of these OHP results South Africa's productivity in the spinning sector was found to compare unfavourably with those of other countries.



Wool samples being washed in the New Zealand six-bowl scourer to determine clean yield. This is standard procedure in the objective evaluation of the South African wool clip.

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.

These functions are discharged by four groups, namely Scientific and Technical Information, Publishing and Publicity, Industrial Research and Development, and University and International Relations.

Library services

The development of specialized information services (mentioned elsewhere in this report) has important implications for the CSIR's central library, especially since it also functions as an important national centre for scientific and technical literature. To meet the demands for copying and inter-library services in support of the information services, the facilities of the library, especially the periodicals collection, are being considerably expanded.

Source guides

The second edition of *Periodicals in South African Libraries* has been completed, and preparations for the third edition have begun. In view of the sharp rise in printing costs the third edition will be issued only in microfiche and not in printed form. The information is recorded on microfiche directly from the computer tapes by means of the 'COM' technique. This system not only results in economies but makes it possible to publish revised editions more frequently.

Information for industry

The literature current-awareness service for industry made good progress during the past year and some 250 firms are now using it. The success of the service depends largely on the effective dissemination of information within these firms and one-day courses on principles of communication for the contact persons in the various firms are being offered in Pretoria, Cape Town and Durban. The number of liaison visits to firms was almost double that of the previous year and the number of technical enquiries dealt with increased fourfold.

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SHEET MATERIAL SUITABLE FOR FOOTWEAR UPPERS/A CLASSIFICATION OF COATED MATERIALS, FLEXIBLE LAMINAE AND OTHER.....	72 00005
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SHEEP MATERIALS, WATER ABSORPTION AND WATER TRANSMISSION PART 11: COMBINATION OF UPPER AND LINING MATERIALS/COMFORT FACTORS OF.....	72 00005
SHORELINES IN THE SOUTHERN AND SOUTH-EASTERN CAPE PROVINCE (PART 2)/PLASTICENE.....	72 00006
SHRINKPROOFER WOOL ON WOOL/POLYESTER BLEND FABRICS/STUDIES OF SOME WOOL/POLYESTER WOVEN FABRICS. PART 11.....	73 00000
SILICON DIOXIDE THIN FILM CAPACITORS/PRODUCTION OF INTEGRATED CIRCUITS CONTAINING SELFHEALING RADIO FREQUENCY SPUTTERED.....	73 00000
SILTING AND BEACH EROSION/STUDY OF DURBAN HARBOUR.....	70 00008
SINGLE STACK DRAINAGE FOR BUILDINGS.....	72 00006
SKIN RESPONSE AND MALNUTRITION/THE GALVANIC.....	71 00008
SKIN/DISTRIBUTION OF COPPER IN THE.....	72 00005



Example of microfiche for the third edition of *Periodicals in South African Libraries*.

Computerized information services

Following a survey in 1972 which showed that a need existed for such a national service — especially in chemistry and chemical engineering, electrical engineering and other branches of engineering and the biological sciences — the South African Selective Dissemination of Information (SASDI) was started at the CSIR.

The service was brought to the attention of interested persons at universities and various other organizations by means of circular letters, informal seminars and personal contact.

Data (on magnetic tape) from various overseas information services such as *Chemical Abstracts Condensates* (chemistry and chemical engineering), *Science Citation Index* (multidisciplinary), *Inspec* (physics, electrical engineering, computer science), *Biological Abstracts Previews* (biological sciences) and *Compendex* (engineering) are being used as the basis of the service. The success of the service, however, largely depends on the ability of libraries in this country to supply copies or reproductions of the literature announced by SASDI rapidly to the users.

Other computerized systems with which the CSIR's Information and Research Services are concerned include those for the production of the *South African National Bibliography*, the catalogue of the South African National Library for the Blind which is available on cassettes and the *Science Advisory Council's National Register of Research Projects*.

Publications

A revised edition of the booklet, *The CSIR — its organization and activities* appeared early in 1973 and work has been started on the next issue. In addition, an illustrated brochure on the CSIR is being prepared. This is intended mainly for the information of the general public and will be published in Afrikaans, English, German, French and Portuguese.

New editions of the guides, *Scientific research organizations in South Africa*, *Scientific and technical societies in South Africa* and *Scientific and technical journals published in South Africa* were also published.

At the end of the year under review, the first edition of *Textile terms* appeared. This technical dictionary (the CSIR's first) comprises about 4 500 English textile terms with Afrikaans equivalents. The publication of the work aroused considerable interest and enquiries were received especially about the computerized system used. Further editions will be published in due course as progress is made in the textile terminological project.

Publicity services

A variety of media, including the radio and films, as well as press releases, popular articles for different publications and the CSIR's own journal, *Scientiae*, are used to keep the public informed about the activities of the CSIR.

A short film was made on the South African Astronomical Observatory and the official opening of the observing station at Sutherland, CP, and released for exhibition as part of news programmes in cinemas throughout the country. Assistance was also given to four film units gathering material on science for television.

In addition, audiovisual programmes using colour slides with synchronized commentaries on tape and double projection equipment were compiled. Two of the programmes were exhibited to Members of Parliament, industrialists and other guests in Port Elizabeth on the occasion of the CSIR's Council meeting there.



Tekstielterme
Textile Terms
(Eng.-Afr.; Afr.-Eng.)



Delegates attending a conference.

Liaison

Staff members of the CSIR are playing an important role on national and international bodies dealing with various aspects of information transfer and handling.

On the national level, there has been cooperation with the National Library Advisory Council's Committee for the National Bookstock, Committee for Information Retrieval and Committee for Bibliographical Services, and also the Science Advisory Council's Sub-committee for the Dissemination of Scientific and Technical Information and Sub-committee for National Research Journals.

On the international level, the CSIR was represented at a meeting of the ICSU Abstracting Board in London, at a meeting of the International Federation of Documentation (FID) Committee on Information for Industry in Brussels, and at the 47th annual congress of the Association of Special Libraries and Information Bureaux (Aslib) in Bath, England.

Techno-economic surveys

Two national techno-economic surveys were undertaken for the CSIR's Advisory Committee for the Development of Research for Industry (ACDRI) in order to explore research needs and opportunities.

One survey, carried out in the textile industry (excluding animal fibres), consisted in an analysis of macro-economic aspects of the industry, including added value, growth, employment opportunities and trade. The views of clothing manufacturers on the textile industry were gathered and a general account of the industry's cost structure was compiled. The views of management in the industry were obtained by sampling and are summarized and discussed in the report on the survey.

The second survey collected information on the cultivation, processing, marketing and consumption of *Phormium tenax* fibre in South Africa to serve as a background for evaluating research programmes.

A number of techno-economic studies were carried out on contract for private undertakings. These investigations, with the objective of acquiring information on executive level about new or improved products or processes, included industrial market analyses, cost studies and economic feasibility studies.

Meteorological data for agriculture

In the course of the year, the results were published of a Delphi opinion survey which was undertaken to obtain estimates from a group of 71 agriculturists and meteorologists regarding the extent of the losses caused in agriculture in South Africa by weather conditions. The object was also to establish what portion of the losses could be prevented by making greater use of better meteorological information and how the weather service should be improved to meet the needs of agriculture.

Other aspects of the survey were the dissemination of weather information and developments which could influence the need for weather information. Farmers, agricultural cooperatives and agricultural marketing organizations were also involved in the survey.

The Weather Bureau estimated what it would cost to expand the meteorological service to meet the needs of the agricultural sector. The benefit-cost ratio of such an expansion is conservatively estimated at 28:1.

Expenditure on research and development

Surveys on behalf of the Science Advisory Council into expenditure on research and development (R & D) in South Africa were continued. A report on expenditure on R & D for the financial year 1969-70 was completed and a survey of expenditure for the financial years 1970-71 and 1971-72 was initiated.

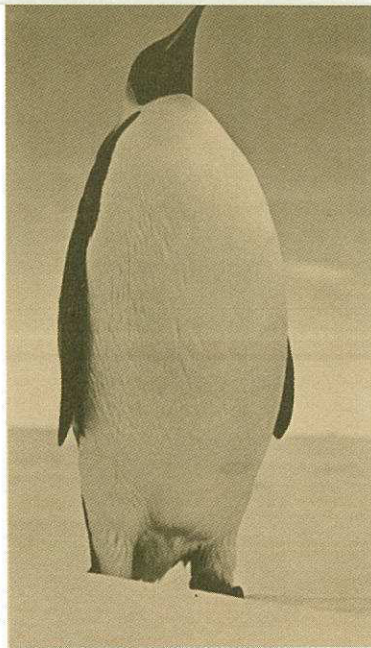
On the basis of the information on the expenditure on R & D collected over the years, it will in due course be possible to analyse expenditure patterns and research trends. The information may also be of value in the formulation of science policy.

Research and economic growth

Investigations into the relation between scientific research and economic growth were continued. The initial work in a study of the process of technological innovation in South Africa undertaken by the Advisory Committee for the Development of Research for Industry (ACDRI) took a step further with a provisional investigation of possible obstacles to technological innovation in the food and beverage industries. The results of the investigation show that further research in this field would be fruitful.

International science cooperation

To give effect to the statutory requirement concerning its role in international scientific cooperation, the CSIR belongs to twenty-six non-governmental international



Ornithological research programmes are also being coordinated by SASCAR.

organizations, most of them members of the family of the International Council of Scientific Unions (ICSU). During 1973, the CSIR was accepted as the South African member of the International Union of Quaternary Research (INQUA), affiliated to the International Union of Geological Sciences (IUGS).

As a member of these organizations, the CSIR occasionally acts as host to international conferences, of which the International Kimberlite Conference of 1973 was a particularly happy example. Held under the joint sponsorship of ICSU's International Association of Geochemistry and Cosmochemistry, the University of Cape Town, the South African Geological Society and the CSIR, about half of the 180 participants were earth scientists from abroad.

During 1973, more than 30 South African scientists received support from the CSIR for their attendance at the business meetings of international organizations. A few which may be mentioned here are the Conference of the Committee on Space Research (COSPAR) held in Constance; the General Assembly of ICSU's Scientific Committee on Problems of the Environment (SCOPE) in Kiel; the meeting of the Inter-governmental Oceanographic Commission (IOC) in Paris; and the Annual Meeting of the Inter-Union Commission on Geodynamics in Lima, Peru.

National programmes

Certain national research programmes, coordinated by members of the CSIR's Science Cooperation Division, maintain close contact with projects of global dimensions initiated by international scientific bodies of which the CSIR is a member.

Antarctic research

The South African Scientific Committee for Antarctic Research (SASCAR) coordinates research activities at SANAE (the South African base on the Antarctic Continent), Marion and Gough Islands. The research activities fall into three broad categories — the biological sciences, the earth sciences and upper atmosphere physics.

During 1973 seal and ornithological research programmes were commenced on Marion Island.

SASCAR has recognized the necessity of air support for the continuation of the Earth Sciences Programme in Antarctica, and negotiations are under way to obtain this.

Upper atmosphere physics

South African participation in the International Magnetosphere Study (IMS) was discussed at a meeting of the South African National Committee for Geomagnetism, Aeronomy and Space Sciences (SANCGASS) at which a leading world authority, Prof. Juan Roederer, was present. A consolidated upper atmosphere physics programme for South Africa has since been formulated.

Meteorology

The CSIR has decided to contribute to the Global Atmospheric Research Programme (GARP), a joint venture of ICSU and the World Meteorological Organisation.

The CSIR's contribution will take the form of a yearly subvention and an experiment in the southern Atlantic and Indian Oceans making use of freely floating buoys equipped with electronic instruments. Signals emitted by the buoys are recorded by artificial satellites and re-broadcast to surface stations, where they are processed to yield information on air and sea temperatures and ocean currents.

Environmental sciences

The National Programme for Environmental Sciences, which endeavours to consolidate environmental research in the Republic, continued to expand during the past year.

During 1973 the Advisory Committee for Inland Waters held a meeting at the Hendrik Verwoerd Dam, devoted to the hydrobiology of the dam and the Orange River. The Advisory Committee for Terrestrial Biology has been planning and coordinating research on weeds, rare and endangered plants and animals, effects of pesticides on the environment, and ecosystems in general.

Geodynamics

The International Geodynamics Project (IGP), launched by ICSU's Inter-Union Commission on Geodynamics, is a global research programme on the dynamics and dynamic history of the earth, with emphasis on deep-seated foundations of geological phenomena.

During 1973, the South African Scientific Committee for the International Union of Geological Sciences (SACUGS) drew up a national programme of research envisaged as a contribution to the IGP.

Conferences and symposia

During the year, seven industry-orientated symposia were arranged on behalf of, or in collaboration with, CSIR insti-



Sir Harold Thompson (centre), Professor of Physical Chemistry at Oxford University, with Dr O G Malan of the NPRL (left), and Prof. C Leisegang, of the University of Cape Town, at a spectroscopy symposium held at the CSIR.

tutes or laboratories for specific industrial sectors. The average attendance at these meetings was approximately 120 delegates, of which about 70 per cent were industrialists.

In addition, two important international scientific meetings were hosted in South Africa by Government Departments and organized on their behalf by the CSIR, namely: the Conference on Timber Utilization for the International Union of Forest Research Organizations (IUFRO) and the Kimberlite Conference for the International Association of Geochemistry and Cosmochemistry. These conferences attracted 85 and 110 overseas delegates respectively.

Visitors

Altogether 86 distinguished foreign visitors from countries as far afield as Taiwan, Jordan, Japan, Scandinavia, Australia, most European countries and the Americas, were received at Scientia during the year by members of the Executive and Directors of Institutes.

Some 1 200 scholars from high schools and approximately 400 other local visitors, including representatives of many professions and students, visited the various laboratories at Scientia and participated in group programmes arranged for them by the Visitors' Office.

TECHNICAL SERVICES

TECHNICAL SERVICES DEPARTMENT

Director
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 Department also undertakes work on contract for other bodies and industry if the work cannot be done anywhere else in the Republic. This service includes advice on the optimization of machining and manufacturing techniques. The Department maintains close liaison with overseas bodies that are active in this field such as the Production Engineering Research Association (PERA) in the UK, to avoid duplication of effort.

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:

- Air filters and density meters
- Variable-depth sampling apparatus for brewing tanks
- Mobile laboratory for brewing technology research
- Steam generator
- Fluidic sensor for the dynamic measurement of vehicle axle mass.
- Variometers
- Fibre glass rotor blades and parts for autogyro
- Wear resistance testing apparatus for flooring
- Universal dynamic rain-testing apparatus
- Ion source
- De-airing vessel
- Small-scale controlled rate bitumen sprayer
- Microphotometer
- Laser heads
- Fibre thickness measuring apparatus
- Optical scanning apparatus
- Measuring table and slit system for cyclotron
- Universal drive for isotope separator

A new branch workshop was established at the CSIR's Regional Office in Bellville, CP, to serve the National Institute for Water Research.

Training of instrument makers

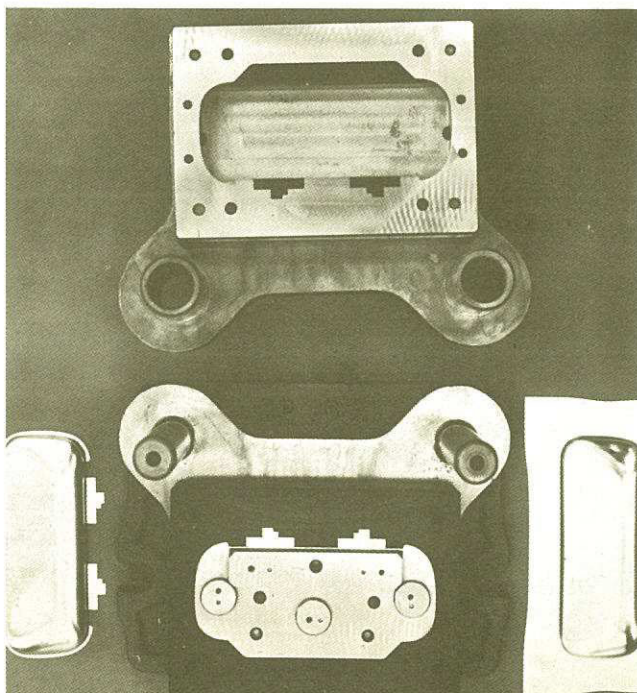
The rate at which apprentices are at present being trained as scientific instrument makers to meet the requirements of the CSIR and industry (on the average 15 qualify per annum) is still inadequate and further expansion of the facilities of the Training Centre for scientific instrument makers is being considered.

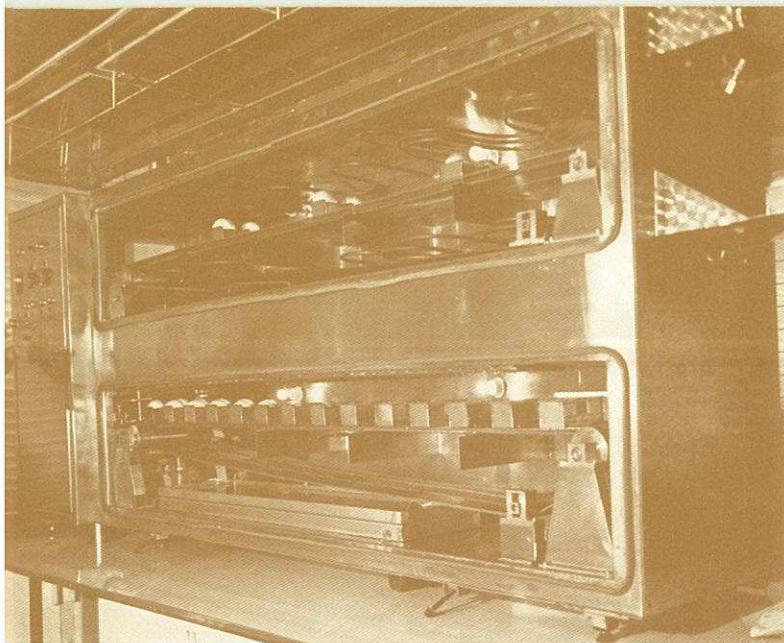
Investigation, advice and development

Assistance that was rendered to industry on a contract basis included the following:

- Feasibility studies *in situ* of low-cost automation systems for factories to improve product quality and increase production at a relatively low capital cost.
- The development of a labour-intensive batch-manufacturing technique for a border industry.
- Technical advice on problems associated with the manufacture of printed circuit boards.
- Investigation of machining techniques (on conventional and automatic machines) to establish the most effective and most economical production methods.
- The design, development and manufacture of pre-production models of equipment intended for batch or mass production.

Pressing tools manufactured for a labour-intensive industry.





This micro oven which was designed, developed and manufactured by the Technical Services Department enables the wheat industry to conduct baking tests with different wheat varieties.

Design and manufacturing

Assistance with the design, development and manufacture of specialized equipment was provided to industry and other organizations. A few of the more important projects are mentioned below:

- Dust-sampling probes for a steel manufacturing concern.
- Fermentation cabinet and micro bakery for the testing of wheat varieties for the wheat industry.
- Pre-production models of mass meters for manufacturing industry.
- Insect traps and blood-sampling equipment for other research establishments.
- Programming and numerically controlled machining for statutory bodies and manufacturing industry.

Low-cost automation

One-day symposia on low-cost automation were successfully held in Durban, Port Elizabeth and Cape Town. About 170 delegates from industry attended the symposia. Numerous requests for advice on the application of low-cost automation emanated from the symposia and more than twenty factories have since been visited to provide advice *in situ*.

The number of applicants for the five basic courses in low-cost automation exceeded expectations and consideration is being given to presenting three courses at other centres (one in Natal and two in the Cape Province) during 1974.

Numerical control

The Technical Services Department maintains active interest in the rapidly developing field of numerically controlled machining.

A practical course in numerical control was presented by the Technical Services Department in collaboration with the National Research Institute for Mathematical Sciences. Such courses fulfil an important role in the training of programmers for manufacturing industry where a serious shortage of qualified programmers is being experienced.

**COOPERATIVE
INDUSTRIAL RESEARCH**

LEATHER INDUSTRIES RESEARCH INSTITUTE

Director DR S.G. SHUTTLEWORTH

The Leather Industries Research Institute (LIRI), which originated in the Chemistry Department of Rhodes University, serves the hides and skins, wattle, tanning and footwear industries with a total output of R208 million per annum. It is governed by a Board of Control with five members elected annually by the subscribers and three members nominated by the CSIR, the Department of Agriculture, and Rhodes University. Technical direction is provided by seven research committees covering all aspects of the work and with members drawn from firms in all the major manufacturing centres. It owes its success largely to the close personal contact maintained with all its subscribers.

Since its early beginnings in 1936, LIRI has maintained a balanced programme of fundamental and applied research and has kept up a rate of publication in overseas journals which has been remarkable considering the small number of qualified staff. This received practical recognition this year in the invitation extended to the Director to deliver the John Arthur Wilson Memorial Lecture at the American Leather Chemists Association Convention in Ottawa, on the subject *Can the US leather industry survive without research?* The lecture was well received by the 400 delegates present, which is an indication of the kind of contribution made by LIRI towards the overseas image of South Africa.

Adoption by US and Canadian sole and harness leather tanners of the Liritan No Effluent Process increased the 1972 value of sales of wattle extract to these countries by more than a million rand, and it is anticipated that the 1973 sales will show further substantial increases.

Growing environmental pressures throughout the world are challenging the existence of many tanneries, and the South African Tanners Association has decided to take the initiative in establishing an Environmental Research Unit at LIRI which could attract financial support from overseas, where LIRI leadership in solving some aspects of these problems is already acknowledged.

Hides and skins

The present internationally accepted preservation method of saturating hides and skins with salt has created an intractable effluent problem, both for curers and

tanners, so that an urgent requirement for LIRI is the development of alternative curing methods. Considerable progress has been made in this direction and, although long-term preservation has not yet been achieved, short-term cures are in sight which could be of great assistance to local processors of skins and tanners of hides. With the increasing world demand for part-processed raw material which can be finished without effluent problems, it is becoming a feasible proposition to eliminate salt from our curing, thereby making re-use of tannery effluent a practical target.

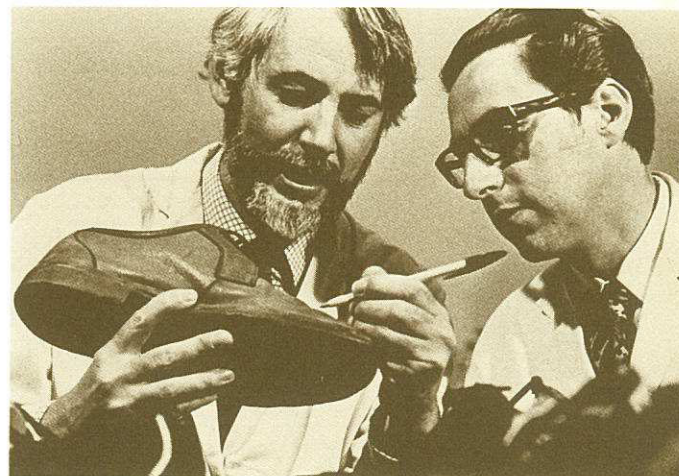
Protein research

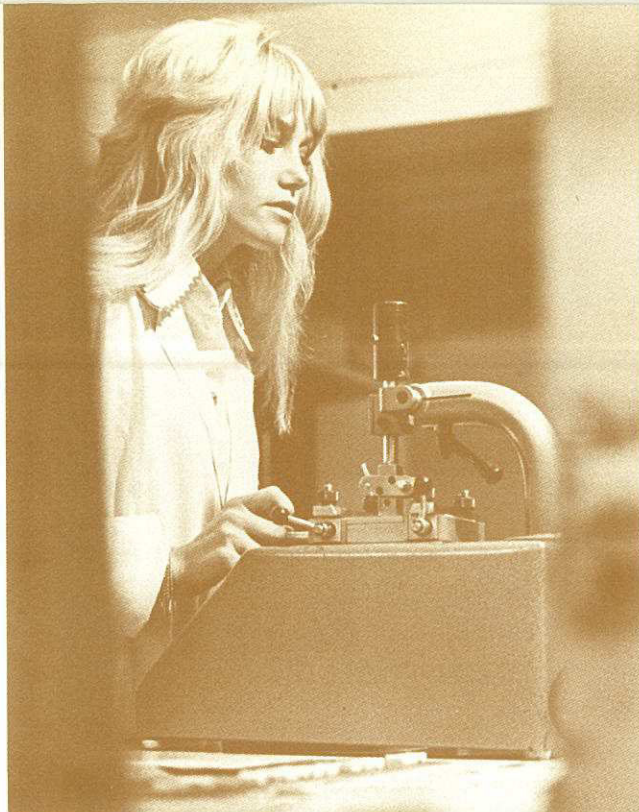
The sophisticated protein research laboratory at LIRI has continued to provide valuable information on the structure and properties of native collagen from hides and skins. Publication of this work in overseas scientific journals has aroused much interest from medical and other research groups abroad, in view of the major role played by collagen in cancer and certain arthritic diseases.

Karakul pelts

The Institute has continued to assist the Karakul Board with the physical testing and quality evaluation of Karakul pelts in the course of field trials designed to rationalize and improve curing practices. In recent studies, special attention has been given to aspects of pelt preparation for

Examining worn shoes for causes of leather failure.





Measuring the rub-fastness of a leather finish.

curing in order to isolate the critical factors at the pre-processed stage which affect final pelt quality. A particular problem with delicate fur skins is the possibility of latent damage which becomes apparent only after marketing and dressing.

Alternative uses for wattle

In view of the declining world market for leather tanned with vegetable tanning materials such as wattle extract, LIRI has been asked by the wattle industry to carry out a crash programme aimed at developing alternative markets. In order to speed up the large-scale use of wattle-based adhesives, the industry has formed a company in co-operation with a South African chipboard manufacturer.

Four successful adhesives have been developed and increasing tonnages are being marketed.

Another successful avenue opened up is in the area of soil stabilization, and already over 400 tons of a special form of wattle extract have been sold for this purpose, with prospects of very large markets arising from further improvements.

Fundamental work on the composition of wattle extract and the structure of the wattle tannins, has played a major role in the development of these new markets.

Metal tannin complexes

Fundamental work on metal-tannin complexes, which earned a Ph.D. degree for a LIRI staff member during the past year, is finding practical application in several directions, including the use of wattle in ore flotation, the development of wattle-based mud thinners for oil well drilling, the use of wattle metal complexes for supplying trace elements to plants, and the use of wattle metal complexes for retanning of chrome leather.

Liritan sole leather process

All except one of the major US and Canadian vegetable leather (sole and harness) tanners have partly or entirely adopted the process developed by LIRI, with consequent expansion of sales of South African wattle extract. The

increasingly stringent standards for liquid and solid waste disposal has made this a survival problem for many overseas tanneries, and there is much interest in LIRI's work in this sphere.

Waste disposal problems of leather industries

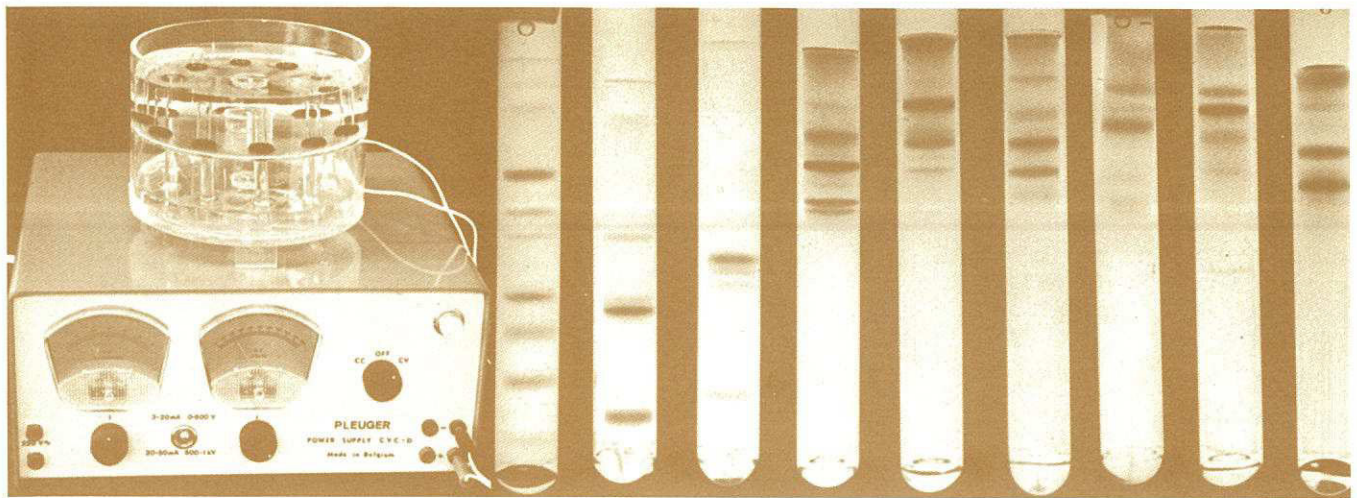
South African tanners acknowledge the role played by LIRI in assisting them to solve the problems associated with their liquid and solid wastes. The approach has been, firstly, to develop process modification to reduce these wastes to a minimum and, secondly, to study methods of purification and disposal. Three pilot plants are in operation at present to investigate the use of surface aerators to deal with the more difficult waste liquors, and this investigation is being coupled with a microbiological study to optimize the effectiveness of these plants.

Comfort grading of footwear

Using apparatus designed at LIRI to measure moisture absorption and transmission under conditions similar to the practical conditions of shoe wear, a survey has been made of the ability of a wide range of upper and lining combinations as well as insoles and hose to keep the average foot free of liquid perspiration during normal wear. This makes it possible to give a comfort and health grading to footwear.

Training

LIRI has continued to make available to its industry the accumulated store of technical knowledge through correspondence courses in tanning and footwear technology as well as management and costing. Some of these courses are used as the basis for training of footwear factory supervisors and managers in 23 overseas countries.



Apparatus used for electrophoresis of fish muscle proteins on polyacrylamide rods.

Electrophoretograms of muscle proteins from different types of fish.

FISHING INDUSTRY RESEARCH INSTITUTE

Director DR R.J. NACHENIUS

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

FIRI is financed by voluntary contributions from the fishing industry, and subsidized by the CSIR. Firms with an indirect interest in the fishing industry can become associate members of FIRI. The total annual income of the institute is currently about R233 000.

The affairs of the Institute are governed by a Board of Control representing the fishing industry, the CSIR, the Minister of Economic Affairs, and the universities of Cape Town and Stellenbosch. Its research programme is planned and executed in consultation with committees comprising the leading technical personnel of the inshore and the white fish industries.

The primary function of the Institute is to conduct fundamental and applied research for the fishing industry. This involves various products and processes, *viz.* chilled and frozen white fish, salting, smoking and drying, frozen whole rock lobster and rock lobster tails, canned pilchards and mackerel, fish meal, fish oil, etc.

The Institute also acts as technical adviser to the industry in matters concerning effluent clarification, odour control, the testing of packaging materials, the purification of processing water, etc. Collaboration with international organizations such as the International Association of Fish Meal Manufacturers and the International Institute of Refrigeration ensures that the industry remains abreast of progress in all fields of fish processing.

More edible fish

To keep pace with population increases and in view of the limited stocks of the types of fish eaten traditionally, the Institute is constantly testing processes to utilize fish normally considered inedible.

In the year under review various lightly and heavily salted products were prepared from pilchards, which can be stored either chilled or at room temperature.

Alternatively an attractive canned jellied loaf can be made from minced fish of the same species. For the first time work was done on the processing of river eel, and excellent smoked and canned products were developed. If sufficient quantities can be obtained, this fish could become an important luxury food item.

Milk substitutes

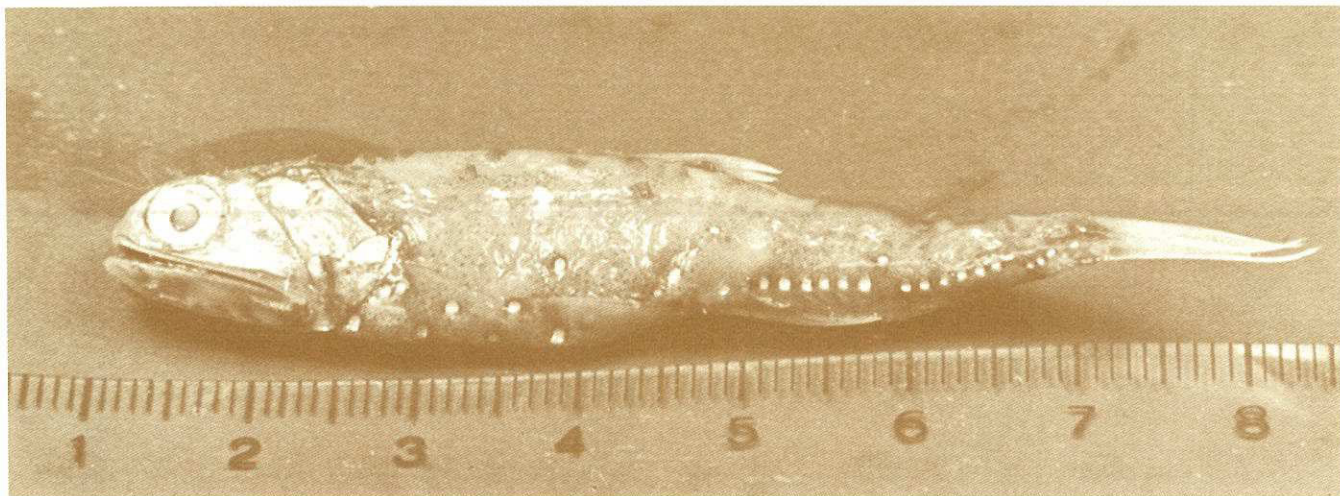
There is an increasing demand for suitable substitutes for feeding calves when milk powder is in short supply. Trash fish of the white fish industry proved a suitable raw material in the preparation of a milk substitute by enzyme hydrolysis. By this process, 1 500 g of minced fish frames yielded about 150 g of dried soluble powder with a protein content of almost 90 per cent, and about 60 g of an insoluble protein-rich residue. The two components combined have an outstanding protein quality. Although the insoluble material will probably be used only in animal feeds, it is possible that the acceptable white soluble hydrolysate may also find a market in the pharmaceutical industry.

Experiments are also being carried out on demineralised stickwater to provide a base for another variety of milk substitute. Encouraging preliminary results have been obtained with the de-salting of stickwater by ultra-filtration and electro-dialysis.

Effluent clarification

At present clarification of fish factory effluent is one of the major research projects of the Institute. Extensive field work was undertaken in testing a pilot sedimentation and flotation tank erected first at St. Helena Bay and then at Walvis Bay. It was shown that by physical treatment only, over 80 per cent of the oil and about 60 per cent of the suspended matter in the effluent could be recovered, while the chemical oxygen demand was reduced by an average of 60 per cent.

Work on the precipitation of the soluble protein in the effluent by flocculation and sedimentation has been pending, as the return to the sea of the chemically treated water conflicts with the provisions of the Sea Fisheries Act. As an alternative, experiments are in progress to



Lantern fish (*Lampanyctodes hectoris*).

determine the economic feasibility of breaking down the organics by anaerobic digestion. In view of the extremely high rate of natural digestion of fish material in the sea, there is reason to believe that this form of secondary treatment may provide a solution to an otherwise intractable problem

Identification of fish species

A need exists in commerce and industry as well as in research for a means of distinguishing between fish species, in both raw flesh and processed products. Sets of electrophorograms on polyacrylamide gels prepared from the water extracts of fish muscle have been compiled, and have been used e.g. to distinguish between *Merluccius capensis* and *M. paradoxus*, two closely related species of hake caught in South African waters.

It is also intended to follow changes in the physiological condition and organoleptic qualities of rock lobster tails by electrophoresis. Its application to the identification of processed fish products, e.g. fish meal made from different species, is more difficult, but progress has been made in adapting the technique to this purpose.

Processing of lantern fish

Lantern fish (*Lampanyctodes hectoris*) which has been landed in increasing quantities in South Africa since 1969, had not been in evidence before and is not commercially exploited anywhere else in the world. Its protein has a high nutritional value, but while it can be readily cooked, pressed and dried in the conventional manner the fish meal produced has an exceptionally high fat content. This may partially be due to an unusually high oil content of the raw fish — at times over 45 per cent on a dry basis — but indications are that the cooked fish is also inherently more difficult to press.

Fish meal with a lower fat content can be made if the cooked fish is centrifugally de-oiled instead of pressed, but factories are loath to install the costly equipment required for this purpose in the absence of evidence that the lantern fish will remain available in commercial quantities. Moreover, fish meal with a high fat content is not unacceptable to the trade, although it may aggravate the tainting problem if incorporated at high levels in the diets of chickens and pigs.

Measurement of protein quality

A chicken feeding facility to measure the nutritional value, generally expressed as net protein utilization (NPU), of fish meal and related products has been established at the Institute. This unit has been used to determine, *inter alia*, the energy value of soapstock in poultry diets, the toxicity of ethoxyquin, the effect of formaldehyde treatment of raw fish and changes in the protein quality of fish meal during extended storage.

At the same time work is proceeding on the evaluation of certain chemical and microbiological tests that identify specific aspects of protein quality. For instance, a collaborative test with laboratories in the UK, Denmark and Norway has yielded valuable information on the value of the dye-binding test as an alternative to the time-consuming Carpenter method of measuring available FDNB lysine. The Institute has independently studied the chemistry of dye-binding and a modification of the recommended technique was shown to provide a more significant correlation with the lysine content of fish meal.

Analytical methods

The Institute is continually reviewing the methods used in its research work to increase accuracy and save time. For example, the Kjeldahl analysis is being adapted to recover total nitrogen. As a member of the International Association of Fish Meal Manufacturers, the Institute is also participating in collaborative tests with overseas laboratories to standardize a number of analytical methods such as pepsin digestibility and FDNB lysine. Similarly, information is being exchanged on tolerances of precision and accuracy for analytical methods in common use in the fish meal trade. In the absence of agreed tolerances, misunderstandings can arise in the interpretation of routine and research analytical data.

The fishing factories' requirements for analytical methods have also to be considered. Generally, factory tests need to be rapid and inexpensive rather than accurate. A useful method, requiring no more than 15 minutes, for estimating the protein content of fish meal was recently developed at the Institute. It is based on the fact that for a constant fat and moisture content, the ash and protein content of the product are inversely proportional. Hence, by rapidly ashing the sample a fair indication of its protein content can be obtained.

Plant for small-scale fish meal production on board trawlers.

Objective quality indices

Claims are sometimes made that an excess of certain chemical compounds or micro-organisms in processed fish is indicative of poor condition of the raw material, or poor process control. A survey is in progress to assess the value of these so-called quality criteria. This has involved *inter alia* the determination of free fatty acids, total volatile acids, total volatile bases, and trimethylamine in fish meal made from raw fish. The information thus gained will be used to assess the validity of any complaints received in future, and to assess the compliance or otherwise of fish products with the quality standards laid down by the South African Bureau of Standards and public health authorities.

SUGAR MILLING RESEARCH INSTITUTE

Director DR M. MATIC

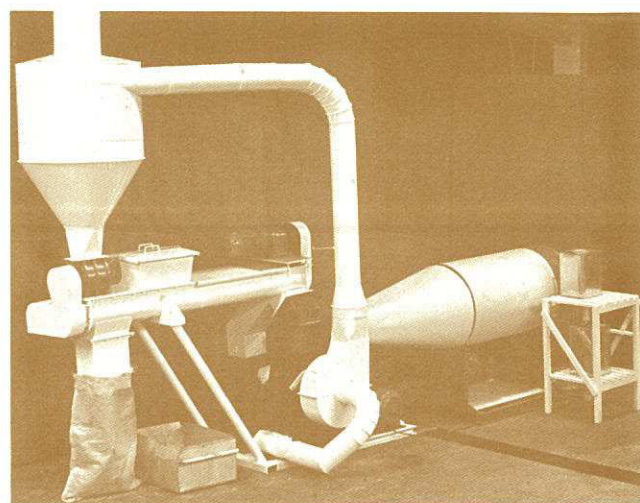
The Sugar Milling Research Institute (SMRI) is the central scientific organization for research into the manufacturing problems of the South African sugar industry. It was established in 1949 jointly by the South African Sugar Millers' Association Limited (SASMAL), the CSIR and the University of Natal,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

Eleven sugar factories in Swaziland, Rhodesia, Malawi and Mozambique are affiliated members of the Institute.

The main functions of the Institute 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 cane growers have their own research station at Mount Edgecombe, Natal, where the cultivation of sugar is studied.)



Diffuser evaluation

Work was continued this year with attempts to evaluate the performance of a diffuser independently of the remainder of the extraction tandem. Utilizing the concept of 'difficult' or 'bound' sucrose, a standardized method has been developed whereby the 'easy' sucrose is removed by a washing process and the analysis may be considered as analogous to the determination of displaceability index.

A wide degree of scatter has been obtained for all parameters calculated and all parameters have shown a strong dependence on sucrose concentration. The average results obtained, however, show that a diffuser in South Africa in comparison with a typical 6-mill tandem may be considered as equivalent to 2 to 2,5 mills, while if the improved extraction efficiency of the dewatering mills is taken into account, it may be equated to 3 mills.

Suspended matter in mixed juice

In order to improve the accuracy of the milling mass balance it was agreed that a correction should be made for suspended matter in mixed juice. The method for this determination used in South Africa includes a filtration step and fears were expressed that this procedure was too time-consuming for routine use. Accordingly the possibility of substituting a centrifugation method for the existing one was investigated.

The crucial error in the mass balance is that the juice is weighed with suspended matter present, but is analysed after it has been removed. Thus there is a gravimetric error in the tons pol as calculated exactly equal to weight of suspended matter present. For this reason it was decided that the method of analysis should be based on a gravimetric result rather than a simple estimation of the volume of sediment in a centrifuge tube. This in turn necessitated double centrifuging of each sample in order to include a washing stage.

Results obtained when using a Martin Christ Junior laboratory centrifuge capable of speeds up to 3 500 rpm were unfavourable. Subsequent work was carried out with a Beckman ultra-centrifuge, using speeds of 15 000-20 000 rpm, with spinning times of 30-60 minutes. Under these conditions it has been found that very good agreement between centrifuging and filtering can be obtained, except where juice has deteriorated in which case centrifuging appears to give correct results while filtration gives very inflated results.

Although it was possible to treat eight samples simultaneously in the centrifuge the total analytical time

was not significantly reduced. Furthermore, the expense involved in providing all Central Board laboratories with high speed centrifuges would be excessive, and it has been recommended that the filtration method be retained as the routine one.

Inversion of sucrose

An attempt was made to determine the amount of sucrose inversion in cane juice at elevated temperatures and at different pH values by using a uniformly labelled ^{14}C -sucrose. The radioactive unhydrolysed sucrose was separated from U- ^{14}C -glucose and U- ^{14}C -fructose formed by paper chromatography and the respective amounts of radioactive materials were determined by scintillation counting.

Three methods of counting the radioactivity in the sugar spots have been examined.

First, the paper containing the sugar spot was cut into small pieces, weighed, suspended in scintillation liquid and counted. Sugar-locating sprays could not be used on the paper before counting as quenching occurred and erratic recoveries resulted. The initial poor agreement between consecutive counts and between counts made on the same sample on following days was improved by stirring the paper in the scintillation liquid and then centrifuging. The counts of the blanks increased with increase in quantity of paper taken and this increase was not due to random scatter. This variation in the count of the blank is very significant due to the relatively low count of all the samples used. Recoveries (as determined by the number of counts obtained) of the invert and sucrose spots ranged from 79,8 to 98,5 per cent with fair agreement between individual invert and sucrose values in any single determination.

Second, paper containing radioactive sucrose or invert was calcined and the radioactive CO_2 formed was absorbed into the scintillation liquid and counted. The percentage recoveries were far too erratic and the method was not further investigated.

Third, optimum conditions were determined for the elution of the radioactive sugars from the paper, using water, and the sugar was counted by removing the water in vacuo and dissolving the residue in scintillation liquid. The percentage recoveries ranged from 94,1 to 105,5 per cent, quantitatively a better result than that obtained by the first method but still far from satisfactory.

It would appear from these experiments that a greater amount of labelled sucrose than originally proposed must be added to a reaction mixture if the required accuracy is to be obtained in a reasonable counting time.

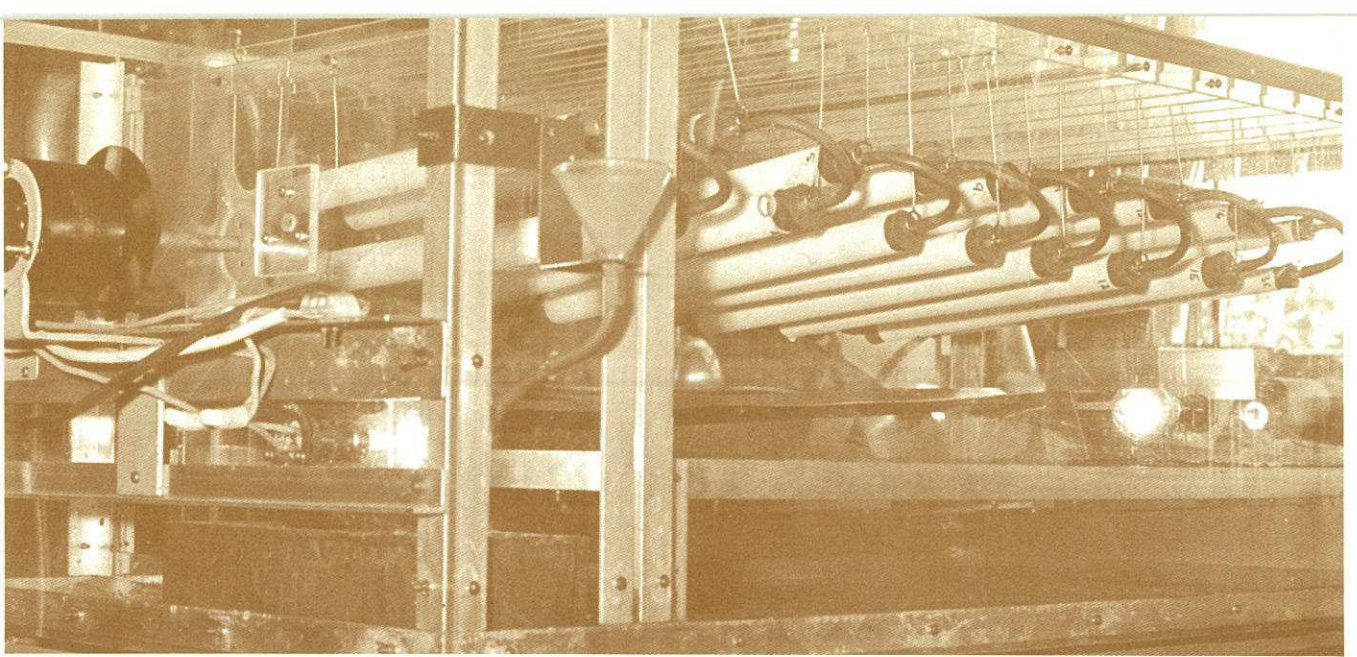
Filtering quality of raw sugar

The investigation of the filtering quality of raw sugar, as measured by its filter performance during the carbonatation refining process, is continuing. Of the various impurities present in raw sugar, insoluble suspended matter and starch are most common. The absolute and relative influence of these two factors on the filterability of raw sugar, which has been carbonatated under steady state conditions, has been determined.

The suspended matter content of raw sugar was varied by removal of particles, selectively by size, using membrane filters. Raw sugar solutions, prior to undergoing carbonatation, were filtered to remove suspended particles down to $0,20\ \mu\text{m}$ in diameter. Likewise, the starch content of the sugar was also varied by either the addition of suitably treated potato starch (up to 500 ppm) or by enzyme hydrolysis. After laboratory processing the carbonatation liquor was filtered at constant pressure and a 'filterability index' was assigned to the sugar.

The results of this investigation show that, with reference to raw sugar filtering quality, starch content has far more effect on filtration rates than insoluble suspended matter content. For example, in one sugar sample studied, it was possible to achieve an increase in filterability index of ten units by lowering the starch content from 200 ppm to 130 ppm, whereas in order to create the same degree of improvement in filtering quality it required removal from the raw sugar liquor of all matter larger than $0,7\ \mu\text{m}$ in size.

The fundamental importance of starch in the carbonatation process has led to a study of the mechanism of starch interference in the formation and growth of carbonate particles. This study has thrown much light on why the results of the CSR filterability test (and other similar filterability tests) have failed to give as high reliability as refinery filtration data. An average raw sugar has a starch content which is high enough to influence refining filterability. Only in exceptional cases when the suspended matter content is extremely high would one expect the effect of starch to be swamped. However, on examination of the role played by starch in the CSR test, no interaction of starch and filter aid was recorded. There is no removal of starch during the test, no



A tropical test cabinet constructed at SAPRI, for evaluating fungicides in emulsion paints.

adsorption on the filter aid and no change in surface charge characteristics of the filter aid before and after the test. In fact, starch is incapable of influencing test data even at starch concentrations as high as 400 ppm. However, the CSR test may still show high reliability compared with refinery data when used to assess raw sugar with high suspended matter content and very low starch content. It appears to be a fair measure of the amount of insoluble suspended matter present in the sugar.

SOUTH AFRICAN PAINT RESEARCH INSTITUTE

Director DR D.A. WILLIAMS-WYNN

The South African Paint Research Institute (SAPRI) is situated on the campus of the University of Natal, Durban, and has close links with the university. Its subscribers include all the main South African paint manufacturers, raw material suppliers and some large-scale paint users. Their subscriptions, if guaranteed for five years, are matched by an equal grant from the CSIR.

Part of the Institute's work is investigation of paint manufacturing problems and the study of the failure and improvement of protective coatings used in South Africa's rigorous climatic conditions. Long-term studies are initiated by a Research Advisory Panel which includes representatives of member firms, the University of Natal, the Corrosion Group of the National Chemical Research Laboratory and the Organic Materials Division of the National Building Research Institute.

The Institute undertakes research into analytical methods and specialized analyses, particularly where the cost of the apparatus would be uneconomical for individual members. A well-stocked library is available to subscribers, and technical reports and abstracts of published papers on surface-coating are issued.

Facilities are provided for studies of paint films under outdoor and accelerated weathering conditions, and a sea raft is used for assessing the effectiveness of marine paints and anti-fouling compositions.

Instruments are made and repaired in the Institute's workshop, not only for the use of the testing and research staff, but also for subscriber firms, for use in their own laboratories.

Degradation of mature paint films

A new research programme is investigating the effect of modification of present curing mechanisms in diminishing the degradative reactions in the life of a paint

film. The role of driers and the choice of the curing system, as well as the incorporation into the medium of compounds which prevent degradation, are being studied. Linked with this is a study of general radiation curing which is being pursued with the help of the Atomic Energy Board.

Assessment of fungicides

The Institute is continuing its work on the selection and testing of fungicides and bactericides for use in emulsion paints. The laboratory evaluation has progressed well, but the choice of exterior exposure sites and substrata for field tests is proving to be difficult.

Preliminary work has shown that only very small differences in behaviour with respect to mould growth and in-can stability can be attributed to variations in binder composition and the choice of type and amount of biocide is of major importance. It is proposed to investigate at a later date the possibility that certain pigments may have biocidal or biostatic effects. Present studies are confined to systems with inert pigments.

Identification of raw materials and paint products

New infra-red equipment has been installed in the laboratories and will facilitate the work of the enquiry section with improvement in the service to members. At the same time, the pure research programme will benefit. These instruments, together with the equipment for gas-liquid chromatography, and other existing sophisticated instrumentation, enable the Institute to identify and determine most of the raw materials and products of the paint industry. Moreover, the close association with the University of Natal means that expensive equipment such as that for nuclear magnetic resonance and mass spectrometry, and also computer facilities, are available if needed.

Quantitative determination of rosin in alkyd resins

Although large quantities of rosin in coatings may be undesirable, small amounts have no adverse effects on the properties of the film. The presence of rosin is easy to detect, but the quantitative determination of rosin in alkyd resins has not been possible. Consequently tall oil with low rosin content, from which good alkyd resins can be manufactured, cannot be used for many purposes.



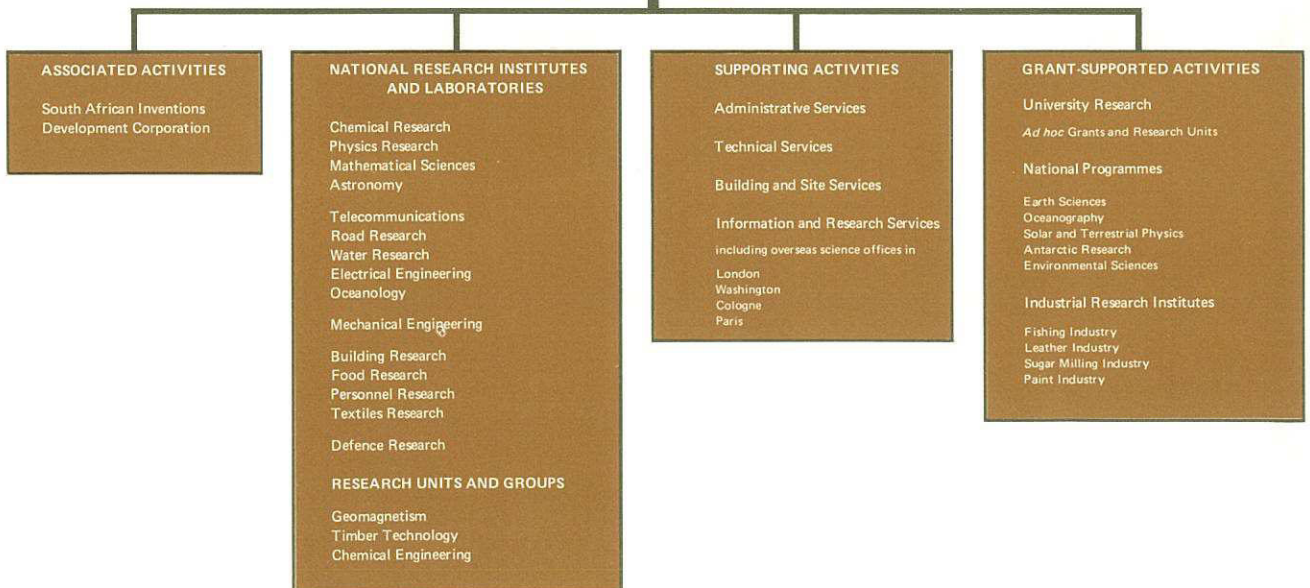
An example of delamination in epoxy tar coatings, which often occurs without apparent reason.

The ASTM method for determining rosin acids has been assessed and modified for measuring the amount of rosin present in alkyd resins. The modified procedure always gives results which are too high, but it could be used for setting a limit for rosin in a specification for an alkyd.

Inter-coat adhesion failures

In certain paint systems inter-coat adhesion failures are inexplicably frequent especially in some epoxy tar coatings. A wide variety of formulations have been studied to test the theory that delamination of epoxy tar is due to a layer of material on the first coat formed by reaction between the amine curing agent and carbon dioxide in the atmosphere. This has been noted as a water-soluble reaction product appearing in the form of a bloom, and is possibly one of the reasons for the declining use overseas of simple aliphatic amines in the unmodified form as curing agents for epoxy resins. In addition, the components of the tars used in these formulations may contribute significantly to the problem. These factors are under investigation.

PARLIAMENT
MINISTER OF PLANNING AND THE ENVIRONMENT
COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
PRESIDENT AND EXECUTIVE



FINANCIAL STATEMENTS

BALANCE SHEET

as at 31 March 1973

Statement No. 1

Council for Scientific and Industrial Research

	General Fund R	Building Fund R	1973 R	1972 R
ACCUMULATED FUND				
Balance – 31.3.72	25 797 677,51	15 626 138,31	45 867 267,21	41 423 816
Inter-fund transfers	(–)327 000,00	327 000,00		
SUB-TOTAL	25 470 677,51	15 953 138,31		
CAPITAL RECEIPTS				
Parliamentary Grants:				
CSIR	1 240 700,00	1 000 000,00		
Grants	30 100,00			
Contributions:				
CSIR	13 500,00			
Grants	3 223,24			
Interest		202 404,07		
Sale of assets written off:				
CSIR	28 349,74			
Grants	-			
Investigations and services	528 515,49	802 377,30		
SUB-TOTAL	1 844 388,47	2 004 781,37		
ADD:				
Excess income	868 492,10			
Physical assets acquired	83,33			
	2 712 963,90			
LESS:				
Physical assets relinquished	858,00			
Cost of assets written off:				
CSIR	257 079,35			
Grants	16 356,53			
SUB-TOTAL	2 438 670,02	2 004 781,37		
TOTAL	27 909 347,53	17 957 919,68	45 867 267,21*	41 423 816
Current liabilities				
Advances for investigations and services			999 257,87	798 981
Sundry creditors and credit balances			1 604 635,43	1 609 261
TOTAL			R2 603 893,30	2 408 242
GRAND TOTAL			R48 471 160,51	43 832 058

Notes – * Contractual obligations against the General and Building Fund as at 31st March, 1973 were R1 231 351 and R847 347 respectively.

∅ Value of assets transferred: To : Medical Research Council R858,00. From: Namib Desert Research Association R40,00; National Council and Research Board R32,93; African Steel Manufacturers R10,40.

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

(Sgd.) J.H. Visagie, *Secretary/Treasurer*

PRETORIA 3.8.73.

	1972/1973						
	Nett Additions				Phys. assets transferred ø	1973	1972
	Grants	CSIR	Written off				
R	R	R	R	R	R	R	
FIXED ASSETS (at cost)							
Land and buildings		2 090 854,63			17 273 048,35	15 182 194	
SUB-TOTAL		2 090 854,63			17 273 048,35	15 182 194	
Laboratory and workshop equipment	94 567,89	1 879 875,50	194 605,26(-)	858,00 (-) 32,93	21 239 077,94	19 460 065	
Furniture, fittings and office equipment	295,33	159 949,95	20 611,10(-)	50,40	1 405 035,20	1 265 350	
Vehicles and cycles	400,00	120 531,35	55 016,16(-)		885 763,09	819 848	
Books and journals	456,80	149 109,21	3 203,36(-)		1 264 505,79	1 118 143	
Prefabricated structures		1 597,25			16 982,08	15 385	
Shares in S A Inventions Development Corporation		60 000,00			200 000,00	140 000	
Stores stock		30 483,35			491 176,84	460 693	
SUB-TOTAL	95 720,02	2 401 546,61	273 435,88(-)	774,67(-)	25 502 540,94	23 279 484	
TOTAL	95 720,02	4 492 401,24	273 435,88(-)	774,67(-)	42 775 589,29	38 461 678	
<i>Current assets</i>							
Saleable stock					68 410,62	81 488	
Sundry debtors and debit balances					1 444 624,83	1 337 891	
Advances and deposits:							
Research grants				461 272,25			
Other				344 468,61	805 740,86	930 046	
Investments					3 167 946,74	2 719 543	
Cash:							
At S A Reserve Bank				142 902,91			
Petty cash imprests				65 945,26	208 848,17	301 412	
TOTAL					R 5 695 571,22	5 370 380	
GRAND TOTAL					R48 471 160,51	43 832 058	

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

PRETORIA
24.9.1973

(Sgd.) F.G. Barrie
Controller and Auditor-General

OPERATING ACCOUNT

for the year ended 31 March 1973

Statement No. 2

Council for Scientific and Industrial Research

Expenditure	1972/73			1971/72
	Grants R	CSIR R	Total R	
Salaries, wages and allowances . . .	87 052,55	16 137 808,71	16 224 861,26	15 143 183
Consumable stores and services . . .	15 347,83	6 078 765,87	6 094 113,70	5 117 016
Subsistence and transport	11 636,53	921 933,08	933 569,61	738 993
General expenses	6 949,79	2 224 697,12	2 231 646,91	2 626 673
Subsidies: Research by Industry . .	-	356 417,92	356 417,92	873 953
Grants	990 371,14	-	990 371,14	326 111
SUB-TOTAL	1 111 357,84	25 719 622,70	26 830 980,54	24 825 929
LESS:				
Income for internal services . . .	4 566,70	3 115 285,38	3 119 852,08	3 101 674
SUB-TOTAL	1 106 791,14	22 604 337,32	23 711 128,46	21 724 255
Balance transferred to Accumulated Fund	108 782,44	759 709,66	868 492,10	716 711
TOTAL	R 1 215 573,58	23 364 046,98	24 579 620,56	22 440 966

PRETORIA
3.8.73

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

Income	1972/73			1971/72
	Grants R	CSIR R	Total R	
Parliamentary grant	1 213 900,00	12 495 300,00	13 709 200,00	12 597 500
Investigations and services	-	9 985 660,27	9 985 660,27	8 891 784
Contributions to CSIR projects	-	661 203,44	661 203,44	879 140
Publications	1 673,58	20 212,58	21 886,16	16 948
undry	-	201 670,69	201 670,69	55 594
TOTAL	R1 215 573,58	23 364 046,98	24 579 620,56	22 440 966

(Sgd.) J.H. Visagie, *Secretary/Treasurer*

CSIR BUDGET 1973/74

Statement No. 3

A. OPERATING EXPENDITURE

ACTIVITIES	EXPENDITURE				FUNDS		
	Salaries	Direct running expenses	Awards and subsidies	Amount internally recovered	Total	Parliamentary grant	Recoverable expenditure
	R	R	R	R	R	R	R
CSIR laboratories and departments	19 947 881	10 428 163		3 414 331	26 961 713	14 303 150	12 658 563
Grants and subsidies	239 520	143 336	1 817 864	77 400	2 123 320	1 984 600	138 720
Total	<u>20 187 401</u>	<u>10 571 499</u>	<u>1 817 864</u>	<u>3 491 731</u>	<u>29 085 033</u>	<u>16 287 750</u>	<u>12 797 283</u>

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	114 255	1 651 430	113 345	80 220	50 000	1 000 000	3 009 250	2 307 550	701 700
Grants to universities etc.	1 000	72 172	378	-	-	-	73 550	73 550	-
Total	<u>115 255</u>	<u>1 723 602</u>	<u>113 723</u>	<u>80 220</u>	<u>50 000</u>	<u>1 000 000</u>	<u>3 082 800</u>	<u>2 381 100</u>	<u>701 700</u>
GRAND TOTALS A & B							<u>32 167 833</u>	<u>18 668 850</u>	<u>13 498 983</u>

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