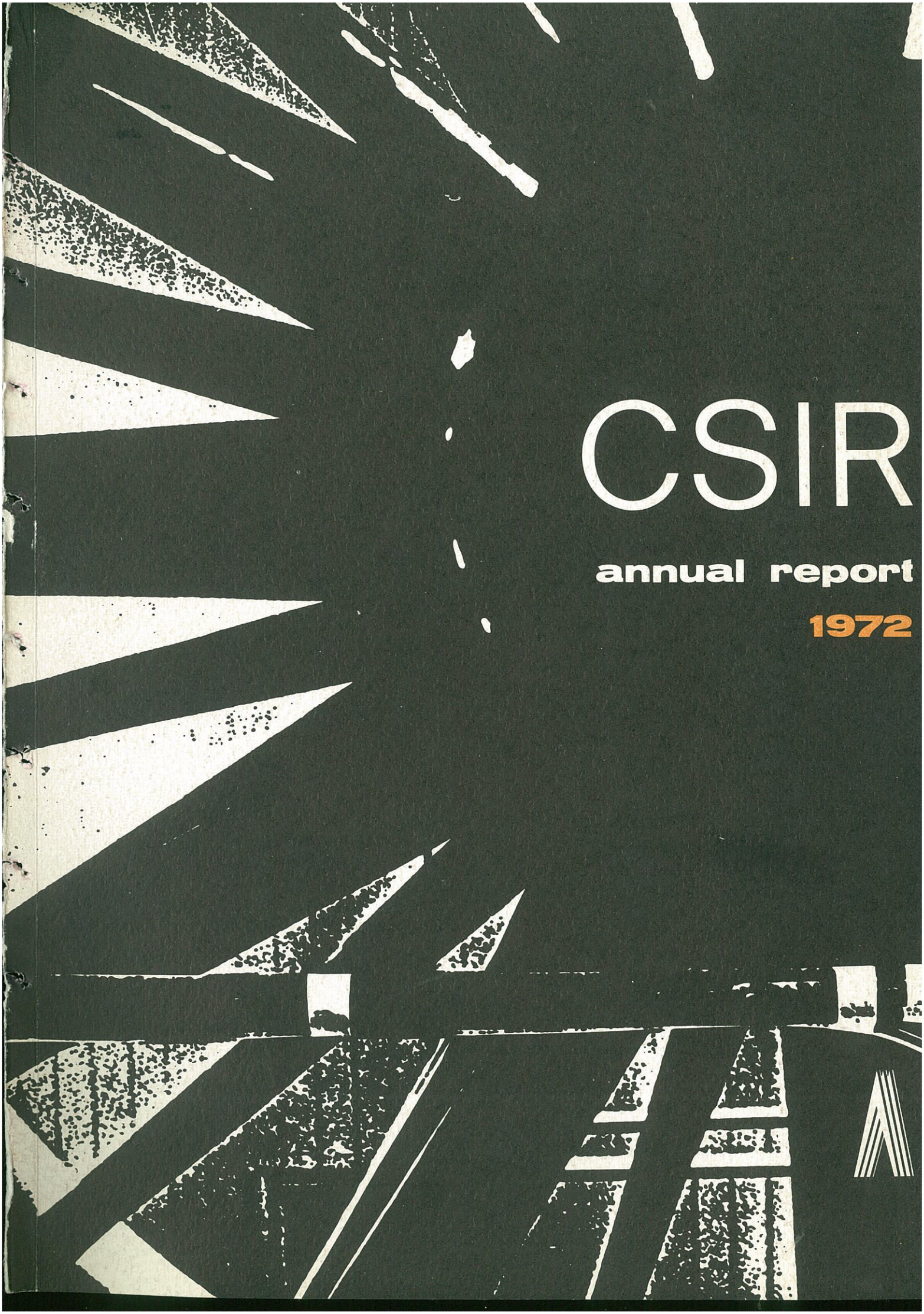


CSIR

annual report

1972

twenty-eighth annual report 1972

CSIR
P O Box 395
Pretoria

1st May, 1973

The Hon. J.J. Loots, M.P.
Minister of Planning and the Environment
Private Bag 9034
Cape Town

Sir

I have pleasure in presenting to you the twenty-eighth Annual Report of the South African Council for Scientific and Industrial Research. This Report covers the period 1st January, 1972 to 31st December, 1972.

Balance sheets and statements of income and expenditure for the financial year ended 31st March, 1972, certified by the Controller and Auditor-General, are included.

Yours faithfully

C. v.d. M. BRINK
President: South African Council for
Scientific and Industrial Research

Copies of this report (in English or Afrikaans) can be obtained from
The Distributor of Publications
CSIR
P O Box 395
PRETORIA
South Africa

Annual Report S. Afr. CSIR No. 28
UDC 5·6]: 061.6.055.5] (680)
ISBN 0 7988 0347 9

Compiled by the Publishing Division
Information and Research Services
CSIR
Published by the
South African Council for
Scientific and Industrial Research
P O Box 395
PRETORIA

Printed 1973 in the
Republic of South Africa
by
Graphic Arts Division
CSIR

south african council for scientific and industrial research

contents

executive of the CSIR

Dr C. v.d.M. Brink,
President

members of the south african council for scientific and industrial research 1972

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 Managing Director, 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

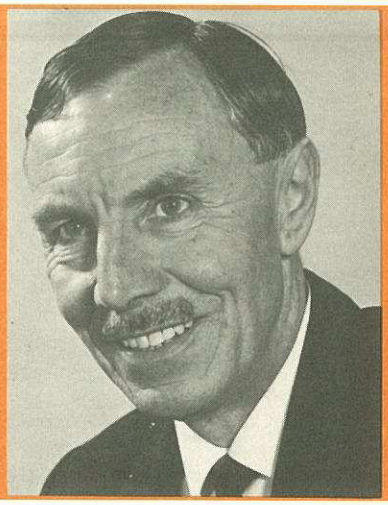
Mr J.D. Roberts
Chairman, Murray & Roberts Holdings Ltd

Dr A.J.A. Roux
Chairman, Atomic Energy Board

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

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

Dr F.J. Hewitt,
Deputy President



Dr P.J. Rigden,
Vice-President

Dr J.F. Kemp
Vice-President

the year in retrospect

The main staff appointment during the year was that of Dr F.J. Hewitt as Deputy President of the CSIR.

Dr Hewitt, who had been a Vice-President since 1965, joined the CSIR in 1946 as officer-in-charge of the Telecommunications Research Laboratory. When this laboratory became the National Institute for Telecommunications Research (NITR) in 1957, he became its first Director, and under his guidance, it became one of the most successful institutes of the CSIR. He played an important role in the negotiations which led to the establishment of the Radio Space Research Station at Hartebeesthoek, which since 1961 has been operated by the NITR on behalf of the United States National Aeronautics and Space Administration. A pioneer in the development of radar in South Africa, Dr Hewitt made important contributions in this field during the Second World War. His subsequent research into lightning, using radar, received international recognition.

In December Dr P.C. Carman retired as Director of the National Chemical Research Laboratory (NCRL), a post he held for fourteen years. Dr Carman has had a long and distinguished career. He is the author of more than fifty original publications mainly in the field of physical chemistry, and was awarded the Gold Medal of the South African Chemical Institute for his contribution to chemical science.

He is being succeeded as Director by Dr P.R. Enslin, formerly Head of the Organic Chemistry Division of the NCRL and a well-known scientist who has gained international recognition for research on the structure of the bitter principles of the *cucurbitaceae*.

Another senior appointment announced during the year was that of Mr T. Hodgson as Director of the CSIR Technical Services Department in succession to Mr J. van der Staaij, who retires at the end of 1972 after 25 years' service with the CSIR. Mr Hodgson, who was Head of the Heat Mechanics Division of the National Mechanical Engineering Research Institute, is an authority in the field of abattoir refrigeration and is well known in the refrigeration and air-conditioning industries in South Africa.

In July Mr P.J. van der Westhuizen assumed duty as the Head of the South African Science Office in Paris with the rank of Scientific Counsellor attached to the South African Embassy. He succeeded Mr O.A. van der Westhuysen, who returned to South Africa to join the Science Co-operation Division of the CSIR, after serving as Scientific Counsellor in Paris since the beginning of 1968.

Regional activities featured prominently in the programme of events during 1972.

On April 19, extensions to the CSIR's Natal Regional Laboratory in Durban were officially opened by the Administrator of Natal. These extensions will permit expansion of the CSIR's wide spectrum of research services in Natal. Also housed in the new building, is the newly-appointed Natal representative of the CSIR's Technical Information Service, whose main function will

be to maintain contact with industry in Natal and in particular to assist smaller and medium-sized firms to make the best use of available information sources and research facilities. The official opening coincided with the annual meeting of the Natal Regional Research Liaison Committee, which has the function of reviewing and co-ordinating research carried out by the CSIR in Natal. Its membership includes representatives of the Natal Provincial Administration, the University of Natal, the University of Durban-Westville, the Durban Corporation and the Natal Chambers of Industry and Commerce, together with senior staff members of the CSIR.

Bloemfontein was the venue of the CSIR Council meeting in June. The Council, under the chairmanship of the President of the CSIR, meets every four months at the CSIR headquarters in Pretoria, but in recent years the practice has been to hold one of the meetings in another city. At a function held in conjunction with the Council meeting in Bloemfontein, the Administrator and members of the Provincial Council of the Orange Free State, representatives of other bodies and prominent business and professional men had the opportunity of seeing the first screening of the latest CSIR documentary film in the series *Science in your Service*.

In the Western Cape, Dr S.G.Wiechers was appointed Officer-in-charge of the Regional Laboratory of the National Institute for Water Research. He succeeds Dr G.G. Cillie who held this position for eight years prior to his appointment as Director of the Institute in Pretoria in November 1971. In addition to general responsibility for water research activities in the Western Cape, Dr Wiechers will have specific responsibility for a project on the desalination of water.

A focal point of attention in the Cape was the South African Astronomical Observatory (SAAO), which was established under an agreement between the CSIR and the Science Research Council of the United Kingdom. The new observatory with its headquarters in Cape Town and its new observing station at Sutherland in the Karoo, is jointly financed by the two parties but is operated by the CSIR as one of its institutes. Sir Richard van der Riet Woolley, Britain's former Astronomer Royal, was appointed as the first Director of the SAAO. The site at Sutherland, which is situated on a high plateau some 33 km east of the town, offers almost ideal conditions for astronomical observation. The Observatory, supported by the sophisticated computing and other support services at the Cape Town headquarters, will provide local and overseas astronomers with excellent facilities for studying the southern skies. Installation of equipment at the site was nearing completion at the end of the year under review, and arrangements for the official opening of the observing station by the Prime Minister, the Hon. B.J. Vorster, on 15th March 1973, were far advanced.

The time service formerly provided by the Republic Observatory in Johannesburg (which has been amalgamated with the Royal Observatory in Cape Town to form the SAAO) has been taken over by a special Time Standards Section of the National Physical Research Laboratory. This Section controls the time signal and standard frequency transmissions for Southern Africa from Radio Station ZUO, and is equipped with an atomic clock that uses the element caesium-133. On June 30 the first step adjustment of one second was made in accordance with the international uniform time scale (UTC) which came into force on 1st January.

A rather unusual ceremony which took place in February was the unveiling of the 'moon flag' at the Radio Space Research Station by the Minister of Planning, the Hon. J.J. Loots. This miniature South African flag, which had travelled to the moon and back with the Apollo 14 astronauts, had been presented to South Africa by the flight leader, Rear Admiral Alan Shepard. Mounted on cardboard together with a colour picture of the Apollo 14 lunar module, the flag has been placed in the care of the CSIR and will be permanently exhibited at the Radio Space Research Station, Hartebeesthoek.

An important event in the sphere of international co-operation was the announcement of South African participation in the earth resources technology satellite (ERTS) programmes. In South Africa the CSIR, the Department of Agricultural Technical Services, the Geological Survey and the Department of Planning are involved. Participation in the programme of the first satellite (ERTS-A) launched at the end of May 1972, was co-ordinated by Dr O.G. Malan of the CSIR's National Physical Research Laboratory. The first photographs received towards the end of the year are being studied to determine their value for surveys of vegetation boundaries and plant growth, land usage, soil types and geology.

The use of satellites to collect information was discussed at a symposium on remote sensing held in Pretoria and organized by the CSIR in collaboration with the Department of Agricultural Technical Services and Spectral Africa Limited. The symposium was attended by leading scientists from South Africa and abroad.

A proposal concerning the use of earth orbital satellites for the study of Antarctica was submitted to the international Committee on Space Research (COSPAR) by Dr F.J. Hewitt (Chairman of the South African Scientific Committee for Antarctic Research) on behalf of SCAR, the international Committee on Antarctic Research.

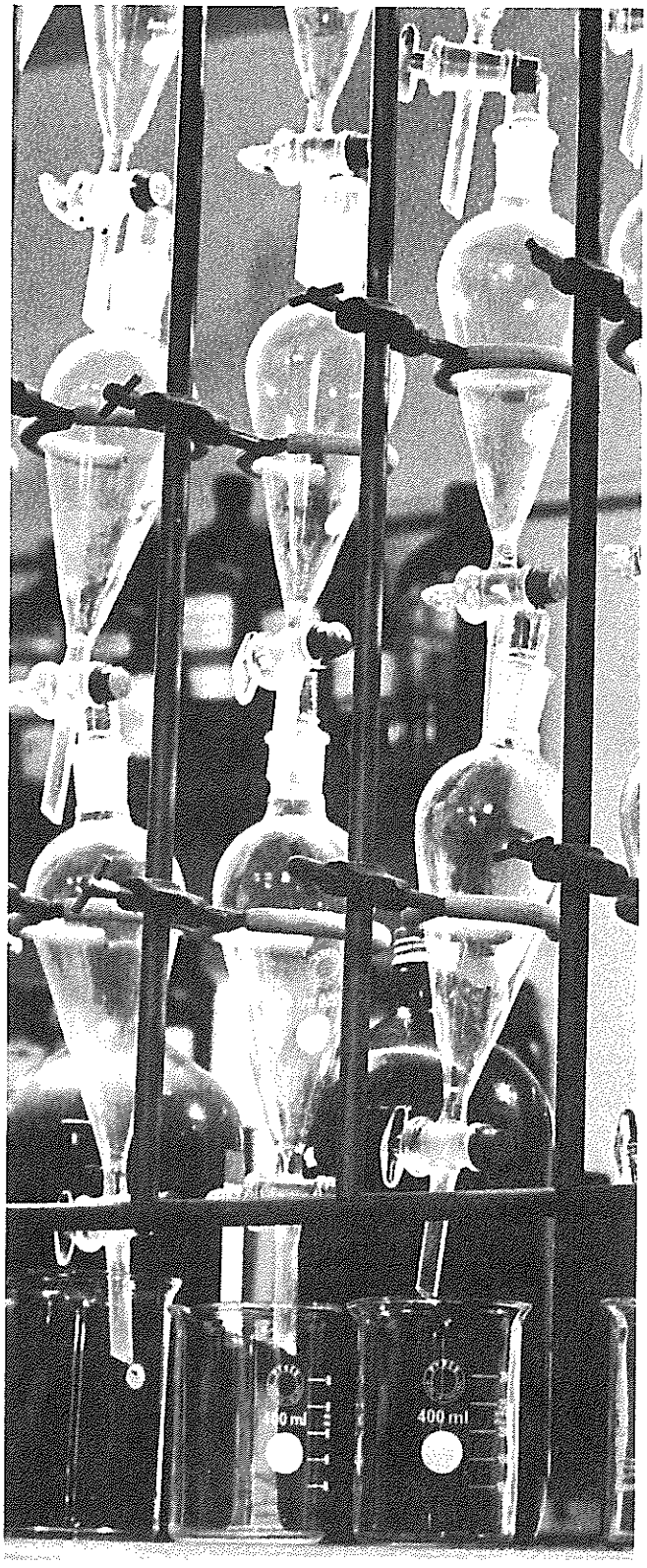
Besides the symposium on remote sensing, several other symposia and conferences were arranged by the CSIR (usually in collaboration with other bodies). These covered subjects such as spectroscopy, corrosion, industrial applications of powder coatings, current awareness services for industry, the challenge of the ocean to engineers, the utilization of sawn timber and various aspects of building research.

One of the most important of these symposia was the one on high density housing held in Johannesburg in September, which focused attention on the problems of adequately housing growing urban populations and on the need for proper planning based on research. This symposium, which was organized by the National Building Research Institute of the CSIR under the auspices of the Minister of Community Development, was attended by more than 500 delegates. The discussions covered virtually the whole field of housing, from the establishment of a satisfactory environment to more realistic building regulations, and included a seminar on the legal aspects of house-ownership in high density developments. One of the major resolutions adopted was that group and cluster housing be permitted as a first step towards more effective utilization of land.

The year ended on a 'high level' with the successful test flights in November and December of the experimental autogyro designed, developed and constructed by the Aeronautics Research Unit of the CSIR. The autogyro project not only provided the prototype for an uncomplicated and safe short take-off and landing (STOL) aircraft, but also provided engineers and technicians with practical experience in the major fields of aeronautical engineering and thus contributed towards the knowledge, expertise and experience necessary for a developing aircraft industry.

National Chemical Research Laboratory

Director: Dr P.C. Carman



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.

The Laboratory is organized into divisions of organic chemistry, biochemistry, macromolecular chemistry, inorganic chemistry and analytical chemistry. The NCRL also operates a chemical physics group jointly with the National Physical Research Laboratory.

Without basic research, whereby fundamental or new knowledge is obtained, applied research cannot progress. Whereas most fundamental research workers, such as scientists at universities, can undertake basic research purely to obtain more knowledge about some particularly interesting subject, a national laboratory like the NCRL must limit its choice of fundamental study projects to those which may benefit applied research.

It is the NCRL's policy to concentrate its fundamental research on fields where, for practical reasons, a demand for more knowledge exists. In accordance with this policy, most of the research projects are carried out in collaboration with other research organizations which are directly concerned with the practical problems involved.

Pharmacologically active substances

In their search for anti-tumour substances the National Institutes of Health in the USA have found that the bark of a South African tree produces an extract with promising activity. Another aspect of this work has been the synthesis of modified nucleosides in which the carbohydrate moiety is varied. Methods for producing new types of aminosugars and branched chain sugars have been developed as part of this project.

Attempts to produce steroids with hormonal and anti-inflammatory properties have been based mainly on preparations of derivatives of cucurbitacins as the Laboratory has had special experience with these steroids. A new development has been the complete synthesis of a testosterone analogue, using an intermediate provided by a French firm, thereby avoiding dependence on a plant steroid as starting material.

Toxic metabolites from fungi

Though ochratoxin was identified and its structure determined by the Laboratory, the occurrence of poisoning caused by it does not appear to be serious in South Africa. It is, however, a very virulent toxin affecting kidney functions in particular. Numerous reports from other parts of the world mention instances in which

ochratoxin has caused mortality in pigs and a high incidence of foetal abortions in stock after the animals had been fed on infected grains.

The investigation into the structure of diplodiatoxin has at length been completed with the aid of a new computerized nuclear magnetic resonance spectrometer. This toxin is produced by a fungus which appears on maize and is responsible for diplodiosis, a disease causing lameness and other symptons in stock fed with the grain.

Much of the current work on fungal toxins originates from a screening programme on foodstuffs of the population of Swaziland by the South African Institute for Medical Research. A *Penicillium* species on maize was identified which yielded citreoviridin, a virulent toxin known to be responsible for yellow rice toxicosis in Japan, though thus far it has not been known to produce harmful effects in South Africa. The Laboratory recently completed a study of its biosynthesis.

Insect pheromones

In the research on insect pheromones definite progress can be reported only on the gregarization pheromone of locusts. Numerous substances showing activity in one respect or another were isolated and identified. One of them proved to have the highest activity, affecting all three characteristics which accompany transition from the solitary to the gregarious state.

Sorghum polysaccharides

In the brewing of Bantu beer, malting of grain sorghum not only produces diastase but also modifies the constituents so that they are broken down more easily. Current work has been concentrated on what happens to the hemicelluloses obtained from the grain husks. An extract has been obtained which appears to have a polymolecular distribution. Attempts to fractionate this by chromatography have yielded one distinct fraction and two partially separated fractions.

Snake venoms

Since the Laboratory began research on snake venoms, contact has been made with four foreign laboratories interested in the work. The rapid acceleration of research in this field can be attributed to the large number of closely related toxins found originally in cobra species but later also in species of two other genera, namely mambas and sea snakes.

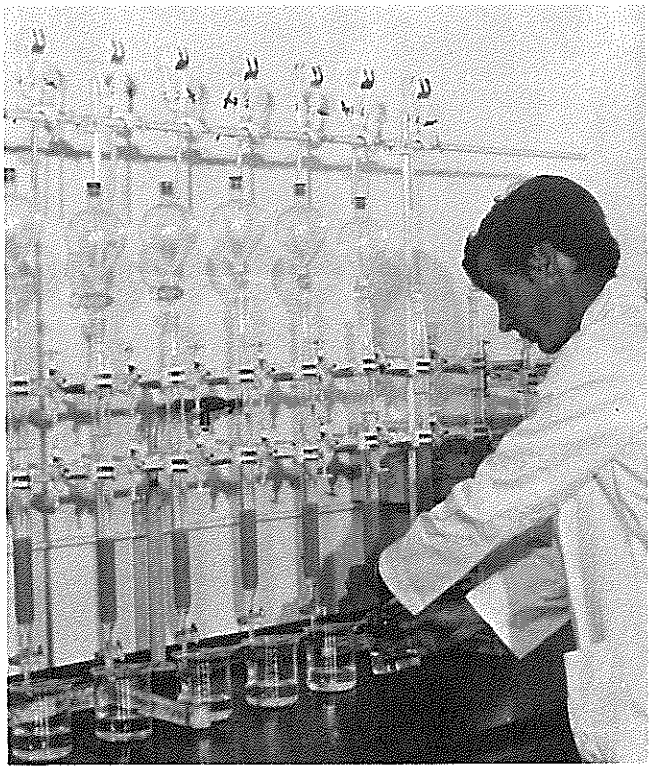
Altogether thirty-two complete amino-acid sequences are now available, half of which were provided by this Laboratory. As may be expected, several general features have been observed. Certain elements of structure are common to all and some of these determine the degree of toxicity. When only eleven structures were available, it was noted that an evolutionary relationship could be traced, i.e., one of the toxins could be distinguished as the primitive ancestor from which the others emerged by mutation, and that an 'evolutionary tree' showing the lines of differentiation could be constructed.

Wool

It was recognized many years ago that when wool is reduced a large part of it can be made soluble. An important step taken by the Laboratory was the development of techniques for separating from the soluble part fractions pure enough for further study. These fractions were used in amino acid sequence studies and the research group concerned obtained international recognition for the first information to be published on the amino acid sequences of portions of the wool molecule. More fractions were studied this year but as the work is now being done in Australia on a larger scale the emphasis here has been shifted to a comparison of wool with mohair. According to findings thus far the two fibres show striking similarities.

Cancer biochemistry

Attention during the last year or two has been concentrated mainly on the action of carcinogenic dyes taken up in the nuclei of liver cells of rats. The results depend mainly upon techniques for isolation of nuclei, i.e. rupturing them completely and fractionating the various components. A new technique was described for fractionation of the chromosome portion, which contains genetic information, and tentative conclusions were drawn. Recently this 'chemical technique' has been compared with modern fractionation techniques by zonal centrifugation, and doubt has arisen about the degree of separation obtained in the fractions. Techniques are being further refined to clear up this important question.

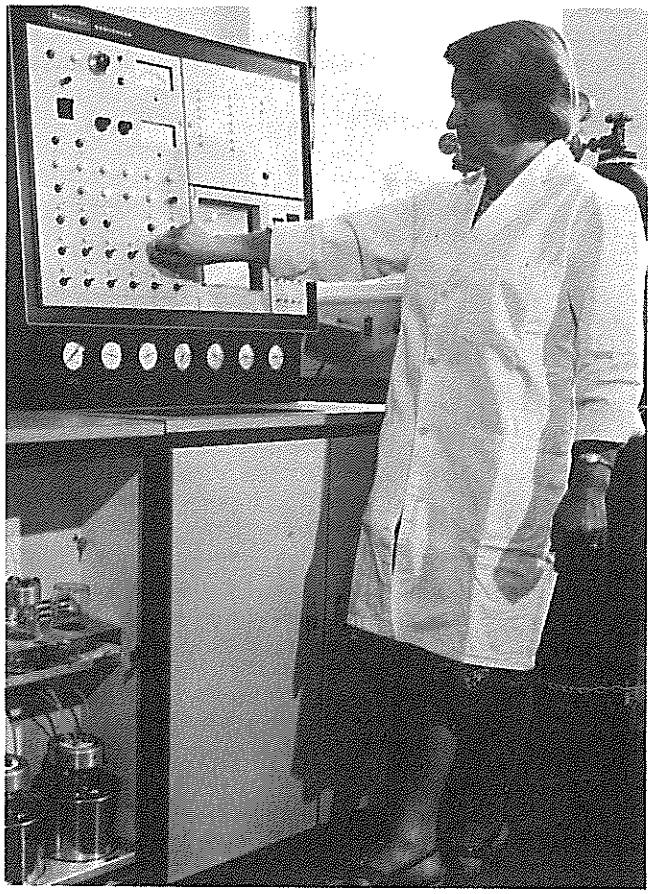


A series of ion exchange columns used in the analysis of lunar samples.

Digestion in ruminants

The joint group formed with the Department of Agricultural Technical Services and working at the Onderstepoort Laboratories has continued its work on a broad front. The introduction of 80 mm fistulas has shown that adaptation of rumen flora to biuret supplements is rapid and presents no problems. In earlier studies this matter had been doubtful as the micro-organisms concerned are found mainly on the coarse material in the rumen, which could not previously be properly sampled. There is increasing appreciation of the practical implications resulting from many years of research on the relationship between ruminal flora and diet. Talks and lectures have been delivered on request to sections of the Department of Agricultural Technical Services concerned with practical feeding problems.

A guest worker from the University of Munich, assisted by members of the Group, made an interesting study of wild ruminants. No marked differences in rumen digestion were found, the contents and behaviour of the rumen in buffalo and several types of buck being fairly similar to the rumen in sheep fed on high roughage rations.



Pneumoconiosis

Much effort has been spent on investigating a claim by an overseas worker that in lungs exposed to silica macrophages develop a 'factor' which stimulates fibrosis. The results obtained by the Laboratory and by the South African Cancer Research Institute, which used a different approach, do not support this claim.

Human growth hormones

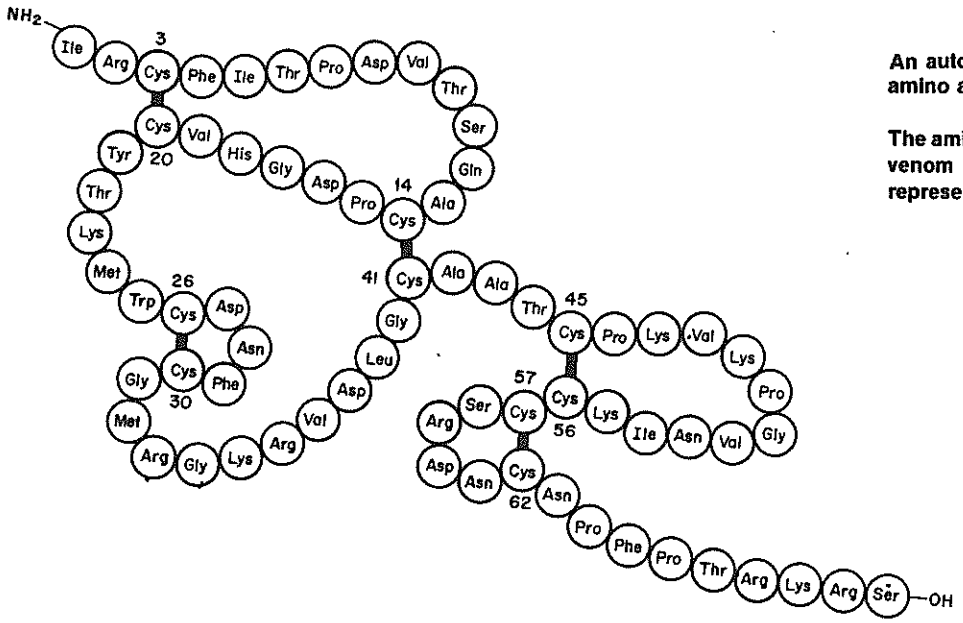
There is a growing realization that if the South African medical profession is to treat dwarfism legal restrictions on the collection of pituitary glands must be removed, as has been done in other countries. In spite of the present restrictions one patient was treated successfully. Enough hormone has been prepared for the treatment of a few more, but a whole panel of doctors will have to select the patients.

Analytical chemistry

Apart from its applications in useful new quantitative separations, ion exchange chromatography has also been employed as an important preliminary concentration step in the spark source mass spectrometry method. It has also been used in the analysis of lunar samples obtained on the Apollo 14 and 15 missions. In collaboration with the National Institute for Metallurgy an ion exchange method has been developed for the separation of rare earth elements in the ppm range.

Gold and platinum chemistry

Work during the past year has been confined almost entirely to the platinum group metals. The chemistry of these is of such importance that it is being studied at many research centres throughout the world, and a thorough



An automatic apparatus for determining the amino acid sequence of protein molecules.

The amino acid sequence of the α-toxin of the venom of the Cape cobra. The circles represent the amino acids.

literature survey has been carried out to pinpoint gaps in knowledge.

The work of the research group concerned is strongly integrated and its papers have become well known. Two of its leaders, with the aid of funds provided by the Chamber of Mines of South Africa, attended the 14th International Conference of Co-ordination Chemistry in Toronto to present papers on their work.

A project has been undertaken to provide fundamental information for the National Institute for Metallurgy which is carrying out a programme for the rapidly growing industry of platinum refining in South Africa.

Very rapid reactions have to be studied and an apparatus for studying reactions with a halflife of 3 milliseconds is now yielding useful results after considerable teething troubles.

Chemical physics

The National Physical Research Laboratory and the National Chemical Research Laboratory operate a joint Chemical Physics Group which is concerned mainly with fundamental studies. The specialized facilities at its disposal, particularly for X-ray diffraction and nuclear magnetic resonance, have been of great assistance to organic chemists and platinum chemists in determining some of the unusual structures of compounds produced in the course of their work.

Corrosion

The Corrosion Group delivered two papers at the second South African Corrosion Conference. The paper on corrosion of metals by anaerobic bacteria awakened considerable interest, particularly as the importance of the incidence of this type of corrosion in South Africa has only recently been recognized. Attention has also been directed to original research on the mechanism of corrosion, but more effort is now being expended on methods of combating corrosion, especially in cases reported by the South African Navy.

A ten-year study of the effects of 'white rust' or staining caused by wet storage of galvanized sheets for roofs has been terminated. Although the effects are unsightly and any actual loss of zinc correspondingly reduces the useful life of the zinc coat, there is no indication that the zinc coating becomes more susceptible to corrosion, as is frequently maintained.

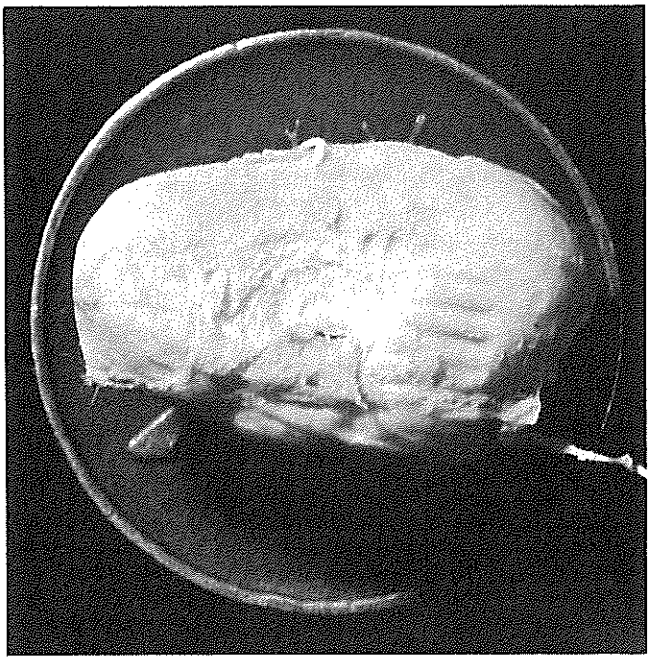
The serious problem caused by the corrosion of galvanized hot water pipe systems in Durban and Cape Town has not been solved. A simulator has been built to study the problem on the spot.

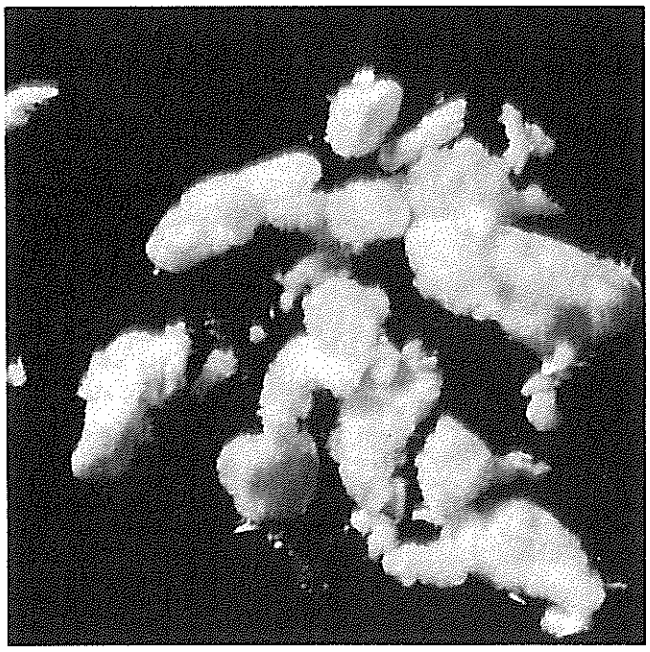
Bantu beer

The activities of the Bantu Beer Unit have been considerably extended and its budget has been increased accordingly. The research work which was already extensive has been expanded but the main change has been a great increase in consultative and service activities.

The Unit is represented on a standing committee set up by Parliament to advise the Department of Bantu Administration on the bantu beer industry. As a result, its staff has become closely involved in all aspects of the erection and commissioning of new breweries and it has become necessary to obtain the help of other CSIR Institutes, e.g. the National Building Research Institute has helped in planning beerhalls, and the Techno-economics Division was involved in the important question of the rationalization of the brewing industry. After a somewhat hesitant start, courses for a National Diploma in Brewing Technology are now running successfully, and much more competent management and operation of breweries can be expected in future.

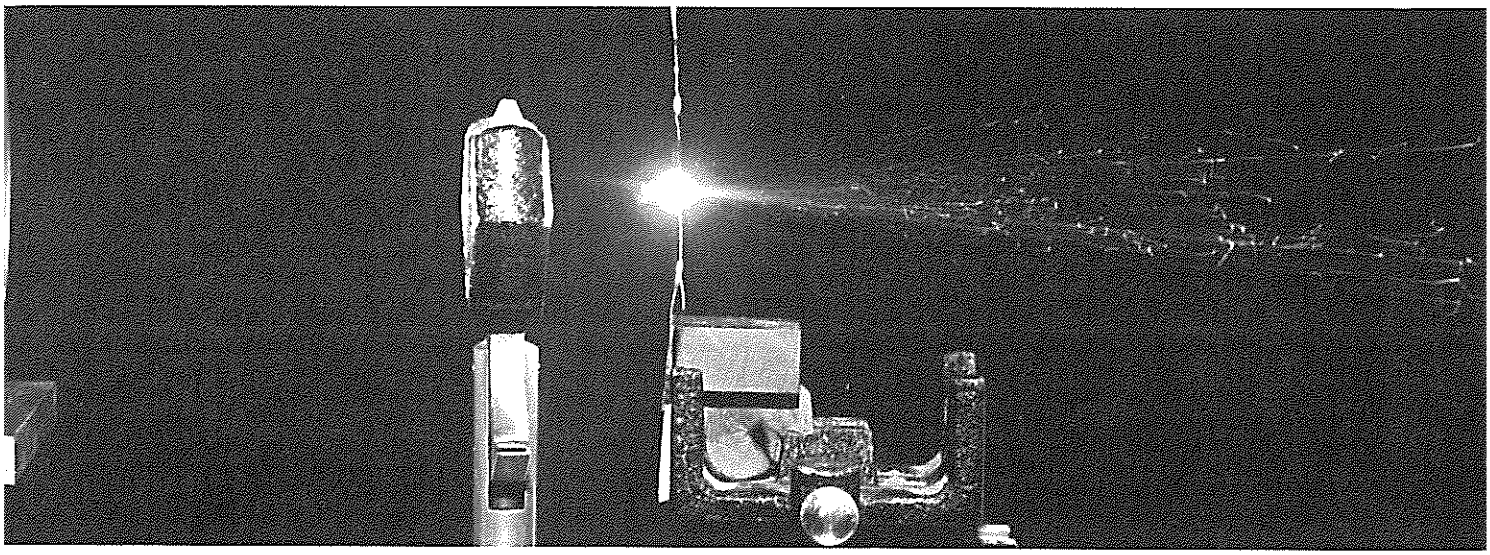
As far as the application of research results is concerned one of the country's major breweries has successfully used frozen inoculum developed for rapid souring. A comparison of local and overseas brands of dried yeast has shown that local products can be improved considerably.

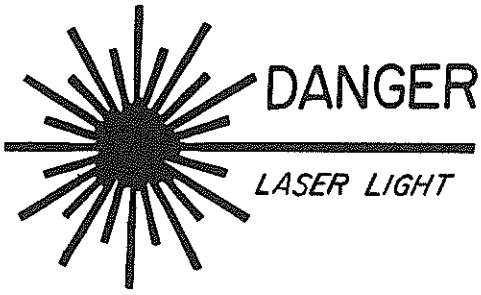




Top: **A human pituitary gland on a one cent piece to show its size.**

Bottom: **On the same scale as above, the amount of growth hormone that can be extracted from one gland. This is enough for one of the 100 to 150 doses needed for one patient.**





National Physical Research Laboratory

Director: Dr A. Strasheim

physical research

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, infra-red spectroscopy, electron microscopy, geophysics, geochronology, oceanography, high pressure physics and natural isotopes.

New developments

The importance of materials in modern technology cannot be over-emphasized. To ensure that the NPRL will become involved in this important field of research and technology a Physics of Materials Group is being established within the Laboratory.

The electric cable used as a shark barrier was successfully laid off the Natal coast at the beginning of May. Work is proceeding on the electronic pulse equipment and the building to house it. It is hoped that this project will be completed during 1973.

Mikronmeter

A prototype of an electronic version of the Mikronmeter (an instrument used to determine fibre thickness) was taken to New York by a staff member of the Laboratory for the ASTM show held from 21 to 24 March 1972. The instrument performed well but little interest was shown by the American wool industry. Representatives of the artificial fibre industry were more enthusiastic, but the secrecy in this industry is likely to prevent rapid developments.

The instrument represents a joint venture by the NPRL, the South African Inventions Development Corporation and an American company.

Cement analysis

On behalf of the Cement Producers' Association an investigation was undertaken into the use of atomic absorption spectroscopy for the analysis of cement and the materials used in its production.

The technique which was originally developed by the Laboratory was found to be almost as accurate and precise as more expensive techniques, e.g. the X-ray fluorescence technique, and considerably better than the chemical methods used in many cement factories at present.

The analytical system was tested under factory conditions and after initial difficulties had been overcome, it reproduced satisfactorily the results obtained in the laboratory. This technique will enable the cement industry to analyse a wider range of elements in their products and raw materials more accurately and more rapidly.

Manufacture of optical glass

The availability of glass of optical quality is regarded as a strategic requirement by developed countries. Although some overseas manufacturers of high-quality optical glass import their raw materials from South Africa the absence of a local optical industry makes the Republic dependent on foreign sources for its supply of optical glass and practically all optical components and equipment.

During the past year a small-scale facility was established for manufacturing specialized optical glasses for research purposes. The use of South African raw materials for the production of laser, photochromic, conductive, semiconductive and infra-red transmitting glasses is one of the major aims of this undertaking.

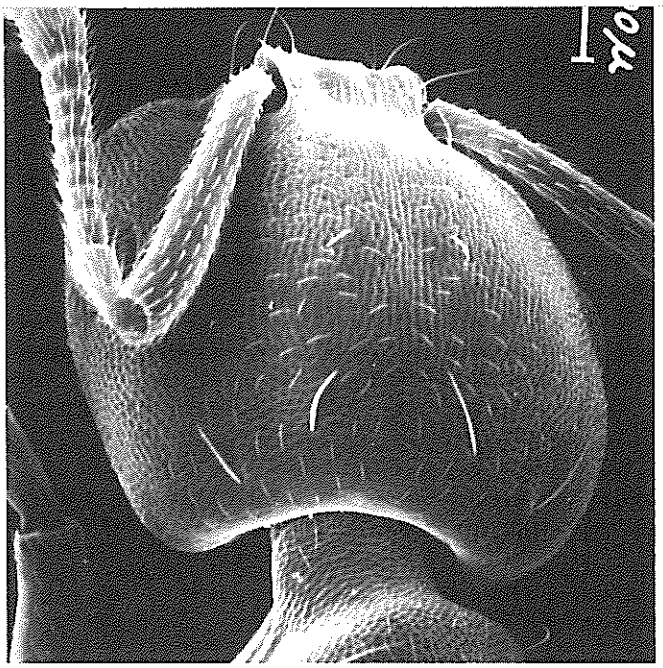
Scanning electron microscopy and electron microprobe analysis

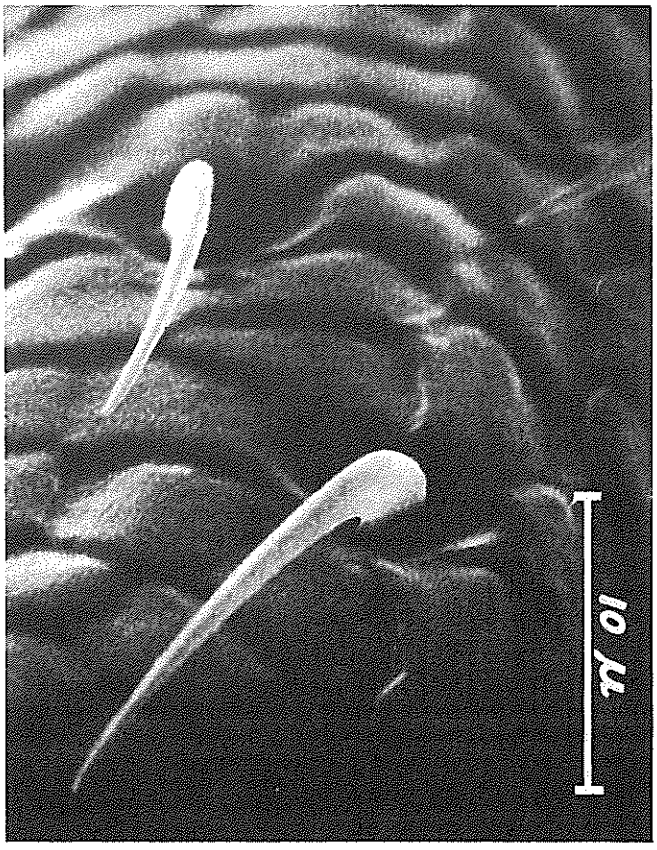
A scanning electron microscope (SEM) with electron microprobe attachments was installed at the NPRL during the year and is available as a service facility to other CSIR departments, universities and industry. It is a very versatile instrument which has wide applications in fundamental and industrial research, and is capable of producing secondary electron images of surfaces with an optimum resolution of 100Å. It can be used in various other modes of operation e.g. in 'voltage contrast' for semiconductor devices, or in the backscattered primary electron mode for composition contrast in mineral samples. The microprobe attachment for the SEM consists of an X-ray energy analyser which produces a qualitative analysis of the elements present in a localized area (as small as 1 μm^2) in a matter of seconds. A quantitative analysis is also possible by using an on-line computer. The instrument has been used extensively by the CSIR and universities and has proved to be of great value to research workers in fields ranging from botany to mineralogy.

Computer for improving analysis of metals

The Laboratory is studying the use of on-line mini-computers in the spectrometric analysis of materials. Inaccuracies caused by certain other elements present in high concentrations in samples can be corrected by applying computation techniques.

These techniques have been applied to the analysis of gold and high alloy steels by using a glow discharge source. In the case of gold the accuracy and precision obtained within minutes compared well with results obtained from fire assay techniques which take several hours. In the case of high alloy steels the direct computation of results obviates to a large extent the need for standard reference materials which closely match the composition of the sample. This is a significant advance as the preparation of standard reference samples is a difficult and expensive procedure.





Top: **The head and antennae of a small household ant photographed under the scanning electron microscope.**

Bottom: **The hair on one of the antennae shown above at higher magnification.**

Production of fluorine-18

A method has been developed for the production of the very important medical isotope fluorine-18. The isotope is made by bombarding very pure, sterile and pyrogen-free water with helium-3 particles. A special target assembly has been designed for containing water during its bombardment in the vacuum of the cyclotron. This is now used for routine production.

A consignment of fluorine-18 produced in Pretoria is dispatched every Monday to places as remote as Cape Town. Close co-operation with the provincial authorities and the South African Airways makes this possible.

Hail research

Information on the growth trajectory of a hailstone can be deduced from measurements of the deuterium content of its different layers. This is possible because the deuterium content of cloud droplets which are swept up by a growing hailstone during its passage through a cloud and subsequently frozen into its surface, is a function of their temperature, which in turn depends on their height in the cloud. This technique is being used in conjunction with ordinary structural investigations of hailstones and radar observations of the reflectivity structure of storms to find out more about the characteristics of hailstorms.

Radar observations during one summer have revealed three types of hailstorm, i.e. isolated single-cell storms, multicellular storms (with a characteristic pattern of development) and lines of storms up to several hundred kilometres in length.

Geomagnetic induction studies

An important conductive structure occurring under the Cape Folded Mountains and the southern Karroo has been detected by a large-scale array study of variations in the magnetic field. This anomaly which runs from east to west is probably situated in the upper mantle.

The preliminary results from a second array study covering parts of South-West Africa, Botswana and Rhodesia indicate the presence of a conductive zone in the vicinity of the Okavango Swamps, an area where small earthquakes frequently occur. These results are at present being computed.

Spark mass spectrographic analysis of rare earth elements

Rare earth element concentrations in geological materials of terrestrial and extra-terrestrial origin were determined successfully by using spark source mass spectrometry, preceded by chemical separation of the rock-forming elements calcium, magnesium, silicon, iron and aluminium. The project was undertaken jointly by the NPRL and the National Chemical Research Laboratory.

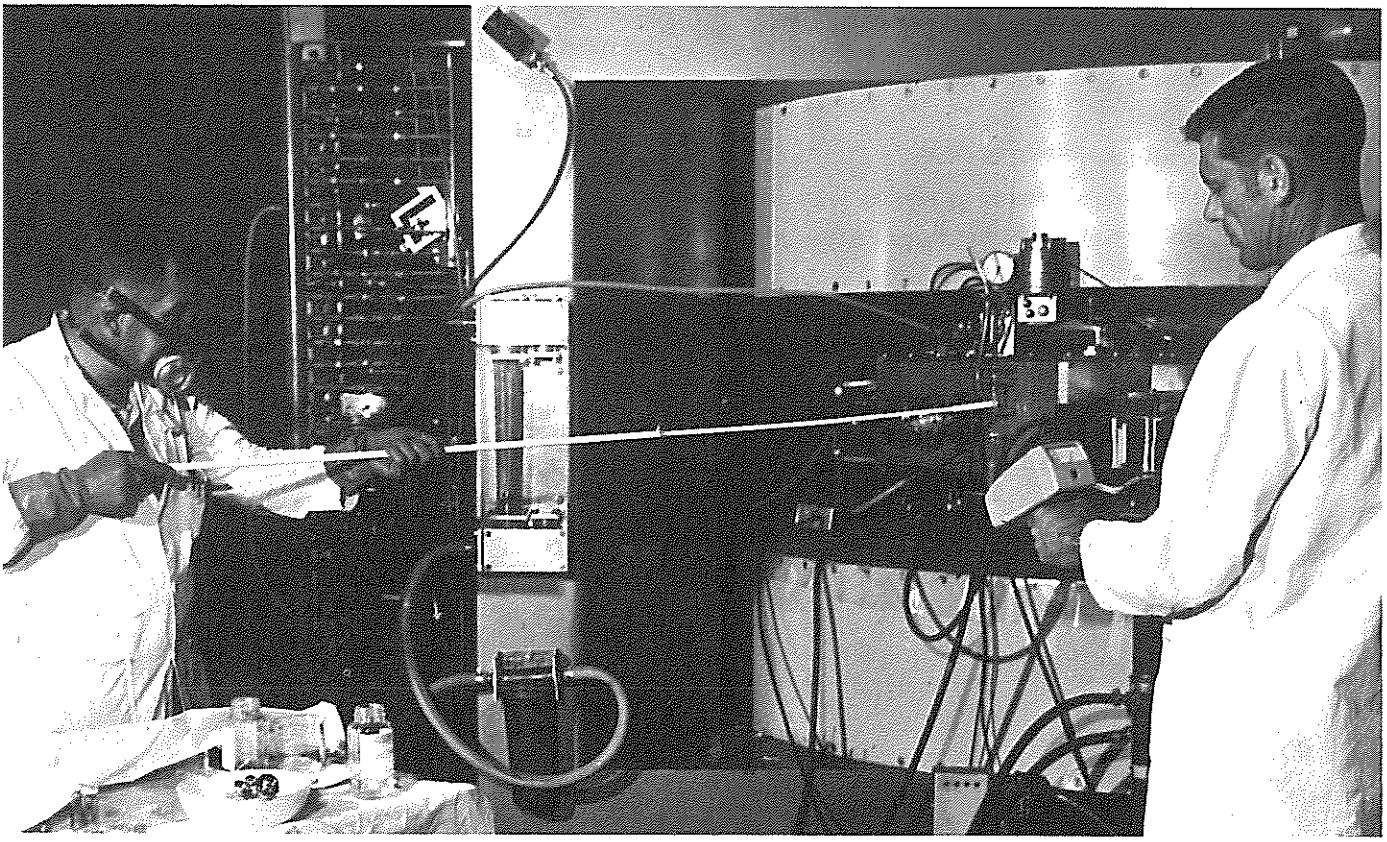
The method has a precision of better than ± 7 per cent and analyses of certain moon samples were satisfactorily accurate when compared with the results obtained elsewhere by internationally recognized scientists.

Fast neutron beams for radiotherapy

The treatment of anoxic tumours requires radiation with high linear energy transfer values. Fast neutron beams fulfil this condition and there is considerable interest in the use of deuteron and helium-3 beams from cyclotrons to produce secondary beams of fast neutrons.

The Laboratory has undertaken a study of the neutron yields and neutron spectra above 5 MeV obtained by bombarding various target materials with charged particles accelerated in the cyclotron.

It can be concluded that the bombardment of thick beryllium targets by helium-3 is a possible alternative to the usual deuteron reactions with beryllium or heavy-water targets. The helium-3 reaction yields neutrons which appear to be more suitable for use in radiotherapy.



Production of the radio-isotope fluorine-18 for medical purposes.

Diffusion in metals during ion bombardment

Prominent diffusion effects in metals at room temperature during bombardment with metal ions have been observed while investigating target sputtering rates and the

accompanying amounts of trapped ion material. In zinc this diffusion is prominent at room temperature and is still present at 77 K. Low-energy argon ion sputtering effectively advances trapped nickel atoms into this metal.

Radiation-enhanced diffusion is often ascribed to an increase in the concentration of vacancies which occurs in diffusion. The results of this investigation show that more mobile defects combined with a trapping mechanism must be involved here.

The results pertain to what happens during noble gas ion bombardment and also to the penetration of ions into metals. It also appears that it is not possible to remove discrete layers from surfaces by noble gas ion sputtering.

Epidote for radiometric dating

The possibility of using epidote ($Ca_2Al_2OHSi_3AlO_{12}$) proper for uranium-thorium-lead dating has been investigated. Age measurements on this mineral, which has a low concentration of radiogenic lead and comes from the Dalmein granite pluton in the Barberton Mountain land, support the preliminary conclusion that epidote data agree very well with the sphene and apatite results, giving an age of 3 230 million years which is 9 per cent higher than the zircon age.

Side-wall reflectors

Model studies were carried out to investigate the possibility of using concave sound reflectors in the vicinity of the proscenium of an opera house.

Because of the geometry of the surroundings, concave reflectors are efficient even when mounted in recesses behind sound-transparent screens. In this way visual and aesthetic problems caused by the proximity of reflectors to the stage may be overcome.

Acoustics of concert halls

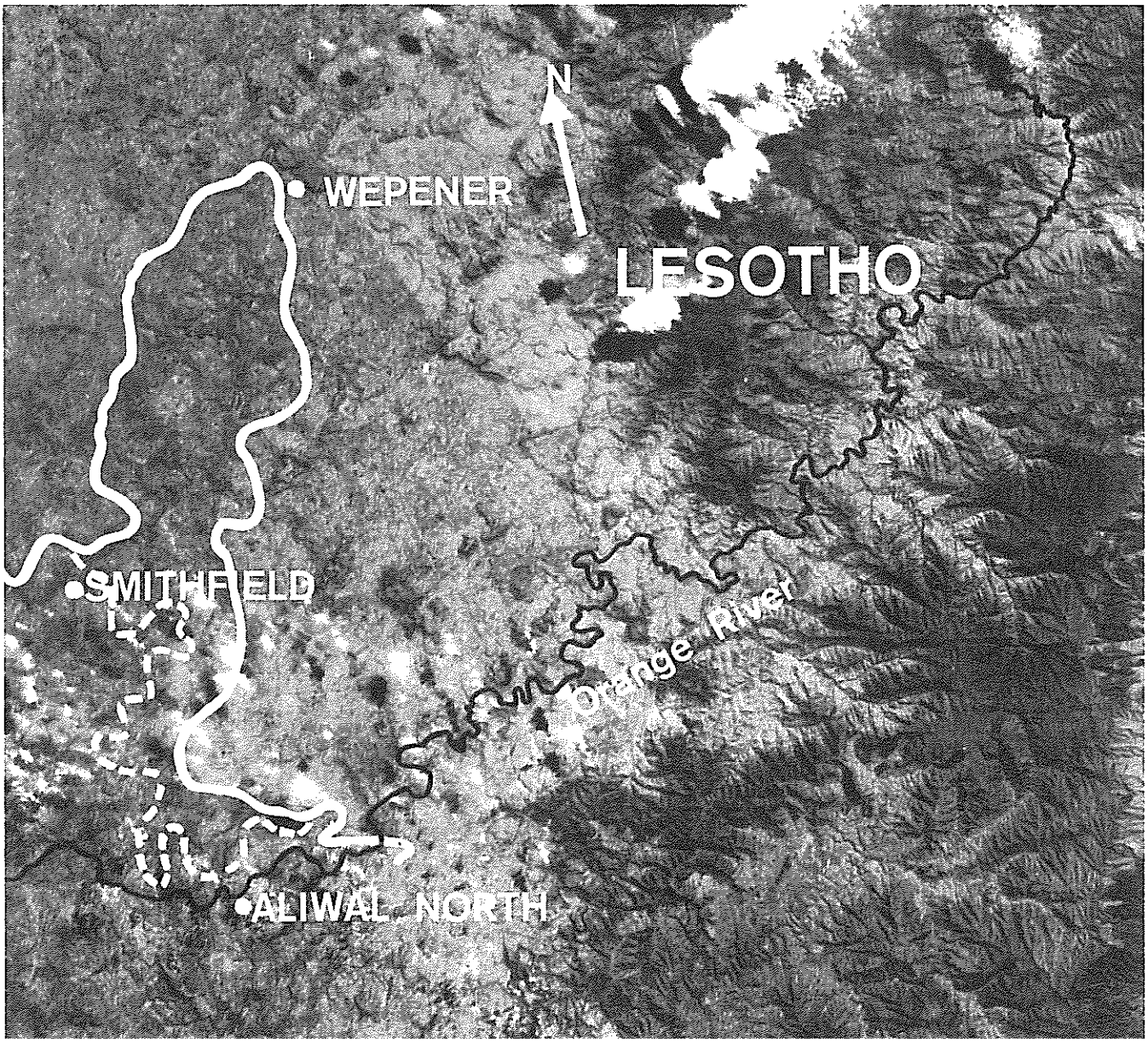
The evaluation of halls used for musical or dramatic performances has been largely a matter of subjective judgment which is difficult to translate into principles on which the design of such buildings may be based. Although physical measurements can be made in halls which are satisfactory these measurements cannot be evaluated fully without a complete understanding of the way in which the hearing mechanism functions. The

Karoo penetration as identified on ERTS photo .

Dashed line: Border of Karoo as mapped by Acocks, 1953.

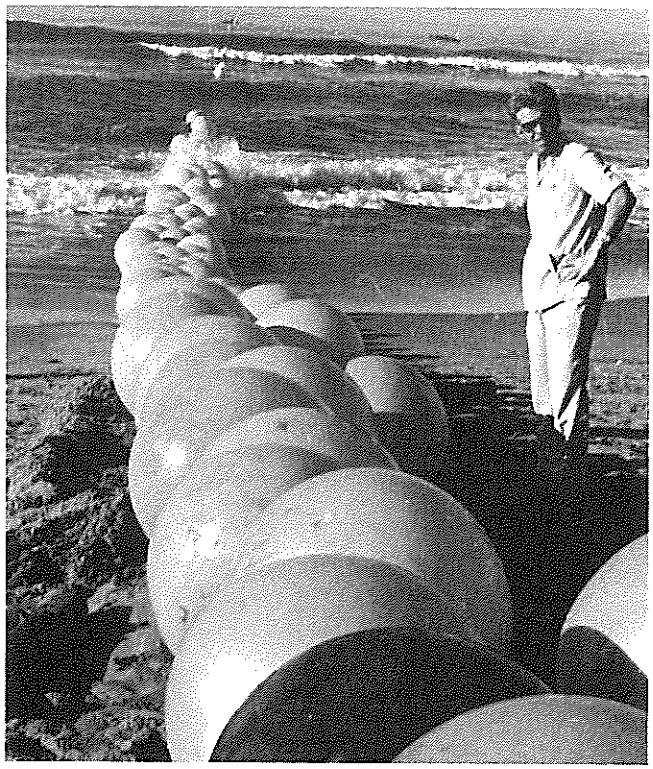
Heavy white line: Border of Karoo as estimated from ERTS photo, 10 September 1972.

NASA — CR — 130012. *To assess the value of satellite imagery in resource evaluation on a national scale.*



establishment of criteria of measurement which will define the properties of a hall in physical terms is therefore a task which is receiving world-wide attention. These criteria will also be used to define design procedures.

A possible criterion, based on the characteristics of the sound decay in a hall, was recently investigated by the Laboratory in such famous halls as La Scala, Deutsche Oper and De Doelen. It was found that this criterion made it possible to differentiate between good and bad seats using purely physical measurements.



A cable for an electric shark barrier being laid in the sea off the Natal coast.

Measurement of acoustic power

In order to protect people from noise and to create an acceptable acoustical environment, it is important to be able to measure the total acoustical power generated by a noise source. The methods used at present are inaccurate and cumbersome.

The Laboratory is developing a direct method in which sound power is measured by calculating the product of the sound pressure and the particle velocity measured at a point in the sound field. Since the phase relation between these two quantities is taken into account in this product, the true sound intensity at a particular point is obtained. By repeating these measurements at a number of points on a closed surface around the sound source, its total radiated power may be calculated.

With this new method measurements are not affected by the acoustical properties of the environment in which the source is situated, whereas with conventional methods the effect of the environment had to be carefully considered and could not always be eliminated.

The method also holds promise of improving the accuracy and ease with which acoustical properties of materials and sound transmission through partitions may be measured. It can also be used to measure extremely low sound intensities as it is essentially a correlation technique.

Symposium on remote sensing

A symposium on remote sensing sponsored by the CSIR, the Department of Agricultural Technical Services and Spectral Africa (Pty) Ltd was held in Pretoria during May.

About 150 delegates, some of whom represented Rhodesia, Lesotho, Botswana and Swaziland attended the symposium. Thirty papers were presented, six of them by overseas speakers, on the application of remote-sensing techniques to geology, geography, prospecting, meteorology, soil and botanical survey, agriculture, fisheries, oceanography, hydrology and regional planning.

Participation in ERTS programme

The first copies of satellite photographs taken over South Africa in different spectral bands have been received from the United States' National Aeronautics and Space Administration (NASA) following a South African request, initiated by the CSIR, to participate in the ERTS-A programme.

The staff of the Department of Agricultural Technical Services, the Geological Survey Division and the Department of Planning will collaborate in interpreting these photographs to survey natural resources.

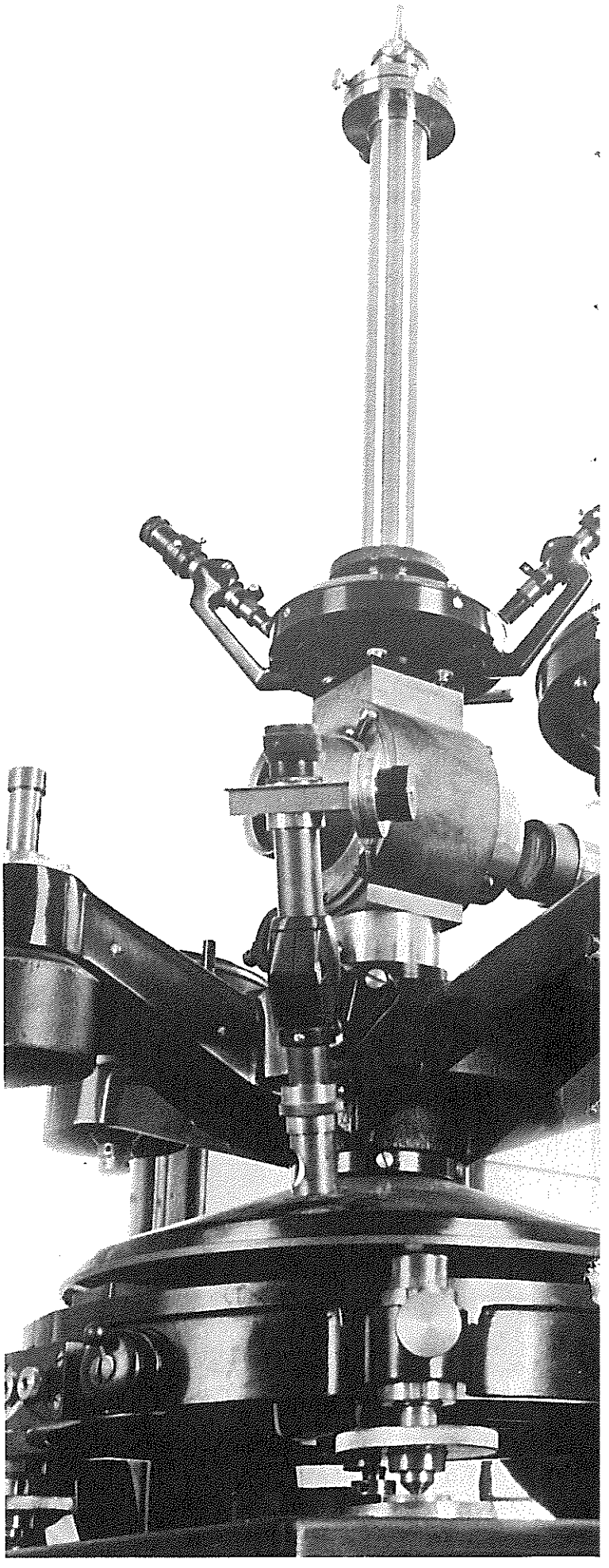
The Department of Agricultural Services has made funds available for a programme of aerial photography which will simplify the interpretation of the photographs. In collaboration with the South African Air Force selected sites are being photographed using different types of film at scales between 1:20 000 and 1:120 000.

The CSIR has provided the funds for a multispectral viewer by means of which selected features in the satellite photographs can be accentuated in colour.

Magnetic Observatory

Head: A.M. van Wijk

Although the activities of the Magnetic Observatory at Hermanus, C.P., have, from their very nature, an international character, the needs of local research workers and national organizations are also taken into account. The functions and current programme of the Observatory include the continuous recording 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. 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 STADAN station.

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 commencement (ssc's), sudden impulses, solar flare effects and magnetic bays.

The results of a recent secular variation survey of the Republic and South-West Africa were reduced to a common epoch and analysed. The data were used *inter alia* for the compilation of magnetic charts of four elements of the magnetic field (D, H, Z and F) for the epoch 1970,0. The charts are used in air and sea navigation and in geophysical prospecting. The latest data in respect of Southern Africa were also supplied to international agencies compiling world magnetic charts.

A regional magnetic survey was carried out in South-West Africa during the year to determine the geographical extent of the relatively rapid changes in magnetic declination in that region.

Research also included an investigation of the latitudinal and seasonal dependence of the range

(amplitude) of the solar-diurnal variation, S. The investigation forms part of a comprehensive study of the S variation. This preliminary analysis demonstrated the inherent weakness of the conventional Lloyd method of grouping the months into three 'seasons' of four months each.

New data adaptive methods of power spectrum analysis used at Hermanus have yielded the first measurements of lines in the geomagnetic spectrum between 2 and 70 years. These results are a significant breakthrough in time series analysis of geophysical data and have important implications for solid earth geophysics.

Cosmic rays

A highlight of the year was the installation at Hermanus of a nine-tube neutron monitor (Chalk River type 9-NM-64) to supplement the existing three-tube instrument (3-NM-64).

The data provided by the smaller 3-NM-64 monitor since 1964 had been put to good use by researchers in this country and abroad, but the 3-NM-64 lacked the stability and resolving power of the overseas 'super monitors'. By enlarging the monitor to four times its original size, this deficiency has been rectified. The counting rate of the enlarged monitor is about 4×10^5 per hour with a standard deviation of 0,16 per cent.

On August 4 and 5, 1972, a few days after the supplementary equipment had been put into commission, a unique decrease in cosmic ray intensity was recorded throughout the world. This phenomenal and transitory decrease in cosmic ray intensity was superposed on a typical storm-time (Forbush) decrease. At Hermanus the neutron intensity decreased by 17 per cent in four hours and then recovered almost immediately.

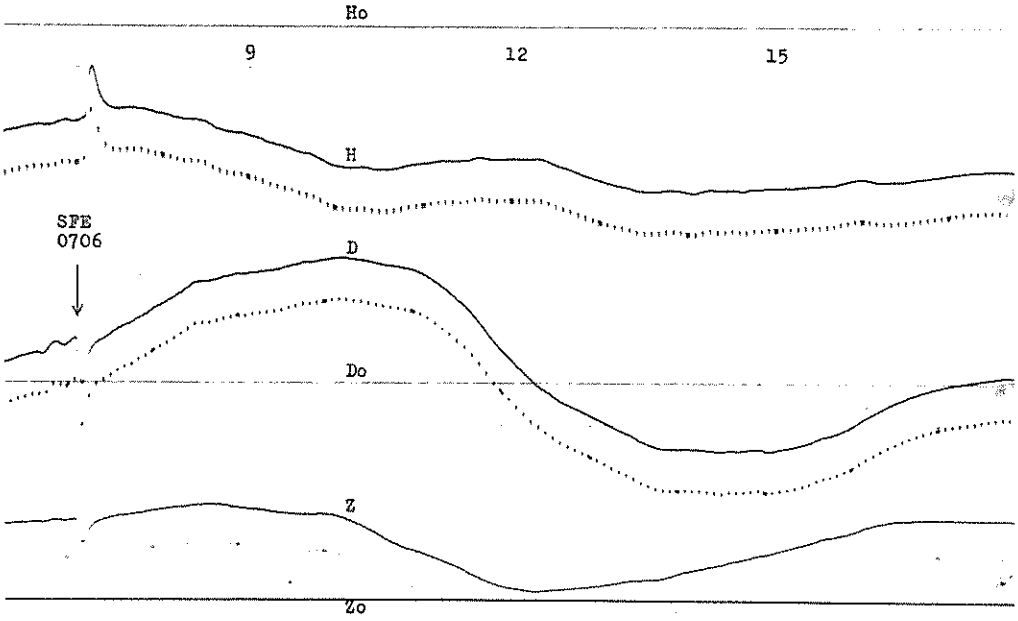
The cosmic ray programme at Hermanus is carried out in co-operation with the CSIR Cosmic Ray Research Unit at the Potchefstroom University. The routine data are processed on the computer in Potchefstroom and published by the Observatory.

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 for the detection of sudden ionospheric disturbances.

The VLF (27 KHz) receiver at Hermanus recorded numerous SEA's (Sudden Enhancements of Atmospherics) of the type associated with enhanced

Solar flare effect recorded at Hermanus



electron density in the ionosphere. The riometer observations and the VLF recordings confirm immediately the frequent solar flare effects recorded on the magnetograms.

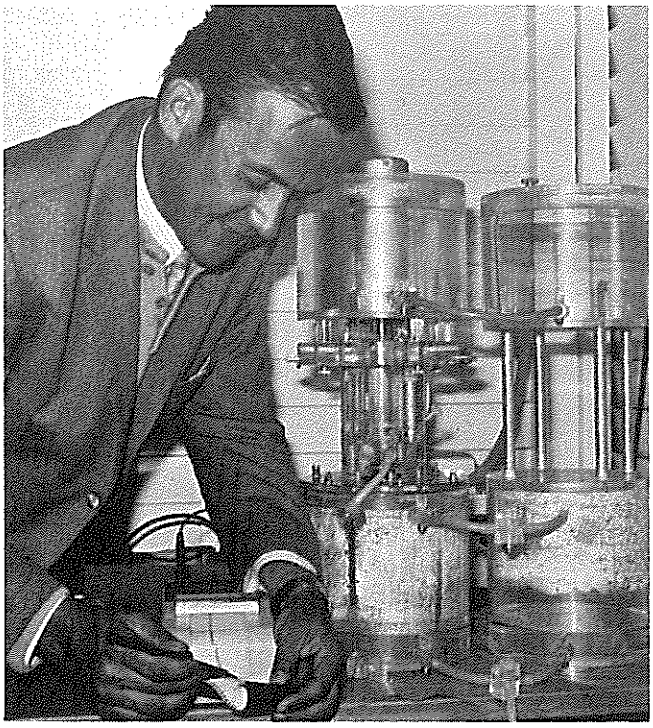
The Observatory operates a Wadley ionosonde for the National Institute for Telecommunications Research (NITR). The data are processed at the NITR in Johannesburg and published in its *Monthly bulletin of ionospheric characteristics.*

Seismology

Earthquake phases recorded by the Milne-Shaw seismographs at Hermanus are reported to the seismological centres in Washington, Strasbourg and Edinburgh every three months. Of the 189 earthquakes recorded during the period July 1971 to June 1972, ninety-seven showed well-defined phases. Although the seismological programme is a side-line for the Observatory, the records have proved useful especially in distinguishing between pulsations of magnetic and seismic origin.

Ozone observations

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



The ozone recorder at Hermanus

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

Computing facilities

The Observatory has recently acquired a mini computer. The availability of the computer has stimulated research and will facilitate routine data processing.

Antarctic research

The Observatory provides laboratory and other facilities for the geophysicist from Potchefstroom University who organizes the Antarctic programme 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.

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. An important development is the establishment of an observing station at Sutherland in the Karoo. The site, at an elevation of 1 760 m, was selected on account of the favourable night sky for astronomical purposes, that is, for the number of fine nights per year, freedom from urban atmospheric pollution, absence of wind and freedom from atmospheric disturbances (the astronomers' 'bad seeing'). The year 1972 has been devoted almost entirely to commissioning the Sutherland station. The instrumentation from the former Republic Observatory in Johannesburg and the former Royal Observatory in Cape Town has been used to furnish the new observatory. The headquarters of SAAO have been established in the grounds of the former Royal Observatory in Cape Town.

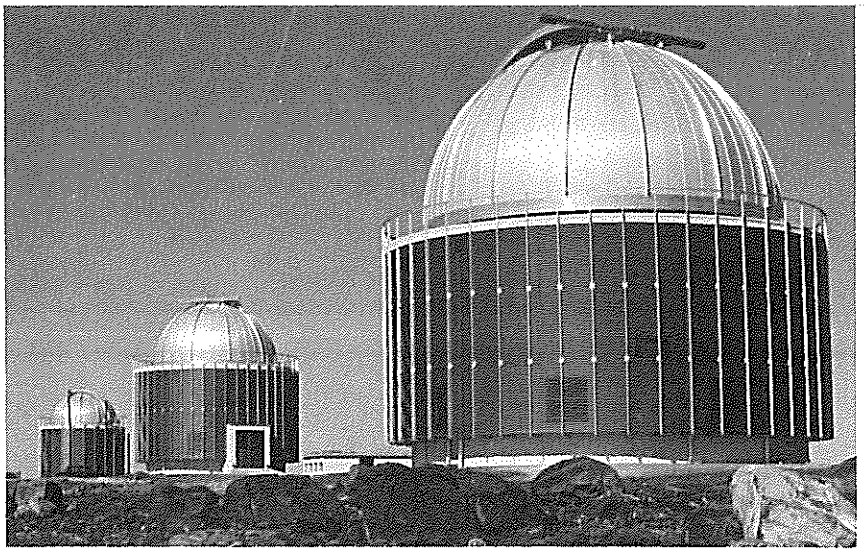
Progress at Sutherland

The station at Sutherland consists of a number of telescope domes, a technical services building and living accommodation.

Three telescope domes have been erected and two telescopes are working. These are the 50-cm reflector, formerly at Johannesburg, which was commissioned at Sutherland in September and the 100-cm reflector, formerly at Cape Town, commissioned in November.

The technical services building consists of a number of offices and small laboratories, a library and workshops.

The living accommodation at present consists of three houses, two chalets and six cottages. Quarters for visiting astronomers will also be built, of which the chalets will form part. At present one house is used by the superintendent and his family, while the other two are used as accommodation for visiting astronomers and technicians from headquarters in Cape Town.

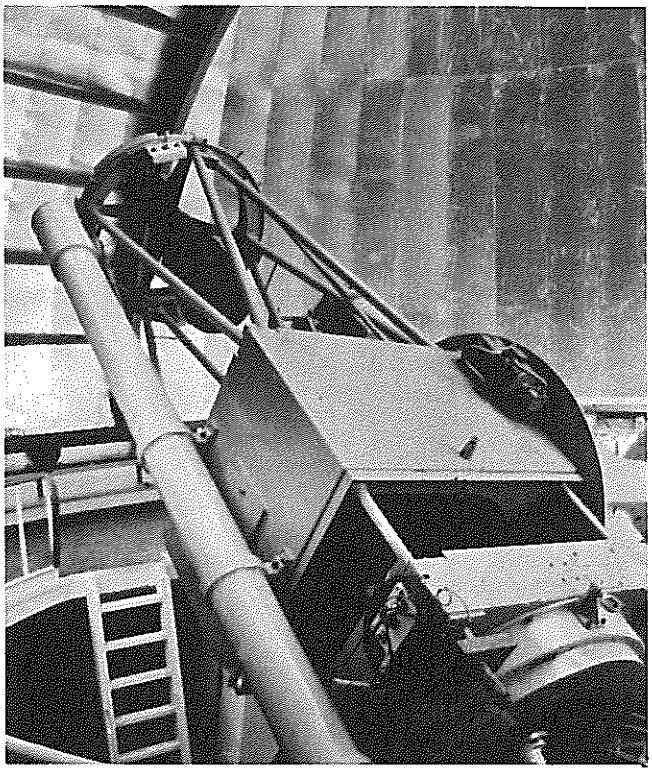


Telescope domes at Sutherland

Observing conditions and auxiliary equipment

The observing conditions at Sutherland are, as expected, excellent. Photo-electric observations of stars as faint as $14^m.2$ have already been made with the 50-cm reflector. The 100-cm telescope will be used for stars one or two magnitudes fainter.

Auxiliary equipment consists of photo-electric apparatus, a spectrograph borrowed from the Royal Greenwich Observatory and an image intensifier made specially for use on the 100-cm telescope at the Royal Greenwich Observatory. In addition the 100-cm telescope will take direct photographs through a field correcting plate which gives good definition over an area about one degree square.



The 100-cm reflector after re-erection at Sutherland.

Distance to centre of galaxy

Preliminary observations have already been made in the programme for investigating the distance to the centre of the galaxy.

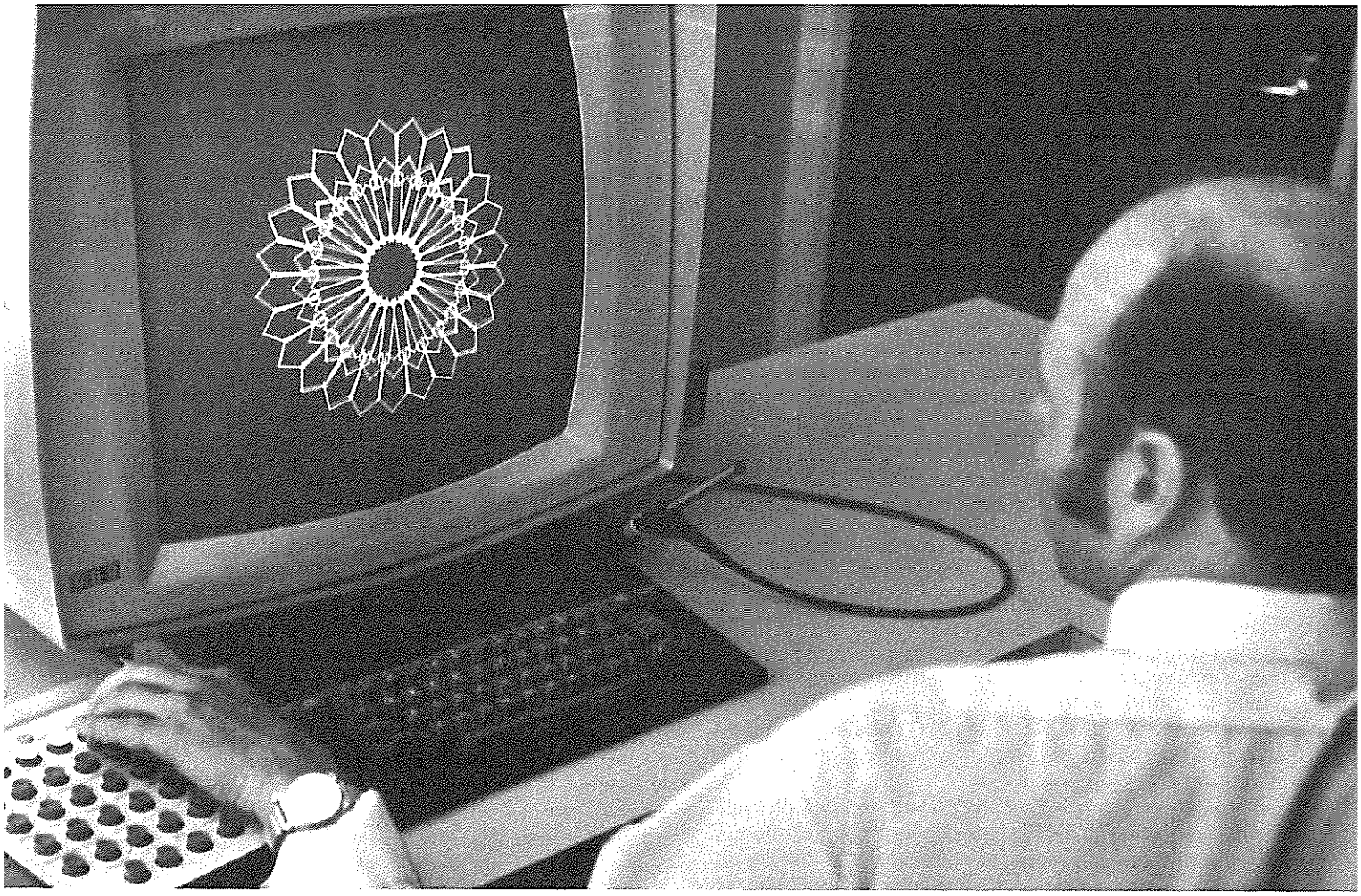
A classical method of determining the distance to the centre of the galaxy was worked out by W. Baade. Baade noted that a field near the centre of the galaxy was comparatively free from absorption and that a number of variable stars (RR Lyrae stars) occurred in this field. He found that the number of these stars increased as the stars became fainter until a peak was reached beyond which the number of variables decreased. He maintained that this peak occurred at a maximum concentration of variables near the centre of the galaxy and that the distance could be inferred from the apparent magnitude (intrinsic brightness) of the variables. This method has two main difficulties. Firstly, the apparent brightness of the variables is undoubtedly diminished by interstellar absorption, and it is necessary to allow for this absorption accurately by comparing the apparent colours and the intrinsic colours, since interstellar dust reddens as it absorbs. Secondly it is necessary to be sure that the peak in the number of variables has really been reached, which it might not have been if many faint variables remained undiscovered.

The programme at Sutherland will repeat the Baade determination using a somewhat brighter class of variable star (the W Virginis stars). There are about sixty of these stars in suitable fields near the galactic centre. They are on the average two magnitudes brighter than the RR Lyrae stars and about a third of them are brighter than $14^m.2$ and therefore accessible to the 50-cm reflector. The programme of obtaining enough observations to ascertain reliable magnitudes and colours of theese stars will take at least two years. It is also necessary to calibrate the absolute magnitudes of these stars by careful observations of nearby stars of the same class, using the Baade-Wesselink method of simultaneous observations of radial velocity curves and light curves. Existing data can to some extent be used for this method but observations have to be very accurate. The calibration will be greatly improved by new observations, especially designed for the purpose, which are to be made at Sutherland.

Another programme to be undertaken at Sutherland consists of redetermining the number of RR Lyrae stars per square degree as a function of galactic latitude. The decrease provides information about the attracting force perpendicular to the centre of the galaxy. Here the value of the result depends on the thoroughness with which the fields have been searched, and special photographic plates will be taken with the 100-cm telescope in an attempt to find out the number of these stars fainter than the 16th magnitude per square degree.

National Research Institute for Mathematical Sciences

Director: Dr A.P. Burger



A systems programmer studying the effects of a kinematic display on the screen of the computer.

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 for numerical weather prediction were further explored in close collaboration with the South African Weather Bureau. After tests with simpler mathematical models of the atmosphere, these models were elaborated to a forecasting model using data at three heights in the atmosphere. In the computation, a forecast is first made for a large portion of the hemisphere extending from South America almost to Australia, and then refined for a smaller inner area covering South Africa. Much work is still needed to evaluate the usefulness of the mathematical model in day-to-day forecasting.

Road traffic problems

Services in mathematical statistics were again provided to the National Institute for Road Research (NIRR) for traffic safety studies. At the request of the National Road Safety Council, statistical planning was done for a three-month sample survey designed to show what percentage of road users involved in accidents are under the influence of alcohol to a degree detectable by the 'Alcotest', a device currently used by the South African Police. The results of this survey will indicate what further local research should be undertaken, and establish the upper limit of the improvement that may reasonably be expected from road safety measures to combat the excessive consumption of alcohol.

Another reason for carrying out the survey is that it is expected to resolve the discrepancy between results obtained by the standard accident reporting process, according to which about five per cent of those involved in accidents are under the influence of alcohol, and evidence from other sources that the true figure is higher than 30 per cent.

The Department of Statistics supplies the NIRR annually with records on magnetic tape of road accidents in the Republic. A computer programme was written to produce from these records a number of frequency tables of accidents, persons involved, casualties and vehicles, grouped according to various characteristics. These figures will make annual before-and-after studies of nationally effective road safety measures possible and will be useful for estimating trends.

Mathematical statistics in fossil studies

The Institute assisted in identifying a previously unknown fossil antelope which the Transvaal Museum found in the Swartkrans outer cave. The fossil is interesting because although its forehead much resembles that of the blesbok and other less advanced antelopes, it shows a pronounced hollowing of the frontal bone underneath the horn cores. This indicates that it is on the more specialized lineage leading to a hartebeest type. The mathematical statistics methods used showed that, on the basis of available data, the fossil probably belongs to an unknown new genus.

Vitamin C requirements

Several studies were done for the South African Medical Research Council, *inter alia* statistical analysis relating to vitamin C requirements.

Bleeding of the gums was observed in a colony of vervet monkeys used in long-term cancer research. Since this symptom is associated with vitamin C deficiency, vitamin C concentration in the serum of such monkeys was studied.

Monkeys were tested at capture and at regular intervals afterwards. It was found that the concentration of vitamin C in the wild monkeys was very high and that it dropped dramatically during the first 18 days of captivity. Then, for two months, followed a period of adaptation, in which the vitamin C level gradually rose. When additional stress was then introduced, it was followed by a drop in the concentration of vitamin C in the serum. Statistical analysis showed that there is a significant increase in the vitamin C requirements of experimental monkeys under conditions of stress.

The movement of vervet monkeys

Statistical analysis of data on the territorial behaviour of vervet monkeys in the Ndumu Game Reserve, Natal, showed, amongst other results, that the location of a troop is closely related to the time of day and season of the year, that individuals in a troop are more widely scattered during the dry months, and that when food is scarce, there is a greater overlap of the areas frequented by neighbouring troops.

Sampling mortar for chemical analysis

The National Building Research Institute, studying the properties of inorganic materials, was assisted by the NRIMS in deciding on a minimal acceptable number of mortar samples from 33 houses, in order to establish the chemical composition of the mortar and whether it contained any portland cement. According to the specifications supplied by the research worker concerned, it was necessary to select twelve houses and take nine samples from each house.

Computing Centre

The Institute's computing service has been further expanded by increasing the total disc storage capacity to over 400 million characters.

Also, the computer at the South African Weather Bureau in central Pretoria was coupled to the CSIR's computer as a satellite computer.

In the past year the total equivalent revenue from computing services increased by 40 per cent. Revenue from sources outside the CSIR now represents 12 per cent of the total.

Kinematic computer graphics

Significant advances have been made in developing techniques for displaying continuously moving images of graphs or geometrical shapes, with the minimum of involvement of the computer's central processor so that other computing tasks fed into the computer will be affected as little as possible.

Numerically controlled machine tools

The Institute has continued its consultation, programming and computing activities in the field of numerically controlled machine tools. For instance, a computer program for machining the internal profile of a Wankel engine and another program for an automatic type-setting machine were developed.

The Institute, in collaboration with the CSIR's Technical Services Department, organized a symposium held in November at the CSIR in Pretoria and later repeated in Cape Town, Port Elizabeth and Durban. Institute personnel read papers on these occasions. An intensive two-week training course in numerical control was presented to a group of people, mainly from industry.

Study of aircraft noise near airports

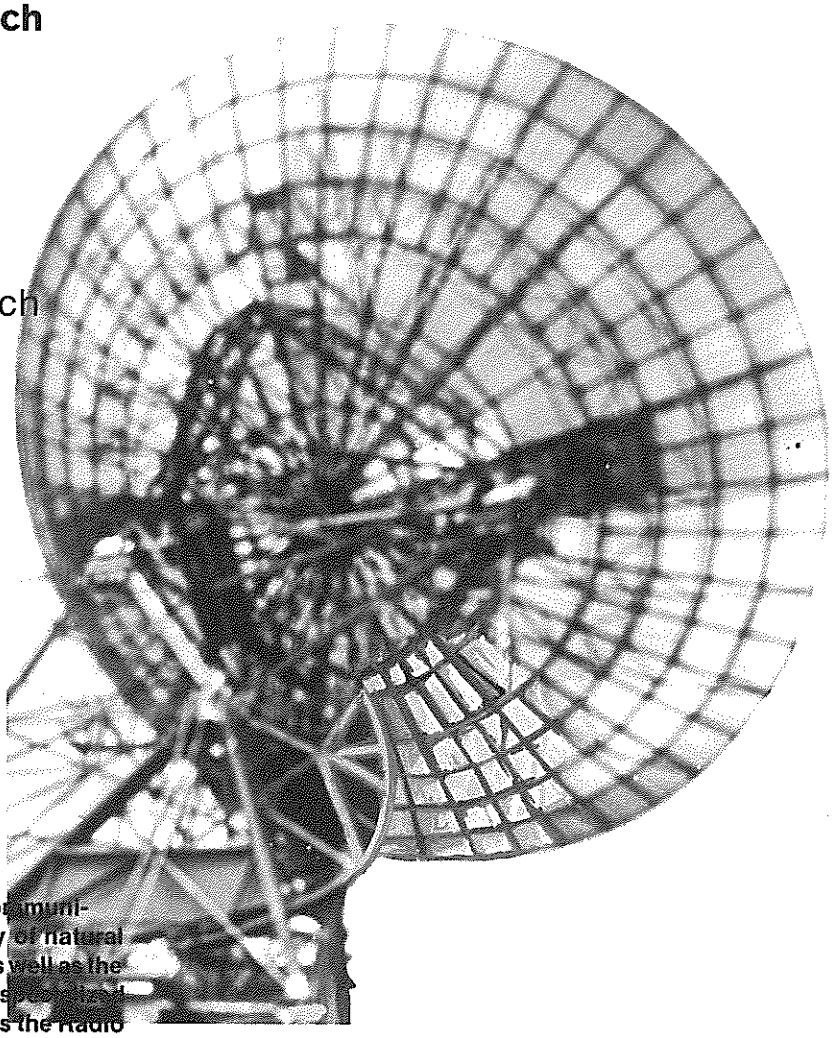
A computer program which can accurately compute predicted aircraft noise in the vicinity of airports was developed in collaboration with the National Mechanical Engineering Research Institute and the South African Bureau of Standards. This program has been tested exhaustively and a user's manual is in preparation. It is expected that much international use will be made of this program.

Service programming and data processing

Computer programs have been developed for numerous investigations into ocean waves, air pollution, lightning and many other phenomena. As in previous years several large data-processing projects were also undertaken. These included work related to agricultural performance data from monthly returns of selected farmers for the Department of Agricultural Economics and Marketing, water resource surveys, magnetic surveys, hail research, urban housing, pneumoconiosis research and the academic performance of students.

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. In addition, the Institute operates the Radio Space Research Station at Hartebeesthoek near Johannesburg.

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 and at Hermanus, while observations of airglow are made near Pretoria. Bulletins of ionospheric data and predictions of optimum frequencies for use in short wave radio communications are issued monthly. The NITR has opened an ionospheric observing station on Marion Island which when fully operational will help to fill an important gap in the coverage of the world-wide network of observing stations.

The Institute co-operates with numerous overseas organizations by exchanging data and taking part in joint experiments. Advice has been given during the year to several local bodies on problems involving the radiation, propagation and reception of radio waves.

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, which was specially designed for the measurement of rain, has been installed and computing equipment and programmes have been prepared to process the radar signals and to store them on magnetic tape. The system will be used to measure rain over a river catchment area in order to obtain data for a hydrological experiment.

A number of storms have been studied with the aid of an 8 mm Doppler radar system. This system, which has a high spectral and spatial resolution, was designed to observe the motions of raindrops, from which the distribution of drop sizes can be derived. Preparations are being made to move this antenna to a site at Frankenwald, some 17 km from Houtkoppen. There are three recording rain gauges at this site, and the intention is to compare the measurements of the gauges and of the Doppler radar system with those of the radar system at Houtkoppen.

Lightning research

The Institute uses a system of spaced VHF receivers to obtain coherent records of the noise radiated by lightning. After processing, these records yield three-dimensional images of the lightning.

These observations are supplemented by radar observations of precipitation, in order to investigate the relation between the paths of lightning discharges and the precipitation. A new radar system is now being built to observe echoes from lightning channels.

A number of lightning flashes have been observed and analysed in detail. Although the processing of the data poses severe problems, the system has proved to be a powerful tool in the investigation of lightning.

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 development of the

'Tellurometer' system of distance measurement in 1955, South Africa has maintained its lead in the production of such equipment.

During the past year the Institute developed a prototype of a new, automatic 'Tellurometer' system. In this 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.

The Institute is now collaborating with the manufacturers of this equipment on the design of a pre-production model.

Space research

The Institute operates the Radio Space Research Station at Hartebeesthoek on behalf of the United States' National Aeronautics and Space Administration (NASA). This station actually comprises two major tracking stations, the Deep Space Instrumentation Facility (DSIF) and a station of the Spaceflight Tracking and Data Network (STDN).

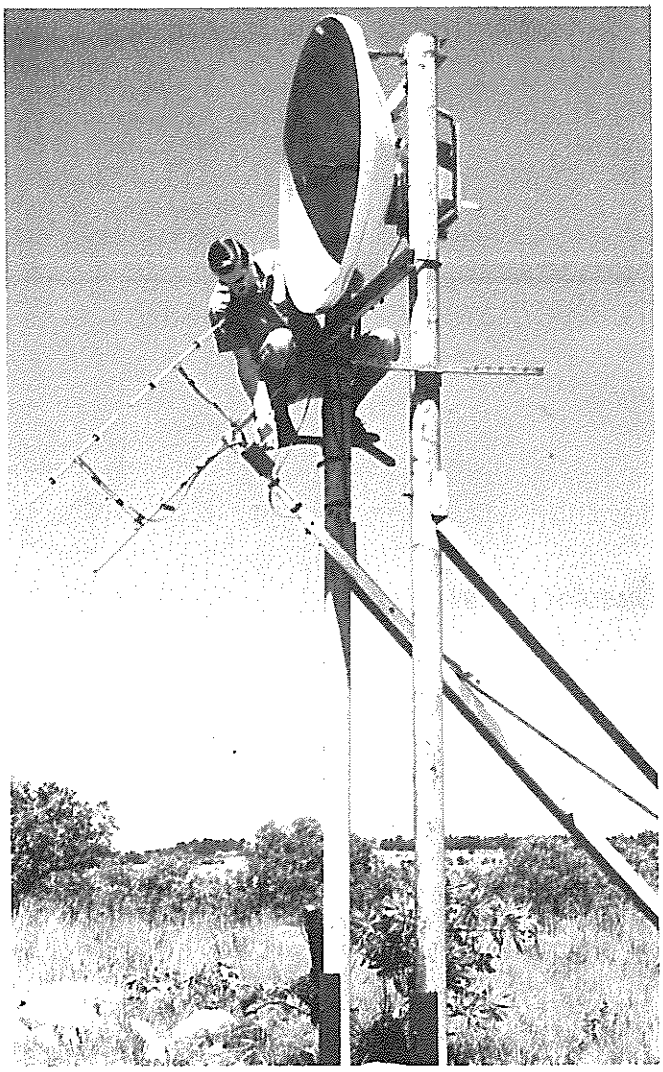
The DSIF uses a 26 m parabolic antenna to track and communicate with space probes to the moon and the planets and in interplanetary space. The station has played an important role in most of NASA's deep space projects and during the past year has been occupied mainly in tracking the Pioneer 10 space probe on its way to Jupiter.

The STDN station is one of the world-wide network of stations established by NASA to track and communicate with scientific earth satellites. The capability of the station has been extended by the modification of its 12 m antenna to allow reception at 1 700 MHz and in the S-band.

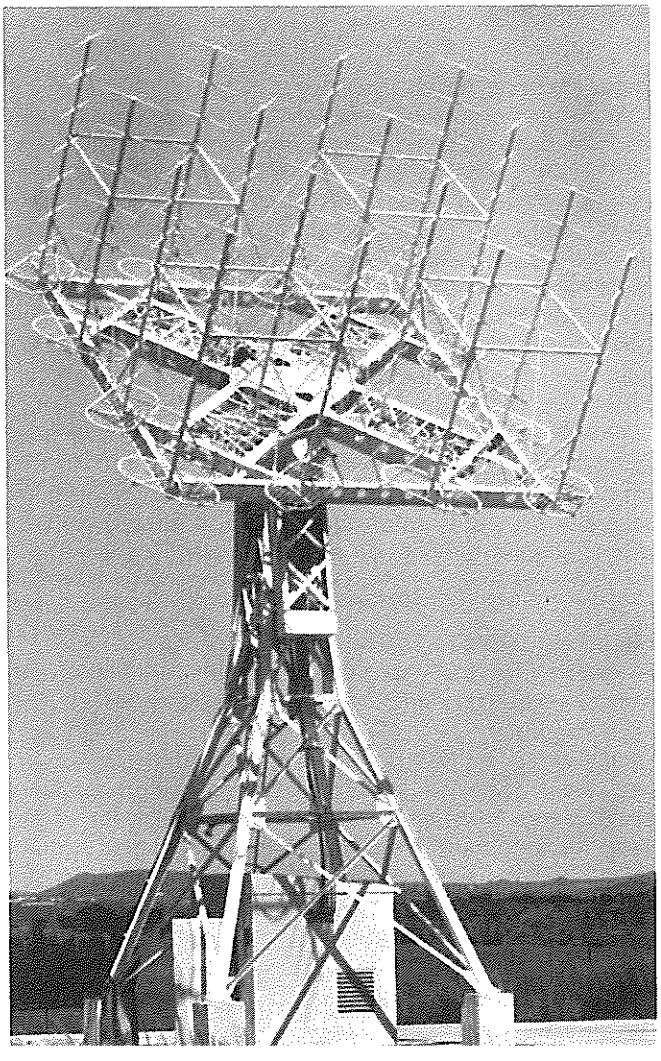
Radio astronomy

When the 26 m antenna at Hartebeesthoek is not required for tracking operations it is used in a programme of radio astronomy. Ancillary equipment, operating at a wavelength of 13 cm, was designed and built by the Institute. Modifications are being carried out to extend the operation to a wavelength of 7 cm.

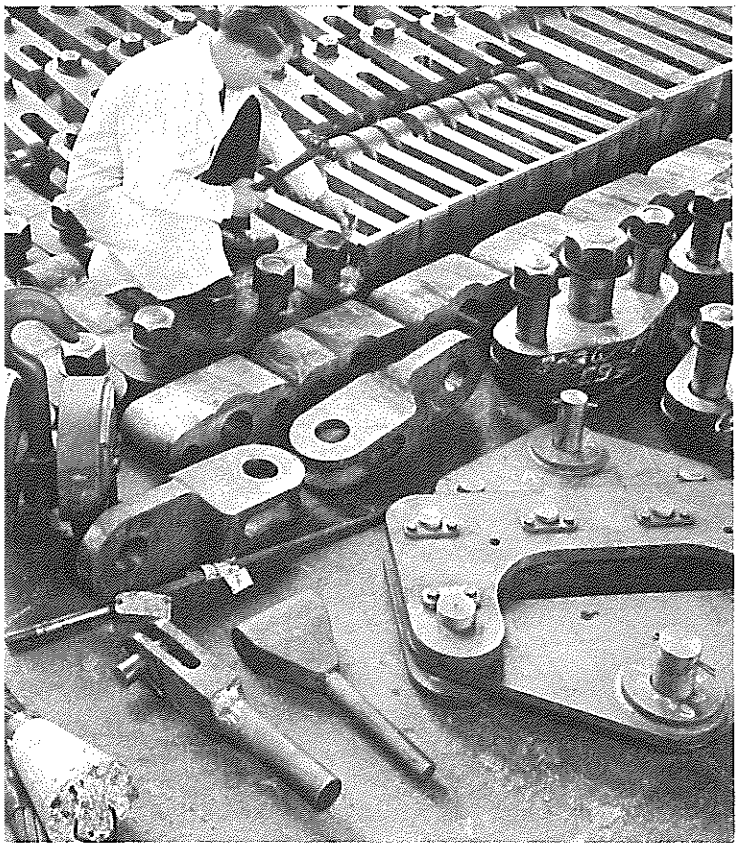
Over the past five years the main continuing programme has been the study of variable radio sources. Most of the sources have been observed with intercontinental interferometers with baselines extending from California to Australia and from Australia to South Africa. Most of the variable sources are not given in the existing catalogues which are based on surveys at comparatively low frequencies. For this reason a new survey covering declinations -20° to -36° was carried out and a second survey covering the zone -10° to -15° is in progress.



A microwave transmitting antenna at one of the lightning observing stations.



The 136 MHz telemetry receiving antenna at the satellite tracking station, Hartebeesthoek.



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 ideas and techniques in mechanical engineering as well as the improvement of machines and materials used in industry. The Institute is also active in fields such as rock mechanics in order to improve efficiency and safety in mining. The Institute has testing equipment, machines, instruments and qualified personnel for research in the fields of metallurgy, strength of structures, process development, geomechanics, aeromechanics (including aeronautics), hydromechanics (including harbour and river engineering) and heat mechanics (including air-conditioning and refrigeration).

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

The six divisions and the Aeronautics Research Unit are in Pretoria, the Mine Equipment Research Unit is in Johannesburg, the Hydraulics Research Unit is on the campus of the University of Stellenbosch and the Fibre Research Unit is in Durban. The four units are integral parts of the NMERI and are responsible to the Director of the Institute.

Failure in service

The Institute provides a service to South African industry by investigating the causes of failure in service of machine and structural components. Numerous *ad hoc* investigations were carried out, most of which entailed inspection, fractographic, metallographic, hardness and strength tests and chemical analyses of the component materials. Typical investigations were described in a paper read to a learned society. It is of interest that of the 83 failures investigated during the past seven years, 26 were caused by fatigue, 20 by manufacturing faults, 19 by material faults, 12 by corrosion and six by excessively severe service conditions.

Technological foundry problems

The Institute's work in the field of foundry research is co-ordinated in consultation with the South African Foundry Research Foundation which assists in financing and directing the projects. The research consists of sponsored investigations into foundry technology. The investigations may be of an applied nature, including tests on moulding materials, or of a more basic nature.

A survey of moulding materials currently used in South African foundries was completed. It is hoped that this will be of assistance in drawing up standard specifications for such materials.

The adherence of moulding sand to the pattern when it is being removed is a problem experienced in most moulding shops, especially when intricate patterns have to be moulded in the foundry sand. Numerous parting agents are on the market but the claims made for them have not been assessed scientifically. This problem was considered important enough to investigate and as a result a testing device was developed which assesses the adherence of sand to the pattern. With this device it is possible to establish how factors such as the shape of the moulding sand grains, the water content of the mould, the presence of additives such as bonding agents, the degree of compaction of the mould, the geometry of the pattern and parting agents affect the adherence of sand to the pattern.

Research with this device has shown that parting agents do not reduce adherence by more than 10 per cent and most reduce it by less. The influence of the taper of a pattern was smaller than expected and was hardly noticeable in sand mixtures with a high moisture content.

Plastic deformation

Interest in the influence of strain rates and impact loading on the deformation behaviour of metals has increased considerably in recent years. Forging, rolling, pressing and extrusion can be done more economically by increasing the strain rate.

An investigation into the influence of the rate of loading on the results of high-speed tensile tests on aluminium was completed. It was found that with increasing impurity in the aluminium the elongation of the metal and its sensitivity to strain rate decreased, but the tensile strength increased. The purity was also found to influence the degree of work hardening. When the data were plotted on a semi-logarithmic scale linear relationships were found between the ultimate tensile strength, the strain rate and the hardness after deformation and elongation.

Unannealed specimens became longer and harder as the strain rate increased and the values depended on the rolling direction in the sheet. Specimens taken in the rolling direction lengthened more than specimens taken across the rolling direction.

Effect of additives on cast iron

An investigation into the solidification of magnesium-modified cast iron was completed. The results indicated that foreign nucleates, a high rate of heterogeneous nucleation, correct orientation of the basal lattice planes in the heterogeneous nuclei and a high interfacial tension between graphite and liquid cast iron favour the crystallization of nodular graphite in cast iron.

Research was started to obtain a better understanding of the process of inoculating cast iron. Although it is a well established procedure, little is known about the mechanism of inoculation. At present the aim is to establish how the addition of different kinds of ferrosilicon to cast iron metals influences the microstructure, graphite shape, number of eutectic cells and mechanical properties of grey iron castings. Grain size, the amount of inoculant, the inoculation temperature and the time-lapse between inoculation and pouring are also being investigated. Preliminary test results indicate that coarse particles of ferrosilicon have a stronger nucleating action than small particles.

Impact properties of metals

The instrumentation of a facility for low-pressure impact testing at high speed was successfully completed. Problems with the development of a displacement transducer which responds fast enough to follow the deformation of the specimen were solved by using an electro-optical instrument.

The testing ability can produce strain rates of $1{,}2 \times 10^{3} s^{-1}$ and higher but it is intended to increase the range by varying initial pressures and using piston assemblies of different masses.

To begin with a series of tests will be conducted to establish whether there is a satisfactory correlation between the results obtained by the facility and those quoted in the literature.

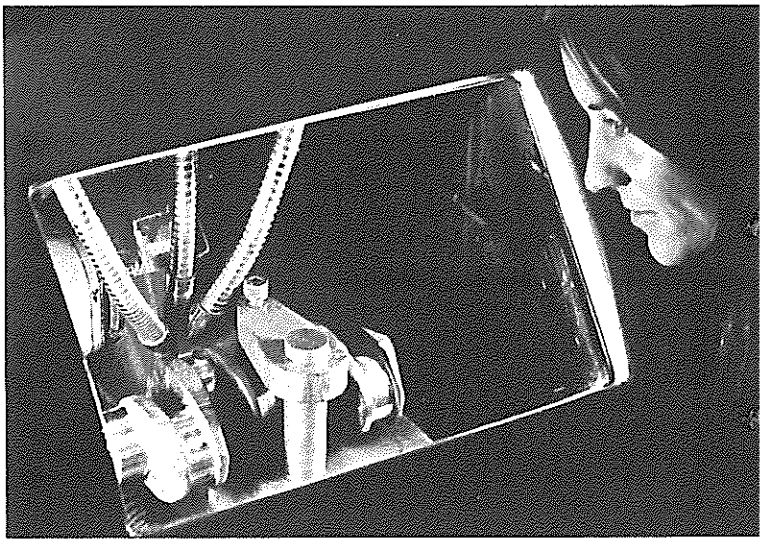
Large-scale underground testing of rock and coal

Methods and equipment used in the past to determine the strength of large coal specimens in collieries were found to be inadequate for testing coal pillars with a width-to-height ratio of greater than 2,0. Since a knowledge of the load-deformation characteristics after failure of pillars with a width-to-height ratio of up to 4,0 is important where pillars are used as natural supports, all existing methods were studied in detail. It was found necessary to develop a new method of testing pillars. The first tests using this method will be carried out during 1973.

This project is sponsored by the Coal Mining Research Controlling Council.

Stability of rock slopes

As the activities of the Geomechanics Division now include civil engineering investigations into the stability of rock slopes were undertaken. One investigation concerned the effect a quarry fall would have on the stability of a new highway which is to be constructed near the rim of the quarry. The orientations of the joints in the face of the quarry were measured and the stresses on these joints before and after construction of the road were calculated theoretically and compared to assess the change in stability.



Cutting a specimen from a crankshaft for microscopic examination.

The finite element method of stress analysis was used in some of these investigations. Of particular importance was a three-dimensional study of the stress distributions surrounding a model open-pit mine. Tests with two-dimensional models of jointed rock slopes subjected to centrifugal loading were also carried out successfully.

Tunnelling in rock

A comprehensive literature survey of the geomechanical aspects of tunnelling was completed and contact was established with various civil engineering bodies involved in the design and construction of tunnels in Southern Africa. The various problems experienced are being evaluated so that the project can be directed along practical lines.

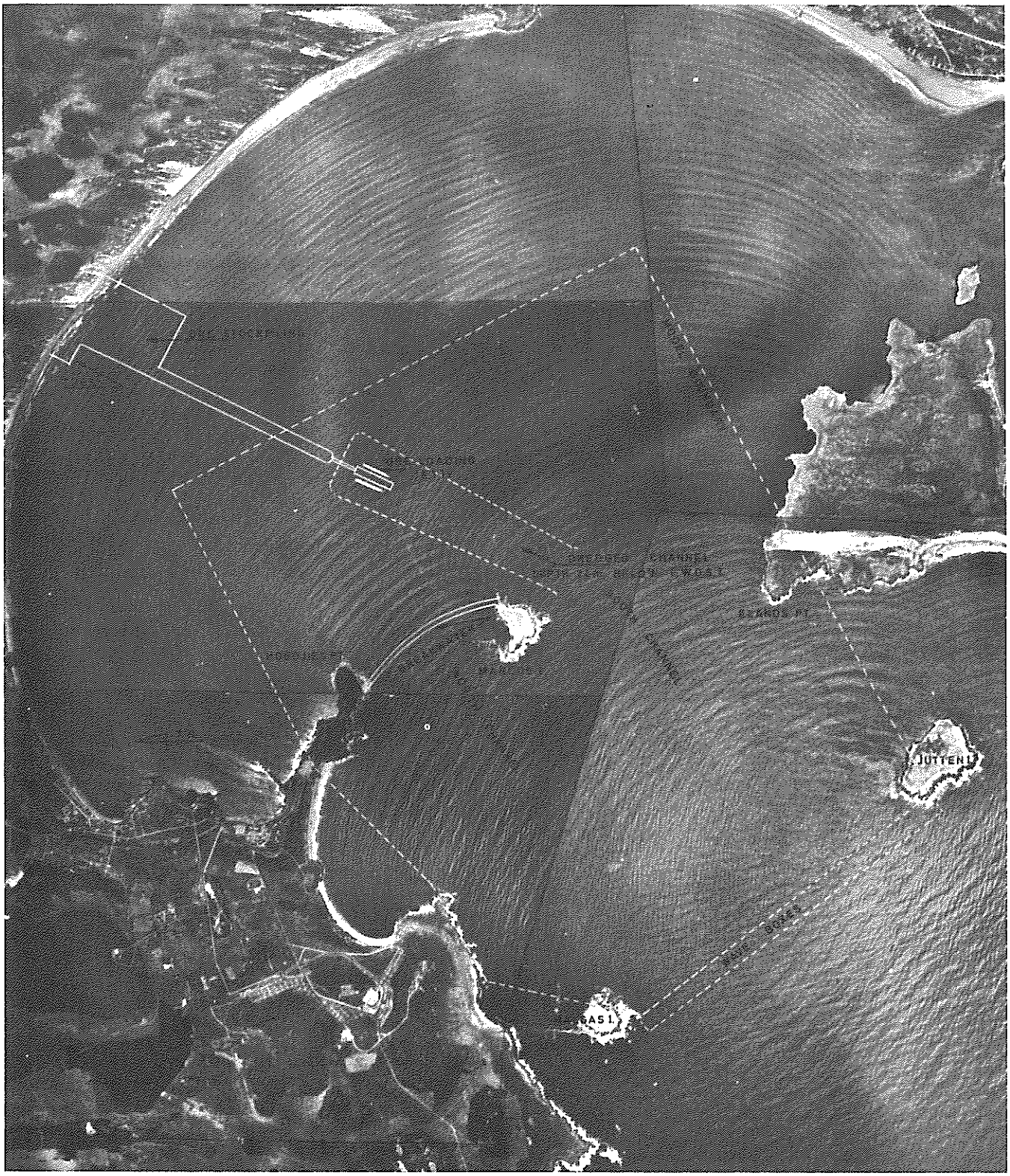
Charts were compiled for the design of flexible tunnel linings by means of a comprehensive series of finite element analyses.

Comminution and grinding

Work on this project was resumed at the beginning of 1971. The object of the research is to establish a scientific basis for the design and control of grinding circuits so that a product of any desired size can be produced at minimum cost from any given feed whose physical characteristics are known. The project includes research into the mechanism of grinding as well as the design of control systems.

Tests were conducted in a model batch mill in the laboratory to establish the basic parameters, namely the rate and breakage functions of a typical quartzite from a gold mine. Future tests in a model of a continuous grinding mill circuit will be based on these results.

The Atomic Energy Board (AEB) helped to establish the rate and breakage functions by using a radio-isotope tracer technique. The AEB is interested in using radio-isotopes to investigate mill grinding problems in practice.



An aerial photograph of Saldanha Bay showing the boundary of the hydraulic model.

The National Electrical Engineering Research Institute is also collaborating in this research owing to its interest in the instrumentation and development of control systems for ore grinding circuits.

Fluid flow

A study of aerodynamic devices to reduce head losses in a bend of simple geometry was completed. It was found that a pair of vortex generators placed downstream of the corner on the inside wall reduced the bend resistance coefficient by three to four per cent. To reduce it even more single vanes with different cambers, vane chords and leading edge incidences were tested. A single vane with a chord-diameter ratio of nearly 0,3 and a camber angle of approximately 37° reduced bend losses by up to eight per cent. However, it was also found that larger vanes and camber angles make the bend losses greater than they would have been without vanes.

Hydraulic conveyance of granular material

Investigations into the pumping of tailings to a slimes dam and of a clay slurry were completed for industrial sponsors.

The instrumentation for determining the transport concentration in normal and segmented pipe circuits 100 mm in diameter, which were installed in the Fluid Mechanics Division, was improved. This made it possible to assess the flow concentrations more accurately and facilitated the operation of the circuit generally. A slurry pipe circuit with pipe diameters of 200 and 250 mm was designed and will be erected shortly.

Tests were completed on a full-scale Hydro-lift system by which ore mixed with water is pumped vertically to the surface through a pipe from the mine. The tests demonstrated that this system is simple and reliable. Solid-liquid ratios can be accurately controlled and reproduced over a large range. From the test results an equation was derived by which a Hydro-lift system with a good performance can be designed.

Saldanha Bay

As a result of the proposal to construct ore-loading facilities at Saldanha Bay, Iscor commissioned the Institute's Hydraulics Research Unit to carry out an extensive survey of wave and wind conditions in the bay in order to obtain basic design information for the most favourable siting and layout of harbour facilities. The field observations were extended for another year.

Model studies were done by the Fluid Mechanics Division in a hydraulic model of Saldanha Bay built to an undistorted scale of 1 to 140 on a CSIR site in Pretoria. Steady progress was made with the investigations in this model and all contract commitments to produce results and reports were kept. The model studies showed that it is essential to construct the proposed breakwater between Marcus Island and Hoedjies Point where it will fulfill its purpose of ensuring that even under extreme open sea conditions, wave conditions in the area proposed for the loading jetty will be kept within the predetermined limits for the safe berthing of large carriers.

Various alignments of the departure channel for 250 000-t ore carriers were tested. According to the recommended alignment the loading jetty is in an area where wave conditions will remain within the established limits for safe mooring and loading of ships.

The hydraulic model attracted a fair amount of attention. Among the large groups of visitors were the Select Committee on Railways and Harbours, journalists representing the entire South African press and many groups of prospective tenderers for the construction of the iron ore loading terminal.

Air-conditioning and refrigeration

Basic studies of the effects of environmental conditions on the chilling and freezing of meat and meat products were carried out. In conjunction with the Division of Veterinary Services of the Department of Agricultural Services and the Livestock and Meat Industries Control Board, experimental cold rooms were designed which are now being built at Onderstepoort for the study of bacteriological spoilage of meat and the extent to which it can be limited by correct chilling and freezing procedures.

Special air-conditioning equipment was designed, including a plant-growth chamber and cheese-curing room.

Climatological data for designing air-conditioning equipment

Climatic data were analysed for the design of air-conditioning equipment and design data were published in the form of maps of Southern Africa.

With the change to S I units, the design data had to be converted from British Thermal Units to S I units. In reconstructing the maps an effort is being made to take the topography into account in order to obtain more reliable design data in regions situated between weather observation posts.

Heat exchangers

Investigations were carried out to optimize the design of heat exchangers for dry-cooling applications. A method of evaluating the performance of heat exchangers was developed. The method makes it possible to determine the performance of any heat exchanger with known heat transfer and pressure drop characteristics relatively easily for a cooling tower of a particular size.

The performance of more than 50 different heat exchangers was evaluated using this method.

Testing of steel wire ropes

The Mine Equipment Research Unit continued the testing of steel wire ropes in accordance with the Republic's statutory requirements. Mining companies in Rhodesia, Zambia and other Southern African states made extensive use of the testing facilities.

The Unit tested about the same number of steel wire winding ropes during the year as it tested in each of the past three years, namely about 5 300.

Sediment movements in the sea

The aim of this study is to identify littoral current systems by using tracer-minerals washed into the surf zone by rivers.

The collection of samples of river and beach sand along the Natal coast continued and sampling at the Umhlatuzi, Umgeni, Isipingo and Umkomaas Rivers was completed. Samples were also collected from the Tugela and Impenjati Rivers and analysed for heavy minerals.

A comprehensive study of the offshore sand movements at the Reunion oil pipeline was completed and a report submitted to the sponsors of the work.

Ocean wave research

The main objectives of this project which was started in 1967, are to record and analyse statistically wave conditions along the South African and South-West African coasts, to correlate wave and wind data and eventually to assist the Weather Bureau with wave forecasting.

The collection of wave and wind data continued during the year. The wave clinometer station at Buchu Bay on the coast of South-West Africa was moved to a more suitable position further south. Three more wave riders were installed, one near Walvis Bay which is expected to supply valuable data for offshore oil drilling, one near Lüderitz (Port Nolloth) and one near East London.

Experiments with wave recorders with magnetic tapes instead of strip charts were carried out and the results appear to be promising. Some progress was made with the proposed conversion of all the wave recorders to the new system.

Changes in Natal beaches

A two-year programme of beach surveys incorporating 41 beach and seven estuary sections between Durban and Scottburgh was completed early in June.

The beach and estuary profiles were surveyed quarterly and the plots show the changes in the various profiles very clearly. Visual observations made twice daily by local observers at Ansteys, Brighton, Amanzimtoti, Umkomaas and Scottburgh beaches are also being compiled. The recorded conditions were analysed statistically in the CSIR computer in Pretoria.

The surveys were extended to include the Natal South Coast to the Transkei border, and the elevations of beach survey beacons as far as Margate were established.

Coastal design

Numerous enquiries on coastal design were received. One concerned the recovery of sea sand for building purposes from beaches in the Durban area and another concerned the siltation of the lagoon at Walvis Bay. Within two months ten enquiries from as far afield as Australia, Hong Kong, Holland, England, Portugal, Canada and the United States, were received on the use of the Dolos breakwater blocks designed in South Africa. Dolos blocks are at present being considered for most large harbour and coastal protection works all over the world.

Harbour siltation and beach protection at Durban

Large-scale dumping of sand on the mound which is being constructed parallel to the coast to protect Durban's beaches, was resumed in October 1971. When the latest echo-sounding survey was carried out in June this year dredgers had dumped 1,3 million cubic metres of sand. According to an analysis of this survey a volume of about 4,0 million cubic metres was on the mound. This was eight per cent less than the 4,34 million cubic metres of sand dumped there.

Unfortunately, it now appears that the South African Railways will not be able to produce the 5 million cubic metres of sand that was expected from the dredging for the new pier in Durban bay. As a result it is unlikely that the mound will be completed. Dumping is continuing with three small hoppers but it is expected to cease shortly.

During 1972 dumping proceeded satisfactorily and echo-sounding surveys showed the accuracy of the dumping. The mound was lengthened by 2 km at the design elevation. A further 1,5 million cubic metres of sand is, however, required to bring it to the design width.

The beaches at Durban are being surveyed monthly and there is still a nett loss in the volume of sand on the south beaches. During March 1972 the volume of sand on the south beaches was the lowest since 1965. The sand on the northern beaches, however, has increased since 1971.

It is becoming clear that it is unlikely that the mound can be extended to the original design and that alternative schemes to protect the beaches will have to be considered.

Richards Bay harbour development

Several breakwater and access channel layouts were tested in a fixed-bed model for wave penetration and navigability. A model ore carrier of 150 000 dwt was used in the navigability tests.

The prototype of the autogyro designed, developed and built by the Institute.

The modified breakwater and access channel layouts investigated in the fixed-bed model, were also tested in a movable-bed model in which sand was used as sediment. The model is currently being calibrated to verify the movements of the existing estuary mouth. Crushed anthracite is being used as sediment.

Preliminary tests were carried out to determine the optimum cross-section of a proposed new outlet to the sea from the so-called sanctuary area south of the harbour. The object is to ensure suitable conditions for tidal flow and flood discharge from the Umhlatuzi River. These tests included an investigation into the effects of flushing the new estuary by letting extra water into the sanctuary through sluice gates in the levee.

As a result of the preliminary tests the sponsors decided to proceed with the outlet to the sea rather than the flood relief scheme previously proposed. The existing sediment model of Richards Bay is being enlarged so that more comprehensive tests on the new outlet scheme can be undertaken.

Multi-arch soil conservation dams

Research is being conducted to produce a design code for the hydraulic aspects of multi-arch dams and the stilling basins used to protect them. Calibration tests were done on a model of a single dam arch to establish the relationship between the head and the discharge for different levels of silt upstream of the dam.

A start was also made on the design of a suitable stilling basin downstream of the dam. A comprehensive model of three dam arches, including side abutments, will be used later to check the influence of side flow on discharge characteristics.

Flight dynamics
After tethered flights had been done with the experimental prototype two-seater autogyro designed and built by the Aeronautics Research Unit, and after an extensive theoretical analysis of rotor dynamics, a new rotor was designed and built. The blades were made of aluminium. Further tethered flight tests proved that no excessive vibrations were transmitted to the aircraft controls, and handling was found to be satisfactory.

Earlier problems appeared to have arisen mainly as a result of vibrations caused by blade flutter, and were eliminated by modifying the blade design. Fluctuating inertial forces, inherent in rotor systems, were reduced by optimizing the rotor head geometry.

Towards the end of the year successful flight tests were carried out with the autogyro.

High-speed wind tunnels
New flexible walls were machined for the 0,45-m trisonic wind tunnel and were attached to the rigid throat blocks. The contours of these assemblies were machined to ensure stepless transition from the throat block to the flexible plate.

Tests were also conducted in the tunnel with fixed-contour nozzle blocks for Mach 1,45.

Interactive computer graphic programmes were developed to facilitate development of adjustable nozzle contours for the complete supersonic speed range of the tunnel (Mach 1,0 to 4,5).

The project leader reported on the nozzle design theory at a meeting of the Supersonic Tunnel Association held in the USA.

Stability and control of missiles and high-speed aircraft
The facility for testing free-flight models in the working section of the trisonic tunnel was developed to the stage where it is ready for routine use.

The model launching system, comprising a launch gun, control devices in a launch cart and a control console, is already in use. The launch gun was calibrated and the control system (which makes synchronized automatic operation of the gun possible), a high-speed camera and a high-speed pulse-light source are all functioning satisfactorily.

Several digital computer programmes were developed for experimental and analytical investigations into flight dynamic phenomena. One of these is a programme for the systematic design of free-flight models. For any particular model type, the programme automatically selects a structural configuration which yields the optimum mass distribution for given test requirements.

Aircraft structures
An investigation was started into the application of locally available materials for aircraft construction. Particular attention is being devoted to the use of synthetic materials. Their effectiveness is judged in terms of structural strength, reliability and stiffness.

Ad hoc studies of a more general nature were also undertaken. One concerned fatigue problems and in another the cause of an aircraft accident was determined.

Aircraft propulsion
A locally designed and manufactured prototype of a rotary combustion engine was subjected to preliminary tests to establish its functional behaviour. After the design had been improved, the engine was tested more thoroughly. Results suggested that with modifications to the engine geometry this type of power unit could have excellent potential in aircraft propulsion. A second prototype is therefore being designed and constructed.

Aircraft noise
A preliminary investigation aimed at the development of a simplified procedure for the assessment of noise disturbance caused by light aircraft was completed. The work was undertaken on behalf of the Department of Planning and in collaboration with the South African Bureau of Standards.

The Institute again participated in the work of the International Organization for Standardization (ISO) and prepared a draft proposal for a standard procedure to be adopted in predicting exposure to aircraft noise in planning the use of land. The proposed procedure is based on the method previously developed by the Institute's Aeronautics Research Unit and accepted by the South African authorities for the assessment of noise disturbance caused by large transport aircraft.

Data processing and instrumentation
A telemetry system for measuring in-flight rotor blade stresses of the prototype autogyro was used successfully. The main components of the system were obtained from the National Institute for Defence Research, but strain gauge and signal processing equipment had to be developed.

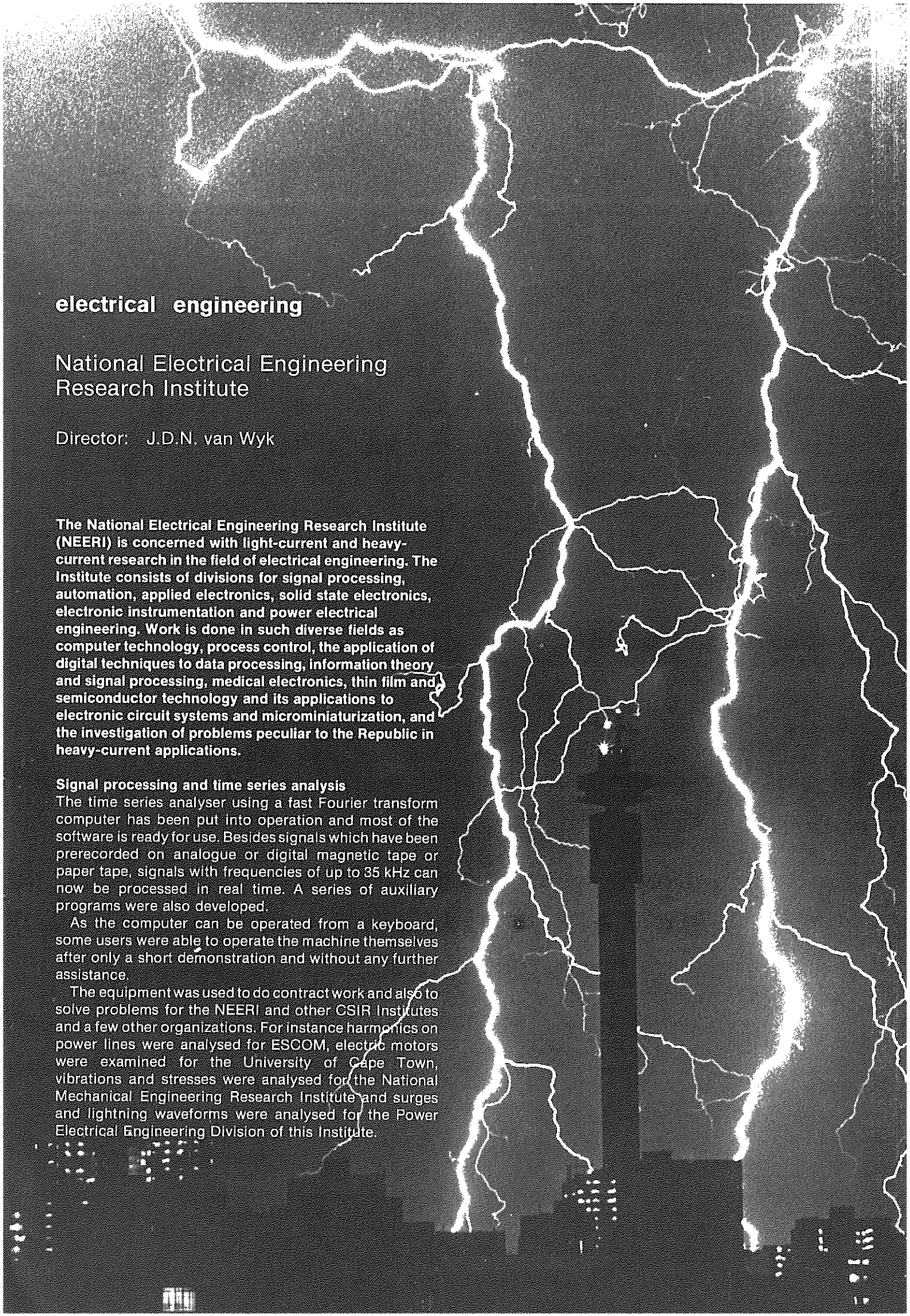
Special-purpose instrumentation was also provided for installation in aircraft, engines and test rigs to measure acceleration, strain, rotational speed, pressure, temperature etc.

Phormium tenax fibre processing
A locally manufactured decorticator for *Phormium tenax* leaves was used by various fibre producers during the year. It was found that if the machine was correctly operated and good quality leaves were used, it produced first-grade fibre at an acceptable rate. Users complained, however, that too many stoppages were caused by fibre wrapping about axles and by breakdowns, and that it cost too much to replace worn parts.

The Institute's Fibre Research Unit did a series of tests on fibre discharge from the machine. The decorticator was modified and its performance improved noticeably.

As a result of the experience gained a new decorticator is being built, in which some of the basic components of the previous machine are being used. The frame is, however, new and provision has been made for larger bearings with better protection against ingress of water and dirt.

Further work is aimed at producing improved components which can replace components in existing machines and so lower the maintenance costs.



electrical engineering

National Electrical Engineering Research Institute

Director: J.D.N. van Wyk

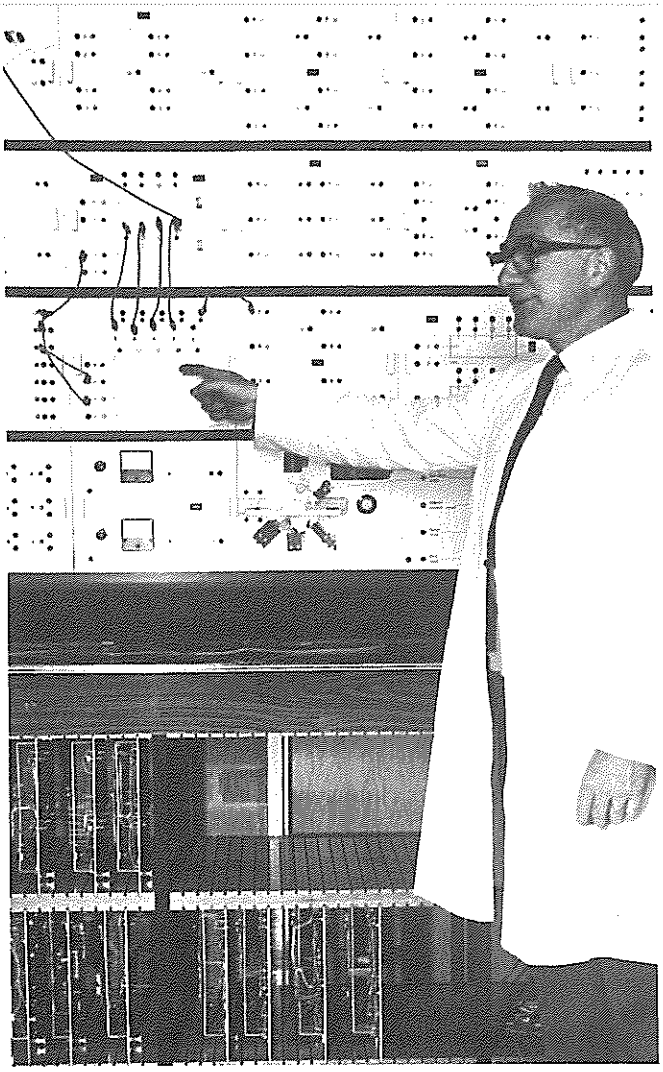
The National Electrical Engineering Research Institute (NEERI) is concerned with light-current and heavy-current research in the field of electrical engineering. The Institute consists of divisions for signal processing, automation, applied electronics, solid state electronics, electronic instrumentation 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 semiconductor technology and its applications to electronic circuit systems and microminiaturization, and the investigation of problems peculiar to the Republic in heavy-current applications.

Signal processing and time series analysis

The time series analyser using a fast Fourier transform computer has been put into operation and most of the software is ready for use. Besides signals which have been prerecorded on analogue or digital magnetic tape or paper tape, signals with frequencies of up to 35 kHz can now be processed in real time. A series of auxiliary programs were also developed.

As the computer can be operated from a keyboard, some users were able to operate the machine themselves after only a short demonstration and without any further assistance.

The equipment was used to do contract work and also to solve problems for the NEERI and other CSIR Institutes and a few other organizations. For instance harmonics on power lines were analysed for ESCOM, electric motors were examined for the University of Cape Town, vibrations and stresses were analysed for the National Mechanical Engineering Research Institute and surges and lightning waveforms were analysed for the Power Electrical Engineering Division of this Institute.



Computer technology

The hardware for the Institute's hybrid computer has been completed and the main activity during the year was the development of the software system. A special engineering program for maintenance purposes was also developed. With the hardware system completed and the software system nearing completion, thought is being given to further development of the system. It was decided, however, to concentrate on applications for the time being, in order to judge the future demand for and requirements in hybrid computation. The attitude of clients when they can choose between the hybrid computer and the general-purpose digital computer for system analysis is being investigated. It was noted that because of its interactive nature the hybrid computer was preferred to the general-purpose computer for solving certain types of problems. The fact that problem parameter values can be changed during solution time, and that the effect of such changes on the solution can be seen at once, is a great advantage when an initial model is being developed to explain experimental results. If the same set of parameter values is used in a digital solution, and excessive amount of computer printout is often produced, and too much time is spent evaluating the printed information.

Work on the simulation of the Grootfontein aquifer continued. This aquifer has a surface area of about 200 km², and is hydrologically isolated from the surrounding compartments. During the past five years about 500 items of data have become available on functions such as groundwater level, rainfall and pumpage. The object of the simulation is to predict the flow from a spring as a function of rainfall and pumpage.

Data-acquisition systems

The computer at ESCOM's distribution station, Apollo, was installed last year but operation was delayed as most of the sensors were delivered and installed later than expected. Data recording has, however, commenced and arrangements are being made to analyse the recorded data on the CSIR's IBM 360/65 computer.

Four groups of data input lines are connected to the computer. The first group of lines transmits the inputs from an experiment on out-of-contact current measurement, the second transmits the inputs from an experiment on out-of-contact voltage measurement, the third transmits data from a corona experiment and the fourth transmits data from weather sensors in the vicinity. Data from the weather sensors provide a record of ambient conditions during the course of any of the experiments and are of particular importance in the corona experiment.

Process control

The research project undertaken in collaboration with a sugar company in Natal on the construction of a mathematical model of a sugar factory continued. For the purpose of the project the factory has been divided into the following parts, each of which is being modelled separately: the milling train, the juice heaters, the multi-effect evaporators, the vacuum pan crystallizers, and the centrifugal separators. The work on the milling train has advanced furthest. The modelling of the juice heaters, multi-effect evaporators and the vacuum pan crystallizers is being carried out by a member of staff of the CSIR's Chemical Engineering Research Group, who has been seconded to this Institute.

A model of the milling train has been constructed, based on weekly average milling data. However, as cane characteristics vary considerably a computer-controlled data acquisition system was installed in the factory on a temporary basis in order to obtain data at shorter intervals.

The modelling of a gold ore reduction plant is being carried out in co-operation with a gold mining company and with the assistance of the National Mechanical Engineering Research Institute and the University of Pretoria. The NEERI is now concentrating on the modelling of the filter plant with the aim of optimizing its performance. The function of the filter plant is to remove the ground ore particles from the slurry which contains released gold in solution. At present the mud cake formed by the fine particles is not subjected to further treatment and gold left in its goes to waste. Any improvement in the efficiency of the filtering process should in the long run be rewarding owing to the recovery of gold which would otherwise have been lost.

Left: The electronic logic simulator used in an advanced course in small-scale automation techniques.

Below: Fitting a radio-equipped collar round the neck of a grysbuck.

Small-scale automation
It had previously been decided that industry should be encouraged to use small-scale automation techniques. The Institute therefore, in co-operation with the Technical Services Department, where a special small-scale automation centre was established, organized a series of basic and advanced courses and developed equipment for helping persons who take the courses to become familiar with pneumatic, hydraulic and electronic techniques.

The Institute designed a series of electronic logic panels which can easily be linked together and used during the advanced courses for demonstration purposes.

Equipment for tracking animals
More transmitters of an earlier design were built for new investigations involving rhinoceros and lion, and a new transmitter for baboons was designed for a medical research project in Mozambique. For tracking grysbuck, one of the smallest antelope, a small two-stage transmitter was designed with a high output but low current drain, the object being to achieve maximum tracking distance with very small batteries. Tracking distances of up to 2 km were achieved during the initial field tests carried out at Jonkershoek, Stellenbosch.

For a trial experiment on hyena, a transmitting collar has been designed made of very strong glass fibre reinforced with a steel band. The containers for the battery and transmitter are of steel. A series of standardized transmitters, providing the best compromise between the demands for a great tracking distance and long battery life, are at present being constructed for springbok, kudu and nyala.

Medical electronics
Interest in the radio telemeter link which is used for observing the electrocardiograms (ECG) of convalescent heart patients and also for other physiological studies, increased significantly. With this link the electrocardiogram of an active patient can be kept under continuous observation. A practicable system is at present under trial in hospitals in Pretoria and Durban. The device has also been used on horses and electrocardiograms were obtained at distances of 200 metres and more.

Two useful pieces of peripheral equipment were produced. One is a meter which gives a visual indication of the heart rate, and the other is a telephone adapter which makes it possible to transmit a given parameter (e.g. ECG or temperature) over the normal telephone system.

Progress was made in the development of a device to measure cerebro-spinal fluid pressure. The immediate aim of the work is to improve the primary pressure sensing capsule and to find a method of obviating wired connections between the patient and the recording device.

Microwave circuits
Research into the technology of microwave stripline circuits was begun and a few simple patterns on sapphire and alumina substrates were produced for test purposes. The required thickness of conducting gold layers on the substrate is about 4 μm, which is considerably more than the 0,5 μm of an evaporated layer. Some means of strengthening this layer and at the same time creating patterns with very close tolerances had to be developed.

Since evaporation to a thickness of 4 μm presents great technical problems and is also very expensive, the additional gold is added by electroplating.

Hybrid circuit power amplifier

In order to study heat flow problems in thin-film and hybrid circuits, a class B audio power amplifier was designed with which some preliminary results have already been obtained.

After detailed experiments it was decided that the fabrication of the amplifier would have to deviate technically from the standard process. A glazed substrate is used, but by means of an ultrasonic drill the glaze is removed from those areas where the power transistor chips are to be mounted. The evaporation and etching of resistors and conductors then proceeds as usual. Next the roughened areas are goldplated and the power transistors soldered onto this gold plating, while the other chips are epoxy-bonded in the usual way.

A complete circuit with an expected audio output of 12 to 15 watts is being manufactured.

Acousto-electronics

Ultrasonic surface waves have become a very versatile tool for signal processing. They are used in delay lines and amplifiers, for phase coding and decoding and for complex filtering applications.

Research into the influence of evaporated films on the propagation parameters of surface waves continued. Attention was devoted mainly to the phenomenon of abnormal wave amplitude attenuation when a metallic film is deposited on the propagation path.

An extensive report on the research into the interaction between charge carriers and ultrasonic surface waves is being prepared.

Monolithic bipolar integrated circuits

Advanced technology has made it possible to manufacture thin-film integrated circuits with a high degree of precision and stability and suitable for frequencies extending into the microwave region. However, such circuits have a rather low component packing density. Silicon monolithic integrated circuits on the other hand, offer a much greater component density — so great, in fact, that in most cases the package limits the useful size reduction. This technology, however, offers neither the precision nor the microwave capability of the thin-film circuit, but this is not important in two-state logic or in linear applications, where the gain of an amplifier is controlled by external precision components.

As the technology of silicon monolithic integrated circuits is a logical extension of the process for making diodes and transistors, this aspect was investigated first. Before such devices could be fabricated four techniques had to be mastered, namely wafer (substrate) cleaning, oxide growth for photomasking and passivation, diffusion of N-type and P-type dopants for junction formation, and photomasking and etching of diffusion and metallization windows.

Once these basic processes had been mastered, it was possible to diffuse small diodes and later also batches of transistors. A typical transistor had a forward current gain of about 100 with a reverse breakdown voltage of 50 to 70 V.

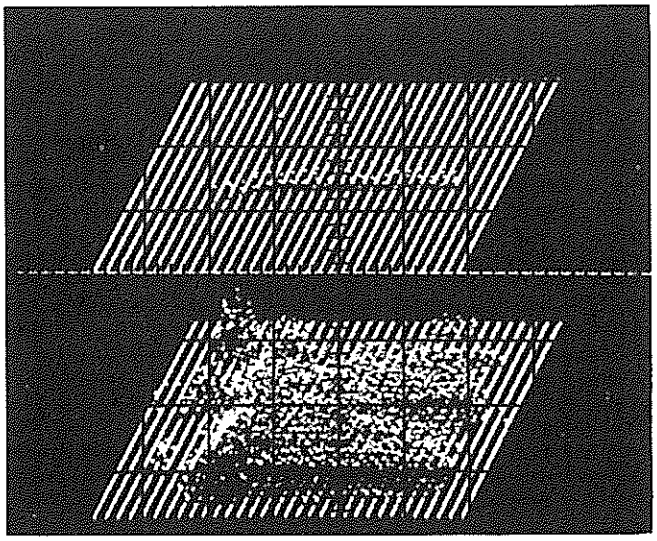
Low-voltage reference

Acting on a suggestion in the literature that a silicon-germanium transistor in a suitable circuit could act as a low-voltage (0,5 V) zener diode, the Institute carried out a theoretical analysis a few years ago and showed that the temperature coefficient of such a reference diode could be made arbitrarily small (either positive or negative). In order to obtain temperature compensation, suitable transistor pairs had to be selected. Further investigations led to the development of a regulated low-voltage supply, which uses the silicon-germanium transistor pair in such a way that selection is no longer necessary. Circuit adjustment is provided instead, which allows adjustment of the output voltage to a predetermined value, 5 V for instance. At this point the optimum condition for temperature compensation is established automatically. Such a regulator would be ideal for battery-operated equipment with limited supply voltage (6 V or less).

Lightning research

The Institute's lightning research programme concentrates mainly on the measurement of ground flash density. This factor is of economic importance mainly in relation to the design of protective equipment for power transmission and distribution systems. The aim in the design of such equipment is to protect power systems against unnecessary interruptions and limit the consequent loss of production man-hours. In addition, communication networks also have to be protected against lightning damage and interruptions. To be able to assess accurately the probability of failure, a knowledge of the actual ground flash density per square kilometre per annum is necessary.

The development and testing of lightning flash counters for recording ground flashes is therefore given priority. Research conducted by the CSIR supplements research in other countries significantly and local researchers are kept well informed of developments elsewhere through close collaboration with the CIGRE Working Group on Lightning.



A three-dimensional display of voice sound (the word 'time') by the time series analyser.

Lightning research is also conducted in collaboration with the Atmospheric Physics Division of the National Physical Research Laboratory, where the relationship between lightning and hail is being investigated. Good use has also been made of radar information on the movements of storms, which was supplied by the National Institute for Telecommunications Research. Over the years a testing ground for lightning flash counters has been established, consisting of a network of four lightning recording stations covering the area between Pretoria and Johannesburg. There is equipment at these recording stations for determining the direction of individual lightning flashes by both electrical and optical means.

The most striking feature of the 1971/72 season is that, in general, there was appreciably less lightning activity than during the previous three seasons. Twenty-eight storms were recorded compared to a mean of 56 for the previous seasons. For various reasons more reliance was placed this season on the optical method of locating flashes, i.e. the method using all-sky cameras.

The effect of intracloud and intercloud flashes on the operation of counters is an important factor which had not received much attention in previous years. This year, however, some indication of the sensitivity of the different counters to cloud flashes was obtained from a sample of 24 definitely idenfitied cloud flashes during a particular storm. The main conclusion drawn from this investigation is that most of the counters are activated by some cloud flashes up to a range of 30 km.

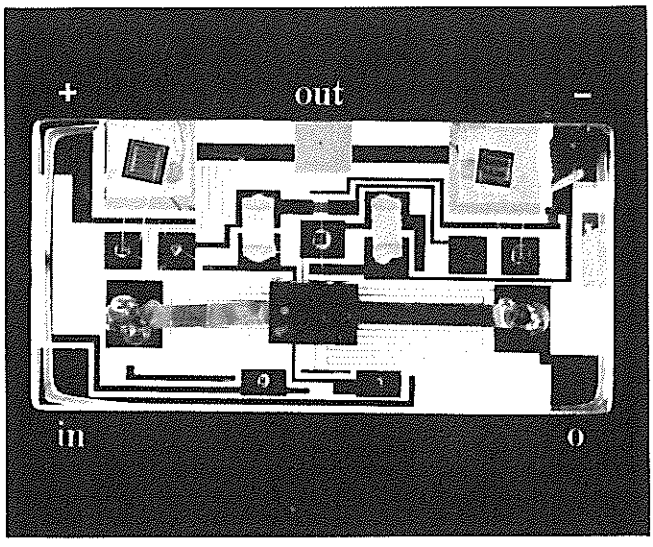
Surges and corona on transmission and distribution lines

The main purpose of the research into surges on power lines is to obtain information on the frequency distribution of the magnitudes of the surges and on their wave-forms, as well as information on the effect of attenuation of surges during propagation along the lines. These data are needed in order to define the levels of impulse voltages which traverse power lines and eventually impinge upon terminal substations where appropriate protective measures are needed to prevent flash-over and damage. The wave-form of these surges is of equal importance, since it affects the voltage resistance of insulation and the breakdown characteristics of protective equipment such as surge dividers and arc gaps.

Surges are now being measured at three locations, namely at ESCOM's 400 kV system at the Apollo distribution station, at an 11 kV distribution line near Pretoria, and at the 6,6 kV signal circuit and 3 kV dc track system of the South African Railways' electrified railway between Pretoria and Johannesburg.

The University of Pretoria also takes an active part in the Apollo research project and the South African Bureau of Standards assisted by making available impulse generator equipment for studying surge propagation and also for calibration. Corona measurements have been made by the University of Pretoria at many sites in the Republic and this aspect will be studied more closely at Apollo.

In addition to measuring surges at the Apollo research station, the Institute has developed methods for the remote measurement of the 50 Hz current and voltage magnitudes of the 400 kV system by means of special antennae. The remote sensing systems may in future obviate the use of conventional current and voltage transformers in some situations on extra-high voltage systems, and will probably reduce considerably the cost of instrumentation for substations operating at high voltages.



A thin-film hybrid power amplifier with power transistor chips soldered to the gold-plated areas near the top edge of the substrate where the glaze has been removed to improve heat transfer. Size of substrate: 25 x 12,5 mm.

Insulation

Research into the insulation characteristics of large high-voltage motors continued. The methods used in 1969 for testing a group of motors operated by the Rand Water Board were used again on the same group of motors towards the end of 1971. In some cases the quality of the insulation had deteriorated significantly during the two years.

A special power supply with a variable frequency was built for long-term tests on sample insulation materials. In such tests the sample is subjected to high voltage at a high frequency so that accelerated life tests can be carried out. At the same time the voltage wave-form should approximate a sine wave in order to simulate normal service conditions.

Maintenance of electronic equipment

Laboratory automation is becoming increasingly popular, but as the use of advanced instruments such as computer-controlled experimental units increases, greater demands are made on the availability and quality of maintenance services. The Institute provides an expert service at the CSIR, where it is responsible for various such installations.

Calibration of electronic instruments

A growing number of instruments are calibrated on a routine basis as CSIR laboratories and institutes realize the need for a regular check on measuring instruments. Calibration work done for outside organizations also increased considerably. In most cases checking and adjusting were necessary.

chemical engineering

Chemical Engineering Research Group

Head: W.G.B. Mandersloot

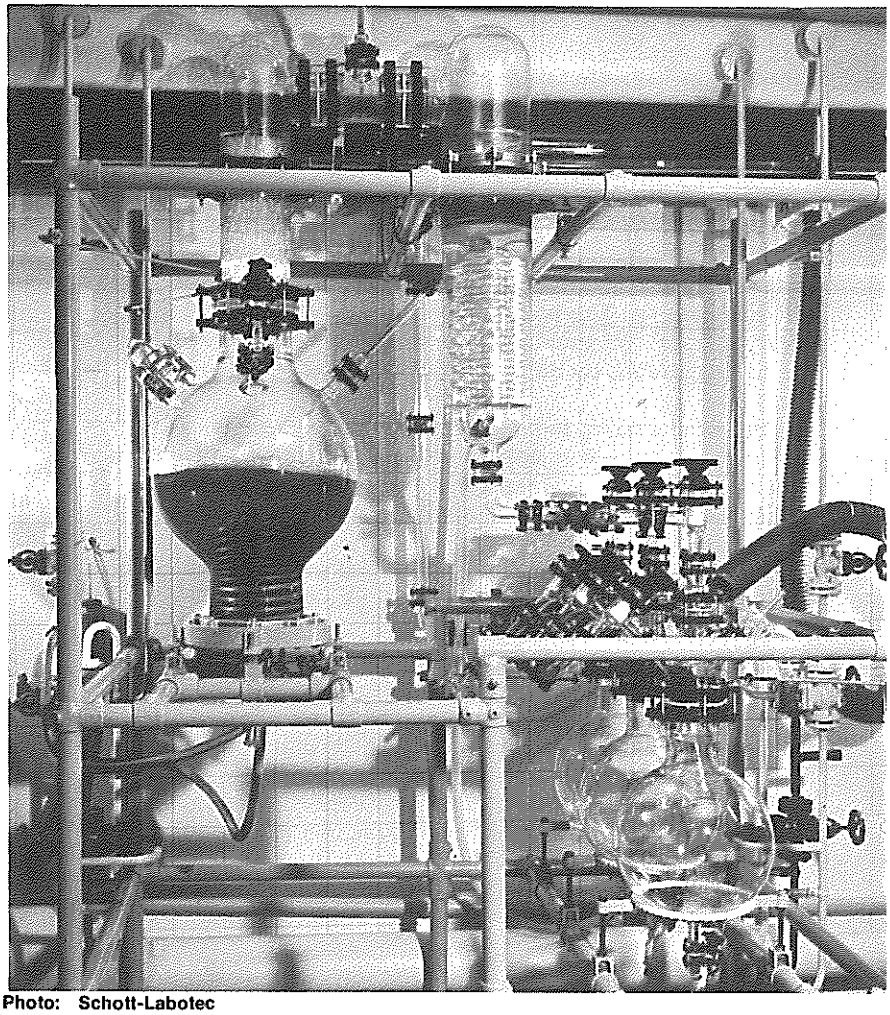


Photo: Schott-Labotec

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

The research and development items on the Group's programme are selected according to the immediate and expected needs of industry. The Group provides extensive consulting services to industry. If necessary these services are backed up by applied research.

Aid with experiments

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.

Prevention of air pollution

The process industry's measures for preventing air pollution are often based on emission measurements. An increasing number of such measurements is carried out each year by the Group, especially since the Department of Health has been enforcing the Atmospheric Pollution Prevention Act more widely. The information thus obtained is used to select dust collectors and other equipment for controlling air pollution.

Concern over the high cost of stack sampling led to a study of sampling procedures. It was concluded that a composite sample taken rapidly across a stack gives a good average composition of the gas which is satisfactory for most investigations into pollution.

Particle size analysis

A large number of samples was submitted by industry for analysis. This service often leads to further advice on related process problems. A special rotary sample splitter was developed for preparing small representative sub-samples for certain analytical techniques.

Computer programming

An increasing number of computer programs developed by the Group is made available to outside organizations. A unified approach was adopted for writing user-oriented computer programs. This approach should be of use to others doing this kind of work.

Heat exchangers
The Group's service for computer-designed heat exchangers (particularly air-cooled units), was extended and there is now a service for the accurate rating of existing designs. Industry can use this service to advantage in the evaluation of tenders for heat exchangers.

These time-saving computer programs on heat transfer are developed in co-operation with the Heat Transfer and Fluid Flow Service of the AERE at Harwell in England, to prevent repetition of overseas work.

To design cost-optimized heat exchangers by computer it is necessary to have methods for the prediction of pressure drop, mean heat-transfer coefficients, etc. which are more reliable than those used in traditional design methods. Reliable methods have already been developed for specific purposes.

Flow in manifolds
Manifolds are widely used in industry for the distribution of fluids and gases but there is no reliable information about their design. This information is now being collected as part of an investigation of the pressure and flow distribution at pipe junctions. The work has reached the second stage in which interactions of adjacent junctions are being studied.

Thickening of mineral slurries
The first step in ore processing is usually comminution. The dilute mineral slurry from the grinding system is concentrated by sedimentation in a thickener before further processing.

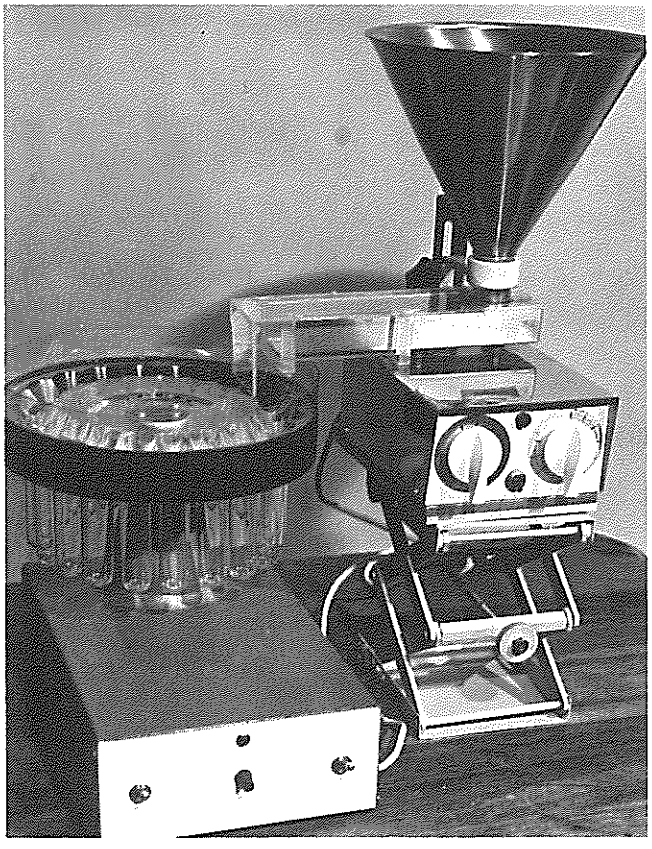
In a system developed by the Group underflow density is measured and deviations from a set point are used to alter the underflow pumping rate. With this automatic control it is possible to maintain a considerably higher mean underflow density than was possible with manual control. The level of the floc bed was controlled by letting the signal from a floc sensor (optical or ultrasonic) control the feed rate or the addition of secondary flocculant.

This work was carried out in co-operation with Goldfields of South Africa Limited and the Chamber of Mines of South Africa.

Manganese dioxide for dry cells
Only active manganese dioxide ores are suitable for use in dry cells. The Pulse Galvanostatic Analyzer developed by the Group to evaluate the activity of manganese dioxide samples was exported to Australia and Germany. The instrument was refined so that it can now be operated and checked without the help of the issuing laboratory.

Bantu beer
The Group worked on Bantu beer brewing technology at the request of the CSIR's Bantu Beer Unit. A number of major improvements were introduced in bantu beer production. The replacement of coarse malt by finely ground malt reduced unnecessary loss of malt. The introduction of plate heat exchangers in Bantu beer breweries improved the heat economy, hygiene and flexibility of operation. A continuous mixer to transport slurries of grit or malt was developed to replace the expensive and troublesome batch mixing tanks.

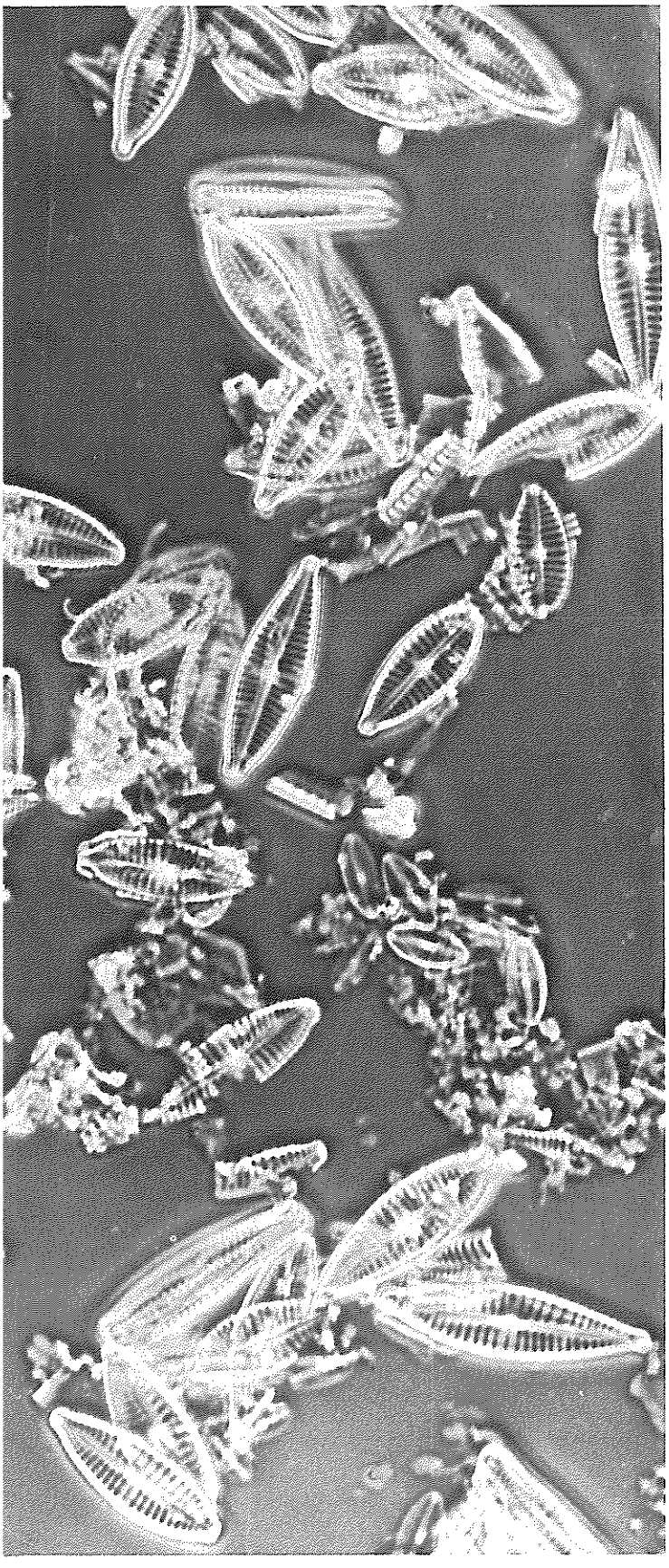
Preparing for industrial stack sampling.



A rotary sample divider developed by the Group.

National Institute for Water Research

Director: Dr G.G. Cillie



Water research is vital in a country such as South Africa with its relatively scarce and limited sources of water. The National Institute for Water Research (NIWR) therefore strives to increase our knowledge of 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 the sea. The Institute has a personnel of 140, 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 problems, research groups in Pretoria undertake basic and applied research on a broad spectrum of problems concerning the country's water resources. Research groups for freshwater biology, water quality, biological treatment processes, physico-chemical treatment processes and desalination have been established. There is also a group which deals with technical enquiries.**

Algal bioassay

Eutrophication, which is at present a world-wide problem, is the enrichment of water with plant nutrients which encourage the growth of large masses of algae and water-weeds. The utilization of water for general use and for recreation is affected and dams are rendered unattractive. Since some dams in South Africa have already been exposed to enrichment, the Institute has embarked upon an extensive research programme to determine the extent of eutrophication and to develop methods for its prevention.

Algal bioassay is a special technique used to ascertain the extent to which water has been enriched, and which nutrient is responsible for the enrichment. A fixed amount of algae from a viable culture is added to each sample of water, and the sample is then kept under optimum light and temperature conditions for a given period. Quantitative values for growth rate and growth potential can then be obtained by measuring the amount of algae which develops. By the selective addition of plant nutrients to water samples, the nutrients responsible for excessive algal growth can be determined.

Biotic index of rivers

The study of river pollution is handicapped by the fact that intermittent pollutants cannot be traced by spot-sampling. Concentrations of such pollutants may vary widely, and chemical samples taken at a specific time are not necessarily representative of the pollution load of the river.

The substances concerned have, however, a permanent effect on the water fauna. After intensive research over a period the Institute has developed a biotic index system according to which the degree of organic pollution at any point in a river can be established. This system is based on

Samples of river water being taken.

the variety of animal species and the number of individuals of selected species found on the submerged rocks at any specific point. The biotic index makes it possible for engineers and water-works personnel to obtain a clear and reliable indication of the degree of pollution caused by specific procedures.

Resistant bacteria and hospital effluent

In addition to chemical pollutants, raw waters can also contain microbiological organisms such as viruses, bacteria and parasites. Many of these micro-organisms are harmless to man and animal, but some of them may cause disease. The Institute undertakes intensive research into the incidence of pathogenic micro-organisms in water sources and especially into the efficiency with which they are either removed or killed off by water treatment processes.

The Institute has recently undertaken an exhaustive investigation of the pollution loads contributed by two representative hospitals to their respective cities' sewage works. Results indicate that hospitals do not contribute excessively to the pollution load on the sewage works. It was found, however, that harmless bacteria which are resistant to a wide range of antibiotics, may be present in hospital and in normal city effluent. It was also confirmed that these harmless bacteria can transfer this resistance to pathogenic bacteria. Although the concentration of resistant bacteria is slightly higher in hospital than in city effluent, the difference is so small that at present it does not warrant separate treatment of hospital effluent.

Positive measures will have to be taken in future to prevent sewage effluent, which contains steadily increasing numbers of resistant bacteria, from polluting water. In this regard it is important to note that the advanced purification techniques developed by the Institute to reclaim drinking water from sewage effluent ensure the total destruction of all bacteria at all times.

Biological processes

Biological purification processes are still of great importance in the treatment of city and industrial effluent before it is discharged into rivers or purified further for re-use. The Institute investigates methods for improving existing processes, and is concerned with the development and application of new processes, especially the efficient removal of nitrogenous compounds from the final effluent. The removal of nitrogenous compounds is of great importance, since their presence in treated effluents can cause eutrophication in receiving waters and affect the potential of such waters for re-use.

Particular success was achieved with a modified flow pattern by which nitrogenous compounds can be removed very effectively in an activated sludge system. The basic principles and the practical applications of the process are being investigated, and provisional patent protection has already been obtained.

Water reclamation

The Institute's success in developing and applying water reclamation has been emphasized in the past year by widespread overseas interest, and the large number of visitors to the Stander Water Reclamation Plant in Pretoria.

Research on water reclamation is continuing, and during the year intensive studies were undertaken to determine whether the various unit processes can maintain the microbiological purity of reclaimed water, and whether shock loads of toxic substances accidentally released into sewers can be removed completely. It was found that bacteria and viruses are completely destroyed at all times, and that even excessive loads of toxic substances such as heavy metals are removed by the integrated unit processes.

Marine disposal of sewage effluent

On behalf of the Durban Corporation, the Institute investigated the effects of sewage disposal into the sea near Durban. Sensitive methods were developed to indicate the extent of pollution caused by various types of pollutants.

It was shown that by pretreating sewage effluent and then disposing of it into the deep sea by means of a submarine pipeline, sea water and bathing beaches could be protected against pollution. The bacteriological quality of the water at the bathing beaches now complies with the strictest requirements.

It was found that by the time the effluent reaches the surface of the sea directly above the end of the pipeline it is normally diluted more than 1 000 times. No noticeable patches are caused in the sea. Pollution is now found only where sewage and industrial effluent are disposed of into shallow sea water by accident or by design. It is clear that well-designed submarine pipelines provide a suitable means for disposal of treated sewage effluent in the deep sea.

Mineralization of water

South Africa's agricultural production is to a large extent concentrated in the irrigation areas along the most important rivers. Potential mineralization of soil by indiscriminate irrigation or by the use of brackish water for irrigation is a constant source of concern.

On the other hand, overseas research and local investigations undertaken by the Institute have indicated that there is as much danger that water from irrigation areas which seeps back to the rivers can cause mineralization of the river water. The extent of such mineralization and possible measures for its prevention are being investigated.

Composting

Because of its knowledge of aerobic processes in the treatment of waste water, the NIWR is also investigating the composting of solid waste.

The Institute recently published a technical guide on the composting process and its large-scale application. This guide evoked considerable interest from municipalities and private concerns, since it deals with all aspects of composting.

The use of sewage sludge in the composting of municipal solid waste was also investigated. Sewage sludge is a waste product of conventional sewage treatment processes, and has to be disposed of or incinerated at great cost and with great difficulty. The addition of sewage sludge facilitates the composting process to a great extent since sewage sludge is rich in the carbon and nitrogen compounds which micro-organisms require to break down cellulose. It may, however, introduce possibly harmful organisms and parasites which are usually present in the sewage sludge.

The incidence of pathogenic organisms in compost and the efficiency with which they are destroyed in practical composting is being investigated. An efficient method has been developed to indicate the presence of such organisms in compost.

Storage of water in sand

The intensive study of the storage of water in natural sandbeds for later recovery is being continued. The results of a series of experiments to determine the implications of storing water in sand under South West African conditions have been published. This study indicated that sand texture and the water level in the sandbed are major factors in the conservation of water in existing sandbeds.

The size of sandbeds in the Cape Flats and their suitability for large-scale storage and recovery of fresh water were also investigated. The exact location of a suitable sandbed has been determined accurately by means of geophysical techniques and borehole tests, and intensive experiments on methods for infiltrating water into the sandbed and for withdrawing it have reached an advanced stage.

Disposal of effluents by irrigation

Irrigating cultivated pastures is a suitable method for disposing of mineralized effluents. Provided the soil and the composition of the effluent are suitable, this method can be used to produce profitable crops.

An NIWR team of experts has made an intensive study of the method, and is investigating its application at specific testing grounds. On the grounds of results obtained so far the Institute has been able to supply various industries with expert advice on the use of this method.

Desalination of sea and brackish water

During the past year the NIWR obtained provisional patent rights on a process for the desalination of sea water. In this process the emphasis is on the reclamation of strategic by-products to render the desalination process more economical. The possibility of applying the process in practice and developing it are currently being investigated.

The Institute has gained considerable know-how on desalination techniques which may be of great value in the utilization of the country's underground brackish waters. A start was made with investigations into commercially available apparatus which can be used to desalinate brackish water for various uses, including domestic use or for watering livestock. An example of such apparatus is the solar distillation unit developed by the Institute. It can supply sufficient fresh water for domestic purposes on farms in dry areas.

Advice to industry

Through its years of research, the NIWR has gained considerable know-how on aerobic and anaerobic biological processes and physical-chemical processes in effluent treatment, on the purification of water for use and on many other aspects of water pollution, water supply and water treatment.

Industrial firms often experience difficulty in utilizing an available water source efficiently for certain processes, or in getting their factory effluent to comply with prescribed standards. On request, the Institute makes its know-how available to design engineers. If a problem cannot be solved with existing knowledge, a team of experts from the Institute can be called upon to do *ad hoc* investigations at a prescribed fee.

These experts have established, during their investigations, that prevention of wastage forms the basis of efficient utilization of water. The recovery of by-

products can, in most cases, make the treatment of effluent economically attractive.

In this way, through its advisory service, the NIWR also contributes to the development of the national economy and the protection of the country's natural resources.

Regional planning of water reclamation

The NIWR's development of reclamation plants at Windhoek and Pretoria, and its continued research into the efficiency and safety of water reclamation, have proved that water reclamation can play an important role in supplementing the country's water resources.

The Institute has started investigating the extent to which reclamation plants can supplement existing and/or planned water supply schemes. From the point of view of regional planning, it is clear that the judicious erection and expansion of reclamation plants can assist in ensuring a water supply for the fast-growing Western Cape. They will be especially important in providing for those periods when the expected use exceeds the supply capacity of other sources. In the long run reclamation plants will also provide permanent supplementation of the water supply of the region.

International co-operation

Under the direction of its previous Director, Dr G.J. Stander, the NIWR made a name for itself internationally in the field of water research. In the past year contact with water research workers from all over the world was extended by the Institute's participation in several international conferences, amongst these the Conference of the International Association on Water Pollution Research in Jerusalem, and by visits to important overseas water research institutions by senior personnel.

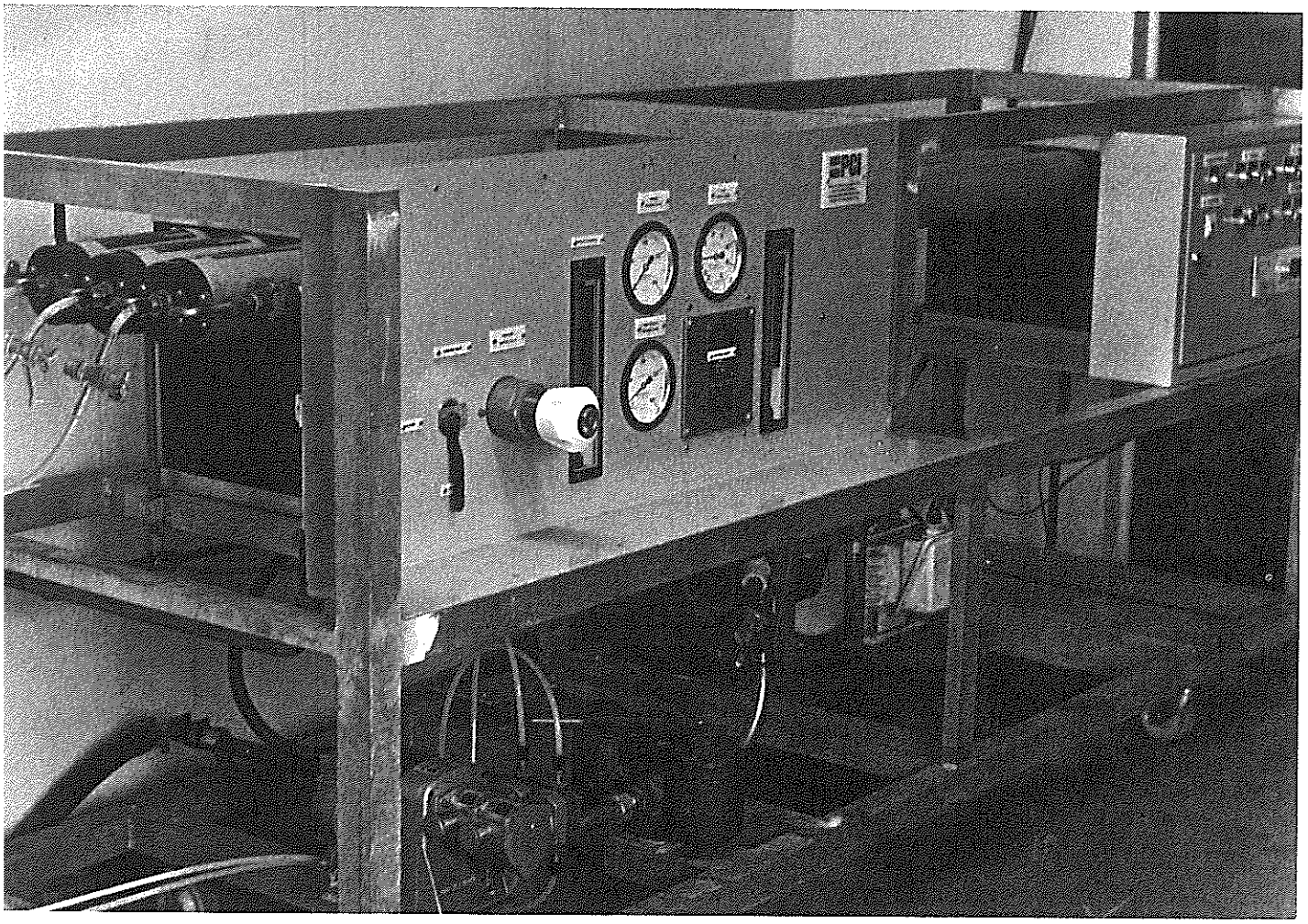
Both personal contact with overseas research workers and the publication of scientific papers have resulted in visits by a number of prominent overseas water research workers and managers of large water schemes to the Institute.

Automation of routine analyses

The abovementioned research projects require regular analyses of the quality of water from a river, dam or purification plant. In this way the quality of the water and the effect of certain processes or changes in processes can be indicated quantitatively. Approximately 50 000 chemical analyses are done per year.

Because of the limited manpower available, the automation of the analytical procedures was started a few years ago. During the year, automation was improved by the installation of an apparatus which can carry out six analyses on a sample simultaneously. The older apparatus could handle only two analyses at a time. It is expected that the analytical laboratory will now be able to handle approximately 150 000 analyses per year.

Reverse osmosis apparatus used for desalinating brackish water.



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.

Natural aroma substances in fruits

Techniques for investigating aroma components in foods were improved, especially the application of capillary gas chromatography and mass spectrometry. Progress has also been made in providing facilities for the olfactometric investigation of aromas. The facilities will be used to determine the strength and characteristic aroma qualities of isolated aroma components, either single or mixed, in controlled gas dilutions.

Various methods for extracting the aroma components were investigated and it was found that in the case of larger samples freon 12 was the best extractant. This method was used to extract the aroma components from marulas and guavas. The aroma components in these extracts were separated by gas chromatography and a large number were identified by mass spectrometry.

Determination of tocopherols in oils and fats

Although there are a variety of methods for determining tocopherols (vitamin E) separating and determining them quantitatively is usually a lengthy process. A method in which existing techniques are used, was developed to determine the tocopherols in oils and fats directly without the necessity of previous saponification or preparing derivatives of the tocopherols for gas chromatographic determination. High pressure and solid-liquid chromatography are used to separate the components and fluorimetry is used to determine them. This is a rapid method which gives reliable results.

The tocopherol contents of several samples of margarine, butter and cooking oil were determined. Since each of the commoner plant oils such as sunflower seed, maize germ and groundnut oil has a typical tocopherol pattern it is possible to establish whether a cooking oil is a mixture of these oils or not. It is also possible to determine the tocotrienols at the same time, and this can assist in identifying oils as some plant oils contain no tocotrienols.

The tocopherol contents of the seed oils of various indigenous fruits and of guava seed oil have also been determined.

Determination of fatty acids in oils and fats

Since soft and hard yellow margarines are now available on the South African market their fatty acid content was determined in order to obtain information on the poly-unsaturated fatty acid composition of margarine and to compare it with that of butter. The vitamin E content was determined at the same time to establish whether these products had a satisfactory ratio of vitamin E to poly-unsaturated fatty acids. In all the products investigated this ratio was satisfactory.

In the case of plant oils results obtained by the Institute confirmed previous work done overseas, namely that in plant oils there is a correlation between vitamin E activity and poly-unsaturated fatty acids. Usually the higher the content of poly-unsaturated fatty acids the higher the vitamin E activity. There are, however, deviations from this pattern and in the investigation of the fatty acid composition of the seed oils of indigenous wild fruits particular attention will be given to this aspect.

Unidentified fatty acids were found in the seed oil of four wild fruits investigated recently. The oil of the grey apple (*Parinari curatellifolia* ssp. *mobola*) contained a highly unsaturated fatty acid which polimerizes very quickly once it is isolated. A stable addition product of the acid has already been made but it has not yet been characterized with certainty.

Indigenous veld foods

The investigation of the nutrient content of edible leaves, fruits and tubers of indigenous plants is continuing. During the past year 80 samples were obtained for analysis from different parts of the Republic and Botswana.

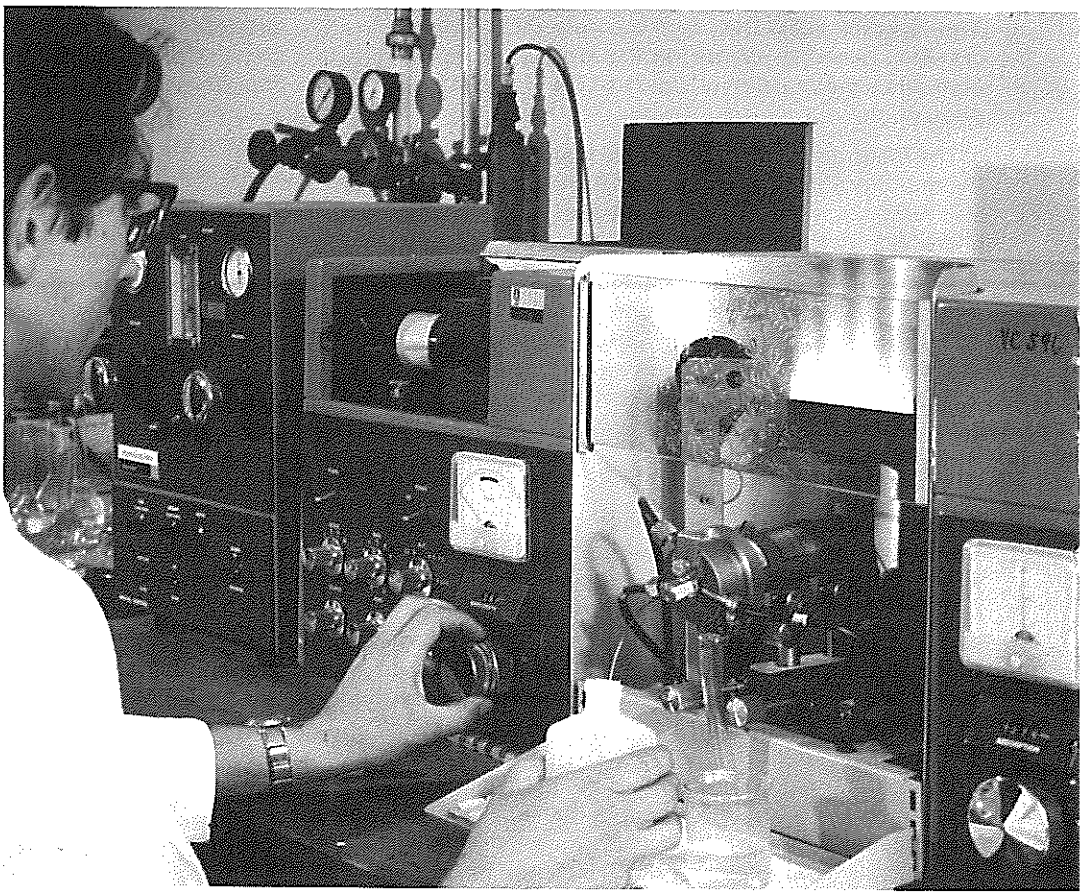
Where there is a possibility of commercial exploitation of these plants, the investigation is extended to the technological aspects of the utilization of the plants or their products. The possibility of using fresh marula fruit for the preparation of a fruit juice is being investigated, as well as the possibility of using the seeds of the marula and the mangetti (there are large numbers of mangetti trees in the north-eastern part of South West Africa) as edible nuts. The problem of successfully extracting the nuts from the seeds on a large scale has not yet been solved. The shell of the marula seed is rather hard and the nut itself is fairly brittle, while the shell of the mangetti nut is extremely hard. Both these nuts are important items in the diet of the indigenous population in the areas where the trees grow.

Maize and maize products

Starch is the major component of maize and much of our export maize is used to produce starch. There is, however, not always a good correlation between starch content, which is determined chemically, and starch yield, which is based on physical separation. An improved method for the determination of starch yield has been developed and the more important South African maize varieties are currently being investigated for their suitability for starch production. South African maize has a good reputation in the starch industry and information on the properties of different varieties can be valuable in helping to keep this reputation.

The tendency to harvest maize at a rather high moisture content and then to dry it artificially, is steadily increasing. Uncontrolled drying, however, may have a detrimental effect on the maize and owing to the importance of good quality, especially for the export market, the influence of artificial drying on the properties of maize is being investigated. For this purpose, maize was dried in a laboratory turbulence drier and in a large experimental drier. It was found that a temperature of 60°C is the

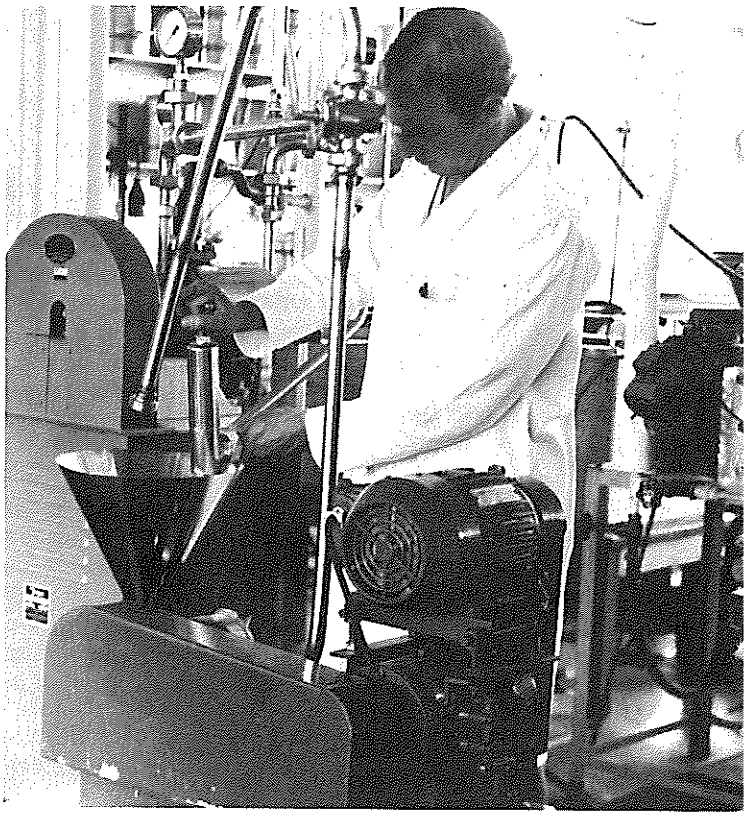
Atomic absorption techniques are used to determine the minerals in foods.



maximum at which maize can be dried without detectable changes occurring. Changes which can develop in the composition of maize are a decrease in reducing sugar content and in soluble nitrogen content and a reduction in viability. It was also found that a high drying temperature can result in starch of lower quality being produced. A quick and reliable method which can be used after harvesting to determine whether or not maize has been dried injudiciously must, however, still be devised.

Because of the high viscosity of cooked maize meal, baby foods which have maize meal as a basis have the disadvantage of a low energy value. Experiments have been carried out in which the starch in cooked maize meal is partially broken down by enzymes and then dried. To make porridge of the instant product so obtained, little water is necessary and this product is therefore a more satisfactory basis for baby cereals.

An investigation into the enrichment of maize meal with the vitamins riboflavin and nicotinic acid, which was carried out in collaboration with the National Research Institute for Nutritional Diseases of the South African Medical Research Council and the Department of Health, has been concluded and the results are being processed.



In the well-equipped food processing laboratory.

Packaging of meat carcasses

In South Africa meat carcasses are sold cold on the hook, a procedure which has certain disadvantages. The carcasses lose mass owing to moisture loss, the meat can become contaminated, especially as a result of handling, and during storage the meat surface loses its attractive appearance to a certain extent.

An investigation was carried out to determine whether these undesirable effects could be avoided by wrapping the carcasses in a suitable packaging film directly after grading at the abattoir. Oxygen should be able to permeate the packaging film — just enough to ensure the retention of the red colour of the meat. The film's water permeability should be such as to minimize the moisture loss of the stored carcasses. In addition the film material should not tear easily and should be self-sealable.

The primary aim of the investigation was to determine whether or not the financial gain obtained by reducing

moisture loss, justified the wrapping of the carcasses. The results indicated that wrapping of carcasses is advantageous.

Biltong manufacture

During the past year special attention was given to two aspects of biltong manufacture. A survey of the hygienic production of commercially prepared biltong was undertaken as well as an investigation of the pickling or salting process.

The Microbiological Research Group examined samples for four bacterial species known to cause food poisoning as well as for bacteria the presence of which is considered indicative of pollution from human or animal sources.

All four of the abovementioned bacterial species were recovered during this survey. Eight out of 36 samples examined were contaminated with *Salmonella* species, while at least 20 out of 36 samples contained bacteria indicative of impermissible pollution. The bacterial counts obtained refer only to the organisms which survived the drying and salting processes. Since these processes favour the elimination rather than the proliferation of the organisms, it can be accepted that the contamination of the product was initially much higher.

In view of the general consumption of biltong, particularly by children, these results should be viewed in a serious light. Stricter control of the health aspects of the manufacture of biltong requires urgent attention.

Experiments in connection with biltong production established that salt penetration continues during the drying process. No differences in the salt distribution in the final product were observed after salting times which varied from one to 24 hours. The influence of the salting time on other aspects, e.g. the flavour of biltong, is being studied. Special equipment is being used to investigate optimal drying conditions and the effect of different conditions on the microflora of biltong.

Fungal metabolites

The Microbiological Research Group has continued investigating the production of secondary nitrogenous metabolites as a possible means of differentiating fungal species within taxonomic groups in which the morphological differentiation is poor.

Penicillium viridicatum produces a nitrogenous metabolite which may be important in determining the taxonomic position of the fungus. The optimum cultural conditions for the production of the metabolite have been determined and the biosynthesis of the metabolite has also been studied. Because chemical investigations of this metabolite showed that the compound chelates metals its role in the uptake of metals by the fungus was investigated. There was no evidence, however, that the production of the metabolite was connected with the heavy-metal requirements of the organism.

A preliminary survey of the chemotaxonomy of the genus *Eupenicillium* was also completed. All the strains of *Eupenicillium hirayamae* examined produced a metabolite which contained a pyrole nucleus. However, fungal species morphologically related to this fungus did not produce similar metabolites.

Biological evaluation of proteins

The absorption of the protein component of a diet from the intestinal tract usually results in a deposition of proteins in the body of a growing animal. Conventionally this accretion of protein — which is usually measured by determining the nitrogen accretion — is used by nutritionists as a criterion of the nutritive value of the proteins in foodstuffs. If the accretion on intake of a given mass of protein A is greater than the accretion on intake of the same mass of protein B, it is said that A's nutritive value is superior to that of B.

The above criterion, however, presents serious biometric problems, because in the case of some proteins the relationship between the absorption from the intestine and the accretion by the body is rectilinear, while in the case of other proteins the relationship is curvilinear. This fact often makes a quantitative comparison of nutritive value of two proteins quite impossible.

To find a more suitable criterion for determining protein values, the relationship between the protein intake and the nitrogen accretion of certain organs in young, growing rats was investigated. The organs concerned were liver, kidney and skeletal muscle. Two types of protein, egg protein and wheat gluten, were fed separately at graded levels in balanced rations to groups of young rats. The protein intake of each animal as well as the nitrogen accretion of each of the organs mentioned, was determined over a period of 16 days.

It was found that the response of the individual organs to protein intake was similar to the response of the body as a whole. In the case of the rats given egg protein, the relationship between nitrogen accretion of the separate organs and protein intake was linear, while in the case of rats fed on gluten the relationship was curvilinear. The results therefore indicated that the use of nitrogen accretion of individual organs as criterion for the biological usability of proteins in foods has no specific advantages over the conventional techniques based on the response of the whole body.

Diet and tissue calcification

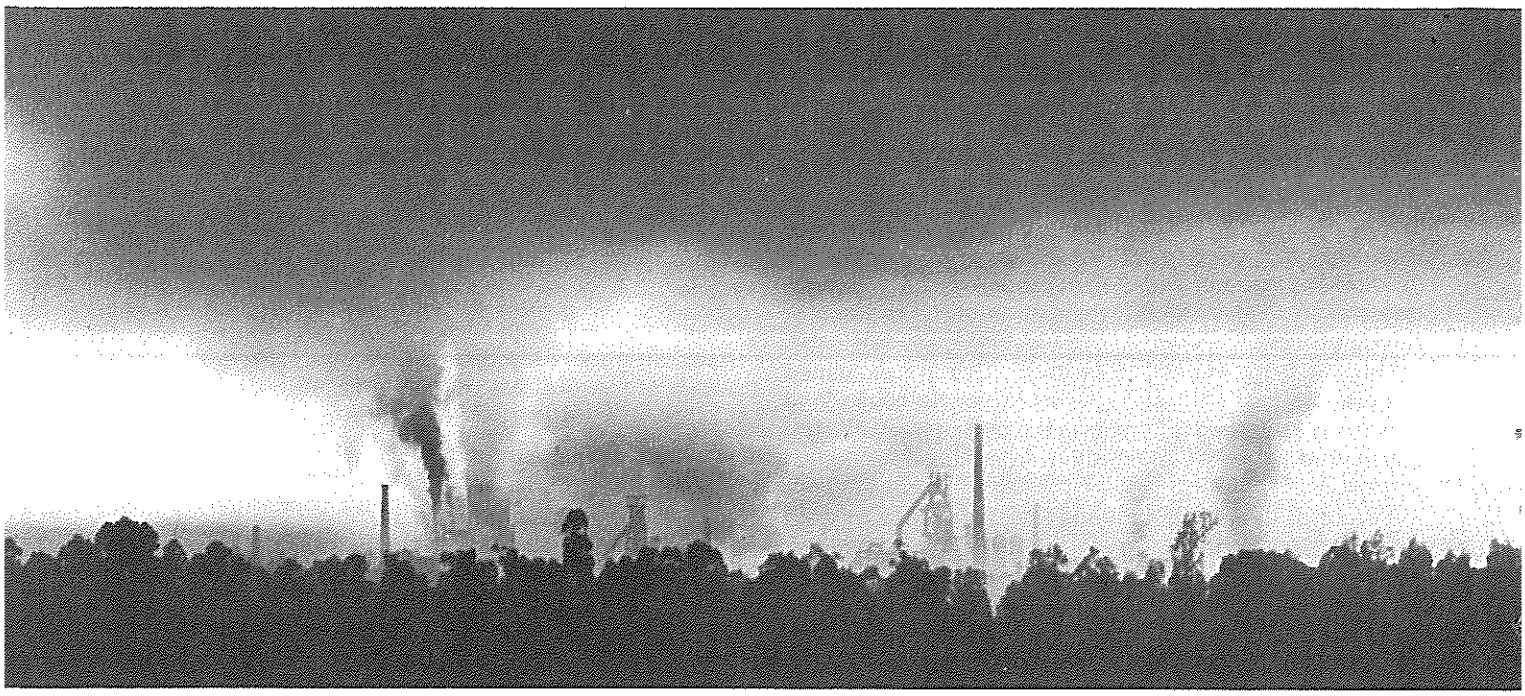
Tissue calcification is seldom observed in population groups using maize as a staple food, but occurs frequently among people who consume a Western diet. This phenomenon is of considerable practical importance and is being investigated by the NFRI.

Rats were used in a series of investigations into the relationship between tissue calcification and diet and then about two years ago, the rats were replaced by young baboons. From a series of studies, in which 35 baboons have already been used, it appeared that tissue calcification — in this work special attention is paid to kidney calcification — can be induced experimentally in young baboons.

It appears that a combination of two factors in particular, namely a magnesium deficiency and an excess of phosphate in the diet, plays the most important role in the induction of calcification. It has been found that when the diet contains 10 mg per cent magnesium and 1 100 mg per cent phosphorus, death occurs suddenly after approximately nine weeks and the kidneys as well as certain other organs of the animal concerned show marked signs of calcification. In cases in which more magnesium was administered (160 mg per cent), death did not occur even after 10 months, in spite of a high proportion of phosphate being fed simultaneously.

The results obtained thus far therefore indicate that an excessive intake of phosphate induces tissue calcification and even causes death, while magnesium protects experimental animals from the deleterious effects of phosphate.

In the light of these results it is interesting to note that the magnesium content of maize is high (approximately 105 mg per cent). It is therefore possible that the low incidence of tissue calcification among maize eaters may be ascribed to their high magnesium intake.



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 operation of control measures and to combat it by effective control measures the Air Pollution Research Group 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 consequent formation of vigilance committees and societies have resulted in 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.

Local atmospheric circulation

Research on the vertical profile of temperature, wind speed and wind direction makes it possible to assess the extent to which poor atmospheric ventilation produces undesirable concentrations of pollutants in certain areas. This enables town planners to determine which parts will be suitable for industrial areas and which parts for residential areas.

The work is done mainly under contract to large industrial concerns and provincial authorities, and also at the request of the Department of Health.

Smoke and sulphur dioxide

Several local authorities have joined in the national survey of smoke and sulphur dioxide in the air and have purchased the necessary measuring equipment. A mobile laboratory has been equipped so that comparative measurements can be made in the towns and cities participating in the survey. The aim is to standardize all measuring methods in order to obtain accurate and comparable results.

Trace elements in the atmosphere

The measurement of concentrations of trace elements in certain areas in Pretoria, Johannesburg and Durban continued and showed that iron has the highest concentration, followed by lead, magnesium and zinc. This is the same order described in an American publication which gives an average for a large number of towns in the USA over a long period of time. Since the South African measurements apply to one winter period and were conducted in industrial areas only the values are somewhat higher than the American values.

Pollutants from motor vehicles

The concentrations of carbon monoxide, hydrocarbons and ozone were measured in Pretoria, Johannesburg and Durban at the same sites as in 1968. The measurements do not show any significant increase in the concentrations of these substances during the three years.

Organic gaseous pollutants

Work has continued on the identification and measurement of organic gaseous pollutants in the atmosphere. The main activities during the year were the testing of a large number of chromatographic separation columns and the connection of the chromatograph to an infra-red spectrometer to identify and measure more precisely the substances initially separated into groups in the gas chromatograph.

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.

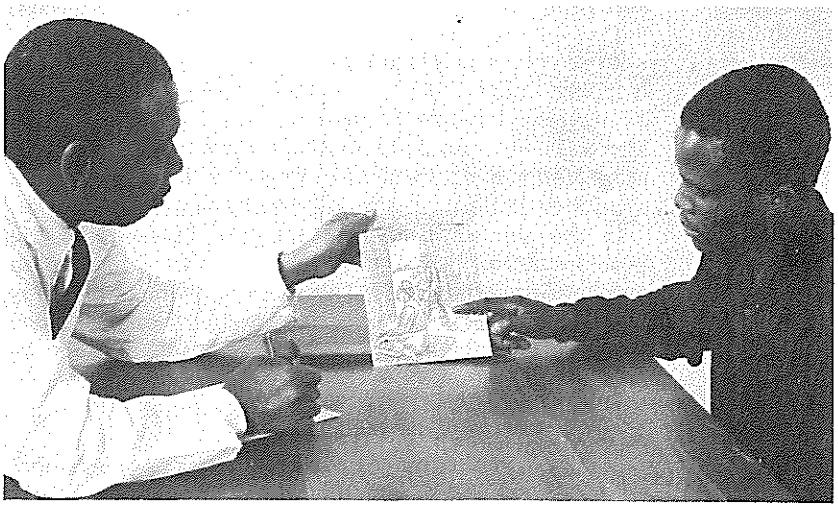
In any work situation there are certain factors directly affecting the worker's productivity and happiness. The NIPR is concerned with the study of these factors, which include:

- **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 condions 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 mal-adjustment to work, e.g. absenteeism, accidents, occupational disorders and group conflicts.**

Organization and staffing

The function of the Work Study and Training Division has, over a number of years, moved away from more conventional work study activities into the field of organization development and managerial problems and skills. Since the name tended to confuse outsiders the Division has been re-named the Management Studies Division.

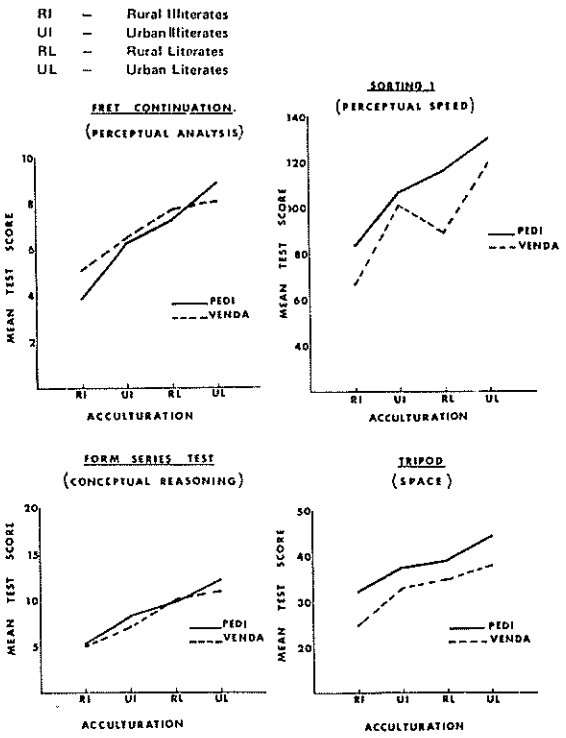
A small unit for Road Safety Research has been established to study the human factor in road accidents. It carries out sponsored research for the National Institute for Road Research and the National Road Safety Council.



The Form Series Test for determining non-verbal reasoning ability.

Application of part of the Projective Personality Test (PPT).

International Biological Programme; comparison of Venda and Pedi mean performance in four selected tests.



Staff turnover continued to be high during the year, especially amongst senior staff. Although several members of staff obtained higher qualifications (six Ph.D. and four M.A. degrees) with theses based on their NIPR research assignments, this did not relieve the position much as half of them accepted attractive offers from outside organizations.

Overseas visits and conferences

A project leader in the Management Studies Division spent almost a year in Europe and the United Kingdom studying current trends in organization development and working as a visiting consultant with NPI International — Institute for Organization Development in the Netherlands. He also attended two international conferences, at one of which he delivered a paper.

Three senior members of staff read papers at a NATO invitational conference on Problems of Mental Testing in a Cross-cultural Context held in Istanbul and also made contributions to the International Congress of Applied Psychology at Liège in Belgium. Another member of staff represented the Director at a conference of the International Committee on Occupational Mental Health. The theme of the conference was Mental Health and Foreign Workers, a topic of particular relevance to South Africa. At all these gatherings the NIPR contributions were very well received and much interest was expressed in the South African work in the field of cross-cultural psychology.

The head of the Psychometric Statistics Division is spending a year as a visiting research fellow at the Educational Testing Service in Princeton, New Jersey.

Bantu labour in urban and border industrial areas

A comparative study of worker stability and productivity among Bantu in urban and border areas was carried out at the request of the Permanent Committee for the Establishment of Industry and Development of Border Areas and the Department of Planning. The main study, based on the outcome of a pilot study and completed during the year, was carried out in the textile industry.

Absence and labour turnover rates were low at both the border and the urban factory; the former however had the lower rates. This appeared to be due to the fact that there was a shortage of labour in the urban area but a plentiful supply in the border area. It was thus possible for the border factory to be more selective in the choice of its labour force. Productivity was high at the border undertaking, low at the urban one. This, too, was due partly to the different methods of training adopted in the two factories. It appeared that the training at the border factory was better. In general the findings were similar to those obtained from other studies of industrial workers in Western countries, in that higher labour turnover and absence rates were found among the young, single, unskilled and short-service men.

When attitudinal data were compared little difference was observed between the employees at the two factories. When differences did emerge however, men at the border factory consistently displayed less dissatisfaction than those at the urban undertaking.

It was concluded that the Bantu adapts readily to industrial work and develops attitudes and expectations similar to those of blue-collar employees in any Western industrial society.

International Biological Programme

The active phase of the International Biological Programme, to which the Institute contributed two studies, has been completed.

One of these studies concerned the mental abilities of Bantu in cultural transition from an illiterate-rural to a literate-urban background. The study was done on adult males — rural and urban samples of the Venda and Pedi tribes. It was found that in all the tests subjects with school education scored significantly higher than illiterates, and that within these two groups, urban subjects did better than rural subjects.

Where there were significant differences in the groups' test performance these could be attributed to the different employment histories of the two tribes. This indicates that exposure to an industrial environment, even if urbanization is not involved, is important in promoting the adaptation of Bantu to a Western technological way of life.

In the second study the Institute investigated the development of needs and their role in work motivation among the same groups. The theory on which the study was based was Maslow's need hierarchy which postulates that human beings have certain basic needs such as physiological, security, affiliation, esteem and self-actualization needs, which normally emerge in this order as dominant needs during life.

In both the Venda and Pedi studies it appeared that physiological needs were the strongest motivators. Next

in importance were esteem needs and security needs. Affiliation needs seldom appeared to be strong and it was hypothesized that this was because in the Bantu social system these needs were fully satisfied. It was thought that the self-actualization needs did not appear because the lower needs were not sufficiently satisfied to permit the higher-level ones to emerge.

The above findings hold possibilities that employers can devise ways of using employees' esteem needs to motivate them in the work situation.

Development of a projective test of personality for Bantu

In a modern industrialized society knowledge of an applicant's abilities alone is not enough to select and place him effectively as a worker since personality and motivation also play an important part.

Because the need to assess the personality of the Bantu has become urgent as he moves into a modern industrial culture, a projective personality test (PPT) for use among Bantu-speaking people has been developed. This project presented several methodological and procedural problems since it was developed from first principles with studies of Bantu imagery and symbolic thought and used material derived from the Bantu culture.

It is expected that the test will be available to psychologists in the very near future.

Psychological attributes and proficiency of truck drivers

A study, sponsored by the National Institute for Road Research, of the psychological attributes and proficiency of male White and Bantu truck drivers was concluded.

An important aspect of the project was the development of a road test to assess driving proficiency, with which highly reliable evaluations of competence have already been made. This test will in due course be made available to licensing authorities, training organizations and employers, and should find immediate application as an objective and standard method of assessing driving proficiency.

Two significant findings emerged from the study. Firstly, with minor exceptions, the two race groups did equally well in the test. Secondly, there were strong indications that the two race groups deploy their inherent abilities, acquired knowledge and personality attributes differently when faced with identical tasks. Should this be a general phenomenon it underlines the complexity of selection and training in a multi-racial society.

It is believed that a programme of studies of this kind could make a valuable contribution towards combating the excessive number of road accidents in South Africa.

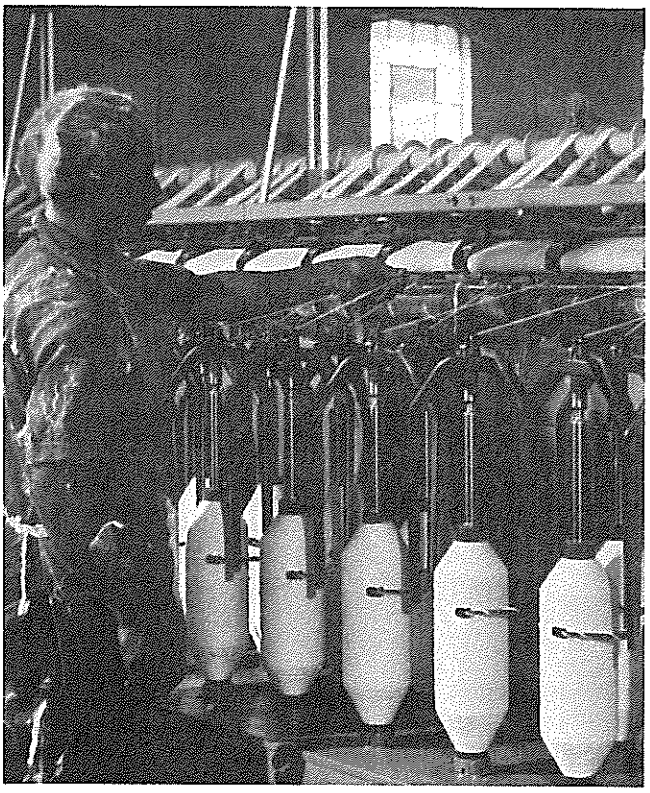
Advisory services

A free advisory service, involving all divisions of the Institute, is provided to numerous and varied organizations and to individuals. A few examples are given below.

During the year the Personnel Selection Division provided information mainly on questions of selection and the use of tests for occupations ranging from unskilled and operative levels to managerial level. Those seeking advice included mines, civil engineering concerns and various manufacturers of consumer products.

In the Sensory-Motor Research Division most of the enquiries concerned the application of practical tests for the selection of industrial personnel such as crane operators, dial watchers, sewing-machinists, vehicle drivers and coil winders. Post-graduate students sought information on available equipment for their projects or suggestions about suitable substitutes. Technicians in a university psychology department enquired into specific constructional problems and the possible effects of constructional simplification on the psychological aspects of an apparatus test.

A Bantu worker attending a cotton-spinning machine in an urban factory.



Training

A great deal of training was undertaken by the Institute. There was, for example, a steady demand for seminars aimed at imparting the techniques of job analysis to members of client organizations. A direct outcome of this demand was the use of closed-circuit television in the training to standardize presentation and save time.

To meet a strong demand from industry it became necessary to train certain categories of NIPR test-users on a regular basis. This service appears to satisfy an important need.

A training course for writers of instructional programmes was held at the request of a chain store group with branches all over the country. Programmes written by the participants in the course and referred to the Institute for comment were of a high standard. According to a spokesman of the group programmed instruction was contributing successfully to the improvement of training in the company.

Identification of White manpower for high-level positions
Although the Institute devotes much attention to studies relating to the improved utilization of the Non-White sector of the labour force, there is also a pressing need for better identification and utilization of White manpower for high-level positions.

The High Level Deductive Reasoning Test was constructed to measure individual differences at a very high level of intellectual competence where traditional measures fail to discriminate meaningfully, i.e. among professional workers such as scientists. It was included in a study undertaken at the CSIR, involving the testing of 200 scientists, and was shown to be a highly reliable measuring device.

Job evaluation
In order to meet existing needs a shorter and more economical method of job evaluation had to be developed. The new Questionnaire Method (Q-method) which was evolved from the existing system is characterized by semi-structured guidelines for the job description schedule and a questionnaire format to facilitate the rating and evaluation process. Job evaluation information and practical experience gained by the Institute over the past years were consolidated in the Q-method to produce a system which makes rapid and accurate rank and grade classification of all jobs in an organization possible without loss of validity or reliability.

An issue of the CSIR's monthly publication *TI (Technical Information for Industry)* was devoted to this topic and aroused considerable interest amongst readers.

Follow-up studies of vocational guidance
Opportunities for studying the effectiveness of the NIPR vocational guidance procedures have been limited. One of the main difficulties in collecting follow-up material has been the problem of maintaining contact with clients. The Personnel Selection and Vocational Guidance Divisions in Johannesburg and Pretoria have now both initiated systematic follow-up studies to improve, where necessary, the procedures currently in use.

Two questionnaire studies have been initiated by the Johannesburg Division. The first aims at determining the adequacy of the information presented in the NIPR vocational guidance reports, while the second seeks to obtain information on the validity of the guidance provided.

The response rate in the first study compared favourably with that usually expected from a postal survey. An analysis of the replies revealed that it was generally felt that the aim in seeking guidance had been achieved and that the presentation of the test results and recommendations was satisfactory. Only a very small percentage of clients offered any criticism.

The validity study is expected to take several years to complete. The response so far has been good and progress is encouraging.

The Pretoria Division is carrying out a follow-up study of CSIR staff-members who received vocational guidance. The advantage of this sample is the availability of the subjects for interviews. A pilot study, using the questionnaire technique, is at present being carried out to determine the most promising basis for the more intensive follow-up study.

Programmed mathematics
In order to publicize the NIPR's programmed mathematics courses, the programmes were described in an issue of the CSIR's monthly publication *TI (Technical Information for Industry)*, in collaboration with the Information and Research Services of the CSIR. The publication caused considerable interest and numerous enquiries were received. The result was a satisfactory increase in the supply of programmed mathematics courses to industrialists, educationists and individuals.

Language laboratory
The Institute was responsible for the installation of a language laboratory at the CSIR in Pretoria where two groups of CSIR personnel are trained daily in the two official languages. The courses are chiefly for immigrants who urgently need such instruction in order to adapt more easily to work at the CSIR.

Provision is also being made for instruction in foreign languages for CSIR personnel who have to travel overseas in the course of duty and urgently need to learn the relevant languages.

Metrication of tests
With the introduction of the SI system to South Africa some NIPR tests have had to be modified. New versions of all cognitive tests are now being printed and as they become available the distribution of non-metric versions will be discontinued. Almost all current pencil-and-paper tests are affected, but in many cases the changes are trivial and unlikely to affect the behaviour of the items changed. In certain cases, however, the difficulty of the item depended on the various units of the imperial system so that new items had to be devised.

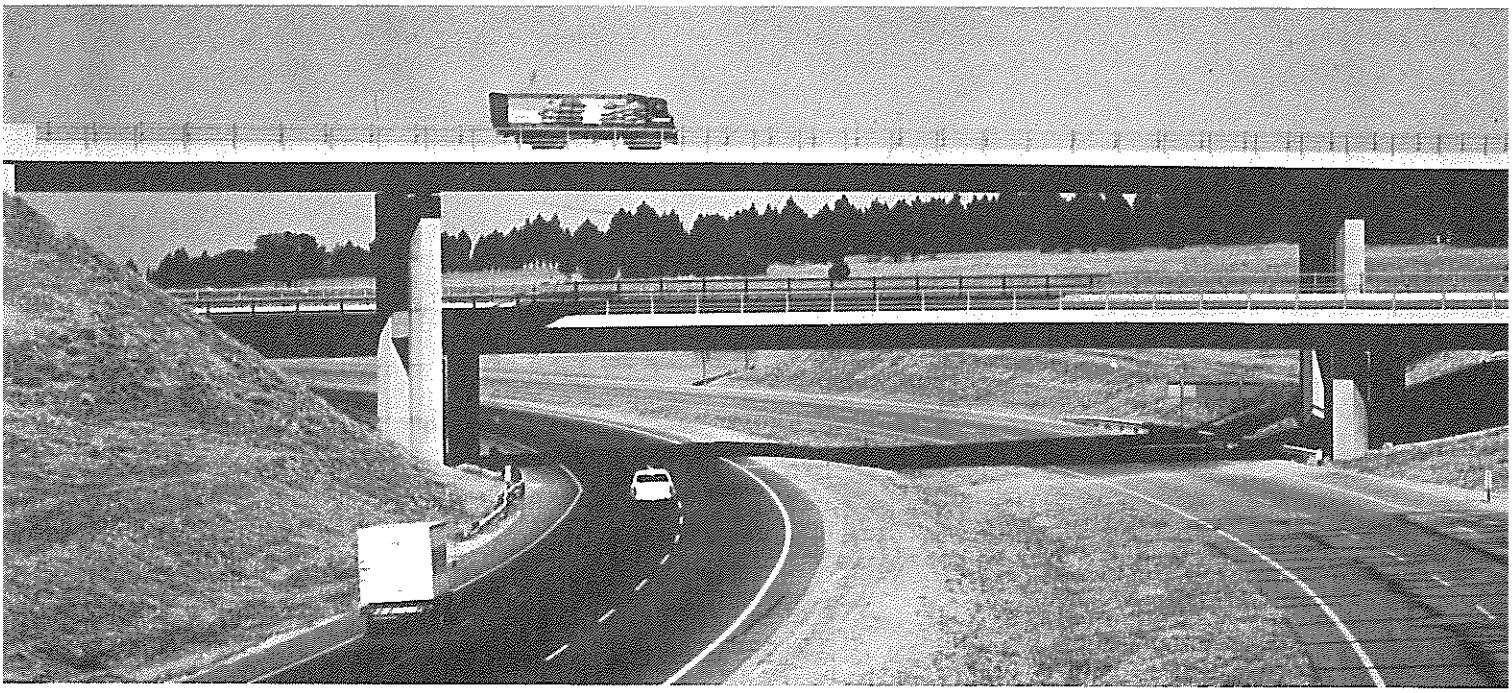
Distribution of attention test
During the year a Distribution of Attention apparatus test for vehicle drivers and aircraft pilots was designed and constructed.

Most sensory-motor tests hitherto applied to these vocations have involved this faculty to some extent, but do not appear to have emphasized it sufficiently. An attempt has therefore been made to produce an apparatus test for investigating it more intensively in conjunction with co-ordinated muscular movements similar to those required in controlling a vehicle or aircraft.

road research

National Institute for Road Research

Director: Dr S.H. Kühn



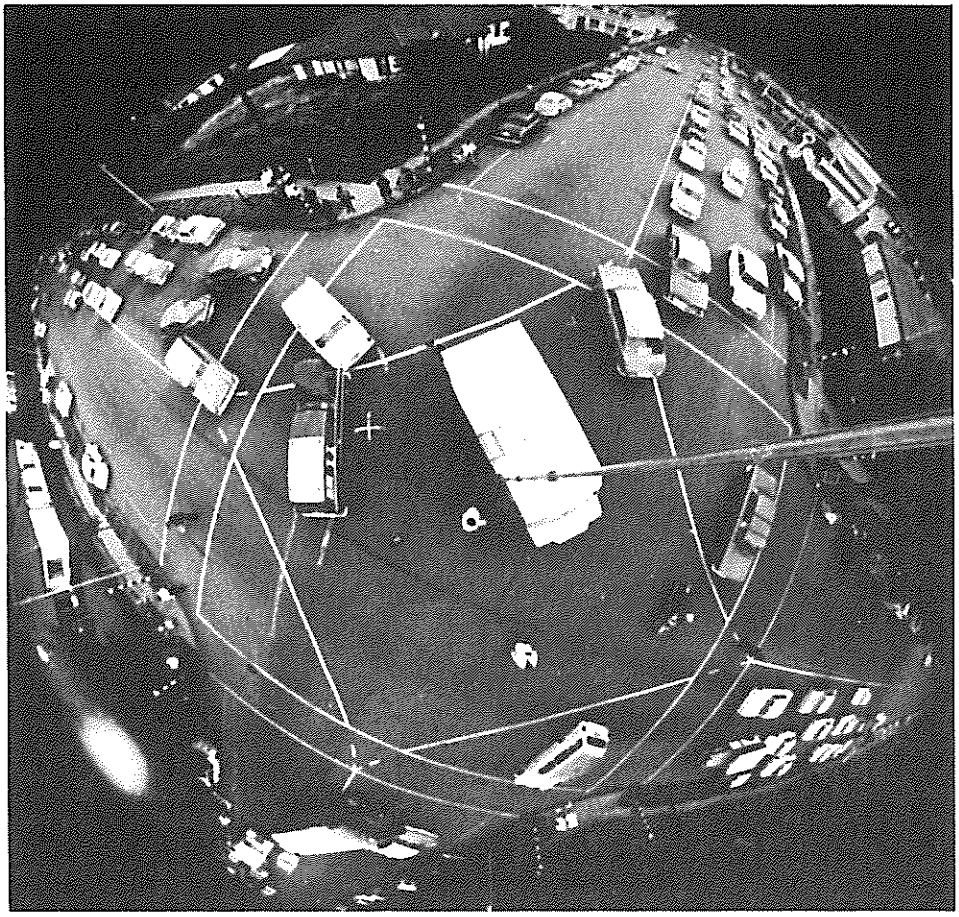
Road and traffic authorities encounter a wide range of problems in their endeavours to ensure the most economic use of roads as a public amenity. The research programme of the National Institute for Road Research (NIRR) is directed at finding solutions to these problems through research into the planning, 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.

Increased effort in road safety research

With the establishment of the National Road Safety Council for the purpose of vigorously attacking the South African road safety problem, additional funds have been made available for research which is an essential part of any effective national drive to reduce the number of road accidents. As the NIRR will be responsible for most of this increased research effort part of the Institute has been reorganized and expanded to form four new research groups, namely:

- the **Road User Group** concerned with the behaviour characteristics of pedestrians, cyclists and drivers, including problem drivers; road safety education and propaganda; accident case studies; and methods for law enforcement
- the **Vehicle Safety Group** concerned with all aspects of vehicle safety, including special vehicles such as trailers and heavy vehicles
- the **Road and Traffic Factors Group** concerned with safety aspects of road design; road surface properties (e.g. skid resistance); and environmental factors (e.g. lighting and road signs)
- the **Systems Analysis Group** concerned with data acquisition and analysis; accident and traffic statistics; and evaluation of the effectiveness of road safety measures.



An 180° photograph of an accident taken through a fish-eye lens

Examples of improvements that can reduce the number of pedestrian accidents and the expected results of such improvements

Type of improvement	Approx. percentage reduction
Pedestrian Accidents	
Pedestrian refuge	30
Pedestrian crossing (uncontrolled)	30 (all accidents)
Pedestrian crossing (controlled)	10 (all accidents)
Subways and bridges	100
Sidewalks	100
Pedestrian barrier	75 (children's accidents)

These four groups will work in close co-operation with the National Road Safety Council and are expected to make a significant contribution to the solution of the country's road safety problems.

Identification and improvement of accident black spots

Road engineers devote much effort and money to altering selected sections of roads in an endeavour to reduce the number of accidents. These sections are, or appear to be, dangerous and are termed 'black spots'.

A recent survey carried out by the NIRR shows that efforts to make these places less dangerous do not always produce the desired results. In over half the cases investigated, the number of accidents actually increased after alterations had been made.

The reasons for this unsatisfactory state of affairs are

- the number of accidents at the chosen locations does not always warrant the remedial measures introduced, in other words the spots chosen for improvement are often selected subjectively rather than on a systematic analysis of the accident pattern
- only a few road authorities attempt to study the effect of road improvements on the accident pattern and therefore little information is available on which to base cost/benefit studies
- the measures employed to improve a particular black spot are not necessarily suitable for the type of accident which occurs there.

On the other hand, it is known from experience in overseas countries that relatively minor changes at dangerous locations can reduce the number of accidents significantly, provided the problem is approached in a systematic manner.

To ensure that black spots are improved in the most effective way, and that optimum use is made of the limited funds available, the Institute has prepared a manual entitled *The Identification and Improvement of Accident Black Spots*. This publication summarizes the results of local research, as well as proven practice overseas, and presents a detailed and practical scheme for use by road authorities. It describes a method of determining what changes and traffic control devices at a given place will be most effective in reducing the number of accidents, obviously within the limits of the funds available.

The real need amongst road authorities for guidance on the systematic identification and improvement of accident black spots is evident from the great demand for the manual.

Effect of environment on road temperatures

During its period of use a road structure is subjected to a number of environmental influences besides those of traffic. These external influences are a function of the climate of the area in which the road is situated. They affect the durability of pavement surfacing materials, the volume changes and the engineering properties of the various road layers, as well as the rates of setting and hardening of lime or cement-stabilized materials.

Under South African conditions temperature is a climatic variable which contributes greatly to the deterioration of road pavements. Research is being undertaken at the Institute to investigate the effects of climatic factors. Particular attention is being paid to temperature and to methods which take climatic conditions into consideration in the design of a road.

The object of this research is to develop a simulation model for the analysis of any proposed road design in terms of the climatic environment in which the road is to be built. In this way, possible detrimental climatic conditions, which could affect the choice of design, will become apparent.

Failure of road embankments

The failure of high earth embankments in the vicinity of Pietermaritzburg, Natal, has been investigated by the Institute and an explanation for the phenomenon has been found. Numerous horizontal shear planes exist in the undisturbed ground below the embankments and the strength of the soil along these planes is sufficiently low to account for the failures. The shear planes are so thin that it is only with considerable difficulty that they can be detected. The ground beneath the embankments consists of debris from ancient landslides and continues to move, from time to time, along the various shear planes. There is clearly a general lack of foundation stability in these particular geological formations.

The Institute has advised the road authority concerned on possible remedial measures, including reconstruction with shallower side slopes to improve stability and provision of extensive drainage to reduce water pressure within the embankments. A number of piezometers have been placed in the reconstructed embankment to make regular readings of water pressure in the soil pores possible. In this way information will be obtained on the efficiency of the remedial measures and some warning will be provided of any further tendency of the embankment to become unstable as a result of a rise in pore-water pressure.

The many embankment failures which occurred early in 1972 in the Haenertsburg area of the North-Eastern Transvaal have also been investigated. These failures were caused by the unusually heavy, but not unprecedented, rainfall during the first three months of the year. The failures that have occurred can be classified as shear failure due to a rise in pore-water pressures, collapse settlement due to inundation, surface sloughing of slopes, and erosion during heavy rain. Shear failure caused by high pore-water pressures has been widely studied overseas and acceptable design methods to meet this problem are available. Collapse settlement, surface sloughing and erosion, on the other hand, have still to be investigated.

Services to road authorities

During the year the Institute provided a direct service to road authorities in a number of ways. Besides the road authorities, various sections of the road industry frequently consult the Institute in connection with practical problems. Help of this nature has covered the whole range of the Institute's interests, with particular emphasis on pavement design, road maintenance and remedial measures. This advisory function is a valuable means of liaison between the research worker and the industry he serves.

Direct assistance to road authorities in the form of specialized testing services and materials data banking has also been continued. These specialized testing services include the estimation of traffic axle loads by means of the axle weight analyser developed by the Institute, the determination of the deflection of road structures under varying traffic loads by means of the Lacroix deflectograph, and the measurement of the skid-resistance of road surfaces with a brake-force trailer. Advice on the interpretation of results and the development of new applications for the equipment is freely available. Stocking the National Data Bank for Roads with data obtained from materials surveys made throughout the Republic for many years, progressed well and measures to encourage re-use of this data have been introduced.

Failure of the Rickivy embankment near Pietermaritzburg

Annual course

The Institute's annual course, *Highway Engineering Topics*, had to be held twice this year because of the great demand for places. A total of 125 delegates from all sections of the road industry in the Republic, South-West Africa and Rhodesia attended the course. Topics discussed covered a wide range of highway engineering aspects including geology, materials and design, traffic, road safety and transportation economics. From delegates' opinions of the course it was clear that it is of considerable benefit to road engineers and a useful means of disseminating research findings.

building research

National Building Research Institute

Director: Dr T.L. Webb

The National Building Research Institute (NBRI) is essentially an applied research organization which maintains close contact with the building and construction industry, the associated professions and related organizations in the public and private sectors. The problems dealt with are: long-term problems of national interest to do with organization and management in the industry, short-term transitional problems arising out of swift technical development in the industry, and *ad* hoc, day-to-day problems which existing knowledge is used to solve.

Because numerous scientific disciplines and technologies are involved in building and construction, the work of the NBRI covers a wide field. Research is being done into construction in general, and into housing, schools and hospitals and their provision to all sections of the population in particular, as well as into factory and office buildings and prefabrication. This involves investigation into design and services, structural foundation engineering, acoustics, lighting, ventilation, heating and cooling, the behaviour and development of building materials, management organization and industrialization. The building industry's role in, and contribution to, the country's development are also investigated. There is also international liaison through the formal and informal exchange of research reports, knowledge and new techniques.

To implement the aims of the Institute an integrated, multi-disciplinary organization, with an industrial-technological-engineering approach rather than a purely academic approach, is necessary.

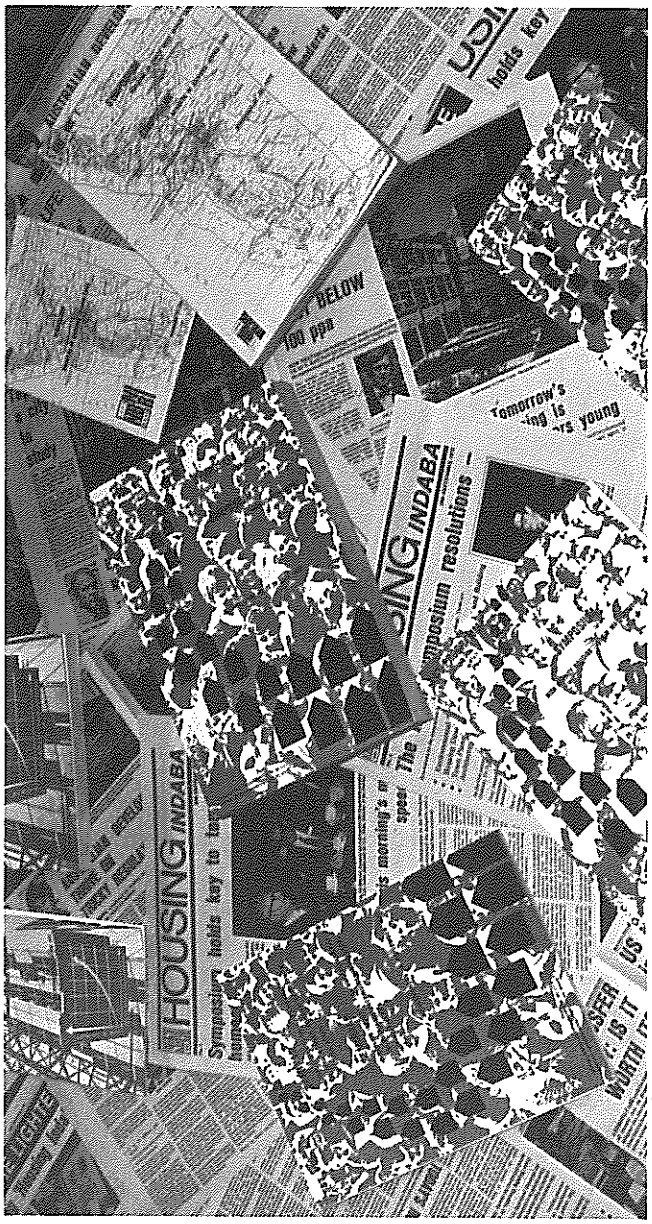
The sustained co-operation between all the ramifications of the building industry and the allied professions necessary for planning building research projects is achieved largely through the agency of the Institute's Building Research Advisory Committee (BRAC). This Committee comprises approximately 40 distinguished local and overseas representatives of all sections of the industry, and its influence reaches far beyond the field of research.

Investment in the South African building and construction industry in 1971 amounted to R2 032 million. The Institute's budget for this period was R1,4 million. Of this seventy per cent was provided by the Government while the Institute itself earned the balance. An important fact is that the Institute, in dealing with technical problems, serves not only organized industry but also the community. Each year, the Institute deals with some 25 000 queries and receives approximately 6 000 formal visitors, of whom about 10 per cent are from overseas.

Building and Construction Advisory Council

The Building and Construction Advisory Council (BCAC) has asked the Institute to undertake the specialized functions of a Building and Construction Industry Computer Information Centre. These functions include surveys of the availability of computer programs already

A selection of documents prepared for NBRI symposia during the year



in use in various fields, such as civil engineering, and research into the computerization of functions in these fields.

The Institute has also been concerned with research into the computerization of planning and control procedures for capital works programmes in the public sector. The BCAC has also sponsored a number of studies of the housing requirements of South Africans on both regional and national levels.

Regional offices

Local sub-committees of the Building Research Advisory Committee advise on the work of the NBRI regional offices in Durban, Cape Town and Windhoek and guide their research into local problems. Members of these sub-committees represent different local sectors of the building industry and government bodies concerned with building. This enables the Institute to keep in close touch with problems and developments in areas far from Pretoria.

The most important function of the regional officers is to maintain close liaison with all sectors of the industry in their areas. Through the regional offices, NBRI and overseas publications are available to builders, engineers, architects, technicians and the lay public. This information service is augmented by quarterly lectures on different aspects of building research, by films and by discussions on building methods and materials and applied building science. Where an investigation is necessary it is carried out on the building site, or the problem is referred to the NBRI or other competent authorities.

Environmental engineering

Living and working conditions are affected to a large extent by lighting, ventilation, thermal comfort and acoustics. Until recently the Institute was able to study the effects of only the first three of these factors on the interiors of buildings. However, staff who specialize in building acoustics have recently been appointed so that it is now possible to co-ordinate studies of all the main internal environmental factors more easily.

Hourly design weather data which can be applied to the thermal performance and air-conditioning of buildings are now available for the first time for 15 different centres in South Africa, South-West Africa and Botswana. Similar design information is being prepared on request for several places in Rhodesia.

Roof design

Measurements of temperature inside test huts have shown that, contrary to general belief, fairly new galvanized iron roofs let through less heat during the day than do tile roofs of the same pitch. This is because the heat radiation characteristics of the underside of the galvanized iron are considerably lower than those of tiles. The tests have also shown that flat-roofed houses are cooler inside during the day than houses with pitched roofs, which was also the opposite of what was expected, and that flat roofs cool down more at night than pitched roofs.

Fissured soils

Materials are often divided into those consisting of loose granules, which behave as a mass of independent particles, and those that have a uniform and continuous composition, such as metals. In the field of foundation engineering, soils are similarly divided into granular materials, such as sands and gravels, and cohesive materials. Lately, however, considerable doubt has arisen about the validity of this approach as it has been shown that many cohesive soils have severe cracks and fissures which affect the strength and behaviour of soil under stress considerably. This aspect is particularly important in South Africa where many of these fissured cohesive soils occur. Laboratory and field studies on the behaviour of fissured soils are in progress, and knowledge gained so far has already been applied to construction projects.

Technical evaluation

There is a continual demand for technical evaluation of building innovations, particularly those concerned with complete building systems. The Agrément Board of South Africa, established in 1969 with the NBRI as its evaluating agency, absorbs about two-thirds of the Institute's effort in the field of broad technical evaluation. The Board has already issued seven certificates, and is in the process of preparing another four, all based on technical investigations carried out by the NBRI in collaboration with the South African Bureau of Standards.

Committees, conferences and seminars

During the year staff members of the Institute served on 146 committees which promote the interests of the building and construction industries. Members of staff delivered 124 lectures and took part in 37 local and overseas conferences at which they delivered 47 papers. Sixteen radio talks were given.

Three symposia were organized during the year. The first symposium — on building in South-West Africa — was held in Windhoek in July and was attended by 150 delegates. The second, held in Port Elizabeth in August, was on modern building and building research, and attracted an attendance of 156. In September, 630 delegates enrolled for the Institute's symposium on high density housing held in Johannesburg under the auspices of the Minister of Community Development. Seven of the 27 papers presented at this symposium were by delegates from abroad. The symposium on high density housing was followed by a one-day seminar at which 270 representatives from the public and private sectors discussed the legal aspects of home-ownership in high density housing developments.

The Institute also organized one of the sessions of the conference on planning for better building held at the same time as the 1972 International South African Building Exhibition in Johannesburg in August.

Films and exhibitions

A film called *A new way of living* was completed during the year for screening during the symposium on high density housing in Johannesburg. It was also shown as part of the Pretoria City Council/NBRI exhibit at the Pretoria Show of the Transvaal Agricultural Society in September. The stand at this show was awarded a silver medal.

Films on mortars and paints are in the course of preparation. A film is also being made for organizations to use in training staff to prepare precooked frozen foods according to systems devised by the Institute primarily for South African hospitals.

Organic building materials

Experimental work on the durability of organic materials used in exposed positions in buildings has to be carried out on a long-term basis since the experimental equipment may be said to include the weather at sites as scattered as Pretoria, Durban, Cape Town, Windhoek and Walvis Bay. The experiments sometimes take five years or more.

The results of three long-term investigations into widely different paint systems on different surfaces were correlated and published during the year. The reports concern the painting of steel and timber under different climatic conditions. The demand for these reports indicates that they have satisfied a practical need.

Problems with the use of organic materials as waterproofing for flat roofs, as sealants for building joints and as plastic components in various forms occur daily. Problems also arise when these materials are used as paints on concrete, plaster, timber and steel, and as floor tiles or carpets. Many of these problems can be avoided, and it is an important part of the Institute's work to see that information about organic materials and their application reaches members of the building industry, associated professions and students.

Inorganic materials

Many naturally occurring building materials are becoming less plentiful. This means that their occurrence should be surveyed and mapped and that the most economical ways of using them should be developed. Both these tasks are receiving the Institute's attention. Clays, sand and stone in different parts of the country are being surveyed and samples are being investigated to determine their suitability for processing into a variety of materials for today's needs.

The Institute's current investigations into the processing of industrial waste products for use in the building industry has more than one purpose. Re-use of wastes reduces pollution and supplements resources of traditional building materials. This work can also lead to the development of recycled products that are considerably cheaper than equivalent conventional materials. The programme of investigations includes the processing of such waste as slag, ash, crusher dust and broken glass.

Concrete technology

Shrinkage has always been a characteristic of portland cement products and for a long time attempts have been made to design concrete in such a way as to reduce and compensate for shrinkage. Without these precautions the shrinkage leads to cracking. One form of shrinkage cracking that has become more prevalent with the increasing mechanization of the building process and in the South African climatic conditions is known as plastic shrinkage cracking. Although it occurs most frequently in hot dry regions in windy weather this type of cracking is also caused by mechanization as the concrete is placed and worked more rapidly than usual.

The Institute began investigating this form of cracking as very little was known or had been written about it. The investigation has shown that plastic shrinkage cracking is caused either by the settling of the aggregate in relation to the steel reinforcement while the concrete is still very wet, or by the over-quick evaporation of water from the concrete while it is still hardening.

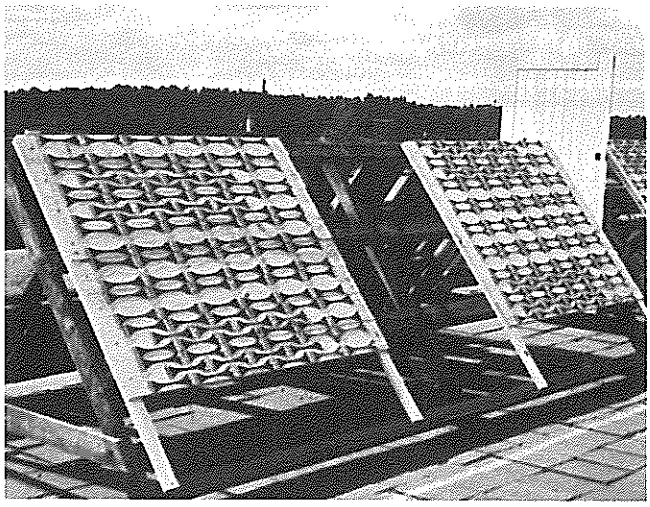
The Institute's knowledge of the reasons for plastic shrinkage cracking has enabled it to advise building contractors on the prevention of cracking and on the repair of cracks that do occur while the concrete is still in a plastic state.

Hospital research

An evaluation of the 250 major surgical operations performed in the clean operating enclosure developed by the Institute and installed in the H.F. Verwoerd Hospital in Pretoria in 1970 has revealed an overall wound infection rate of 1,1 per cent. This represents a great improvement over the rate of 11 per cent for similar operations performed in conventional operating theatres at the same hospital over a five-year period.

The Institute's work on multi-enclosure suites, using the same clean air principles, is progressing well. The use of multiple enclosures simplifies planning and makes better use of staff and equipment. A private surgical hospital in Pretoria is now installing a suite with five enclosures for orthopaedic, neurological and general surgery.

Exposure tests related to the development of durable SBR rubber blends



Prefabricated brick panels

The Institute's research on prefabricated brick panels bore more fruit during the year with the signing of a licensing agreement between the South African Brick Association and an Australian company for the use of the NBRI process for the manufacture of panels. The Institute assigned the overseas patent rights for the process to the South African Brick Association and undertook to develop the equipment necessary for the adaptation of the process to Australian conditions. The Institute also advised the Australian licensees on aspects of the manufacturing process and on the use of suitable Australian raw materials.

In South Africa the panels have been used to construct three experimental houses, and their potential use in housing has been described in a research report. A further development is the adaptation of the process to make it suitable for the mass-production of small fencing panels These panels are being successfully marketed by a commercial firm.

Portable housing

Research on portable accommodation for Bantu workers employed on construction sites is being undertaken on behalf of various bodies. Discussions with various government departments and a survey of employers who use temporary accommodation indicate that the results of this research will be of interest not only to the present sponsors, but also to many other organizations.

Planning of government offices

A research project was begun during the year to provide the Public Works Department with information on the planning of government offices. The work includes the compilation of a planning manual which will provide information on materials, layout, functions and environment. Other important aspects concern the preparation of briefs for office design, the control of the design process and the procuring of office buildings.

Connections between precast concrete panels

The stability of multistorey buildings made from precast concrete panels depends to a great extent on the strength of the connections between the panels. The Institute has therefore started an investigation to determine the strength of various connections.

In the first part of the investigation the strength of horizontal wall-to-floor connections was determined by subjecting the connections to horizontal force. This form of test was used because the horizontal strength of a joint determines both the resistance of the joint to unusual horizontal forces, such as would result from an explosion inside the building, and the ability of floor panels to resist complete collapse should the supporting wall along a joint be removed accidentally, for example by an explosion inside the building or by the impact of a vehicle out of control.

Although certain joint reinforcements are superior to others, most of the joints tested so far are stronger than required by recent regulations introduced in Britain as a result of the collapse of part of the Ronan Point building in 1968.

International co-operation

The Institute is an active member of the International Council for Building Research, Studies and Documentation (CIB), an international organization of which 76 countries are members. Its Director is a member of the policy-making Board of the CIB. The Institute also participates in the CIB system for the exchange of research programmes and abstracts of publications between building and allied organizations throughout the world. Through personal contact and the exchange of correspondence it takes part in the activities of a number of working groups and commissions. Great benefit is derived from such co-operation. Co-operation with Rhodesia and Malawi takes the form of reciprocal visits and regular lectures by NBRI personnel.

The Institute is a member of 22 international or overseas organizations. Attending international conferences and other gatherings has contributed significantly towards furthering international co-operation. At several congresses members of the Institute's staff presented papers, and participation in formal and private discussions with representatives of countries such as the United States, the United Kingdom, Australia, Finland, Western Germany, Japan, France and Sweden proved most rewarding.

An example of practical co-operation during the year was the supply of prototype solar heaters to the Public Works Department of Malawi. The use of solar energy for domestic water heating has considerable potential in Malawi and the Institute willingly made its research experience in this field available. Two experimental systems have been installed, one relying entirely on solar heat and the other incorporating an electrical heating element to supplement solar heat during overcast conditions.

The Institute, in collaboration with building research organizations in France, the USA and Australia, continued with research on the exposure of plastic and rubber materials used in buildings.

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 af 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 products**
- **the development and improvement of manufacturing processes**
- **the effective use of timber products.**

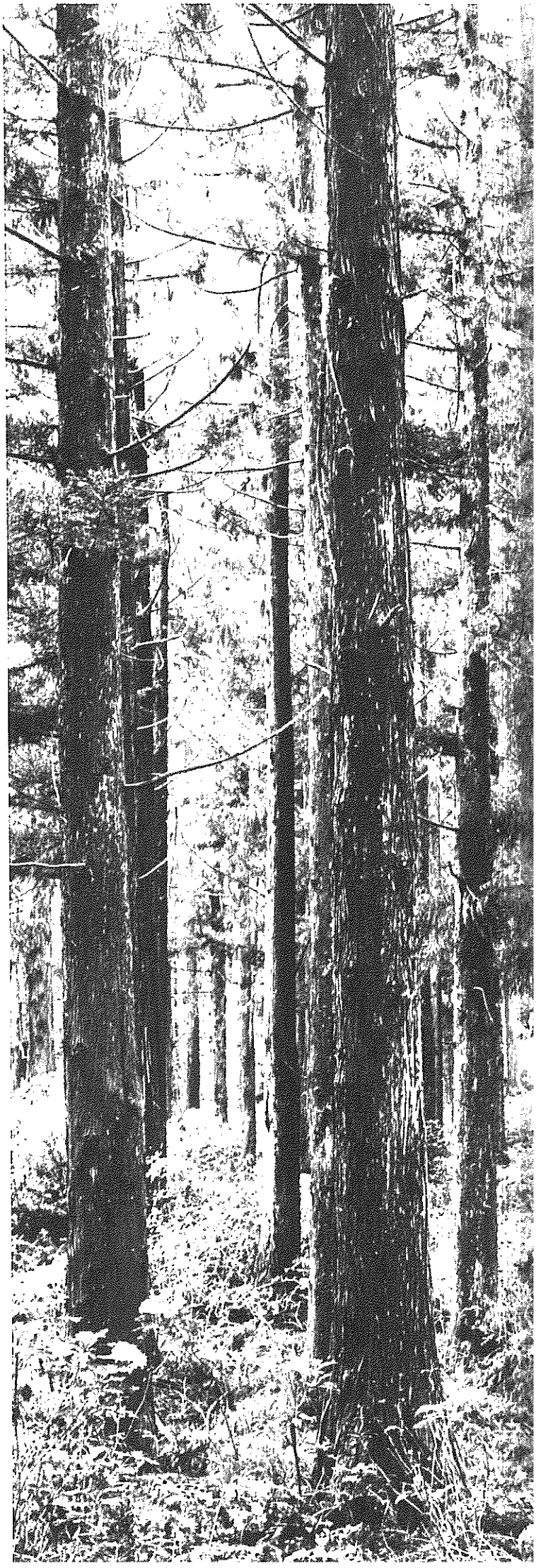
Timber engineering

The Timber Engineering Advisory Committee (TEAC) which was nominated by the TRU to advise the Timber Engineering Division on the development of sound timber engineering practice in South Africa, the research needs of the timber engineering industry and design requirements of timber structures, held its inaugural meeting in 1971. This committee is taking an active part in the formulation, revision and implementation of timber engineering standards.

The Unit has undertaken site investigations and given expert advice on many timber engineering projects.

Stress grading

The Timber Engineering Division continued testing the timber sampled during 1966. The object of the project is to relate timber stiffness — the variable measured by a stress-grading machine — to the various strength properties of timber (bending, tension, compression and shear strength). The results are being computerized, which will save a considerable amount of time in the future.



Arrangements have been made through the South African Inventions Development Corporation for the commercial manufacture of the simple grading machine developed by the TRU. A number of these machines have been sold to industry and this method of grading structural timber is gradually being applied in practice, particularly by roof truss manufacturers. The Unit is continuing to improve this method of grading and to promote its use in industry. In future special attention will be paid to using the machine to stress grade scaffold boards.

Joints

The TRU has undertaken a considerable amount of work on the properties and design data of various proprietary truss connector plates on a contract basis with industry.

Roof trusses

A series of economical standard designs of wooden trusses for tiled roofs has been produced. The designs, which include cutting schedules and nailing templates, incorporate nailed plywood gusset connections. The designs are the result of studies of the structural behaviour of prototypes from which the design parameters were derived.

Stock glulam

This relatively new project sponsored by industry is now well under way.

A large sample of material from nine manufacturers was tested to establish the structural quality of well-made stock glulam. Seven stock glulam factories were studied in detail to obtain information on present manufacturing procedures. An earlier study of the cost of manufacturing this product has been updated and a survey of the market for stock glulam has been completed. A survey of what the consumer requires of the product is in progress. A plant for the manufacture of stock glulam for research purposes has been planned and funds for it have been approved.

Finger jointing

The Unit assisted the South African Bureau of Standards in determining the acceptability of various new profiles of finger joints for structural purposes.

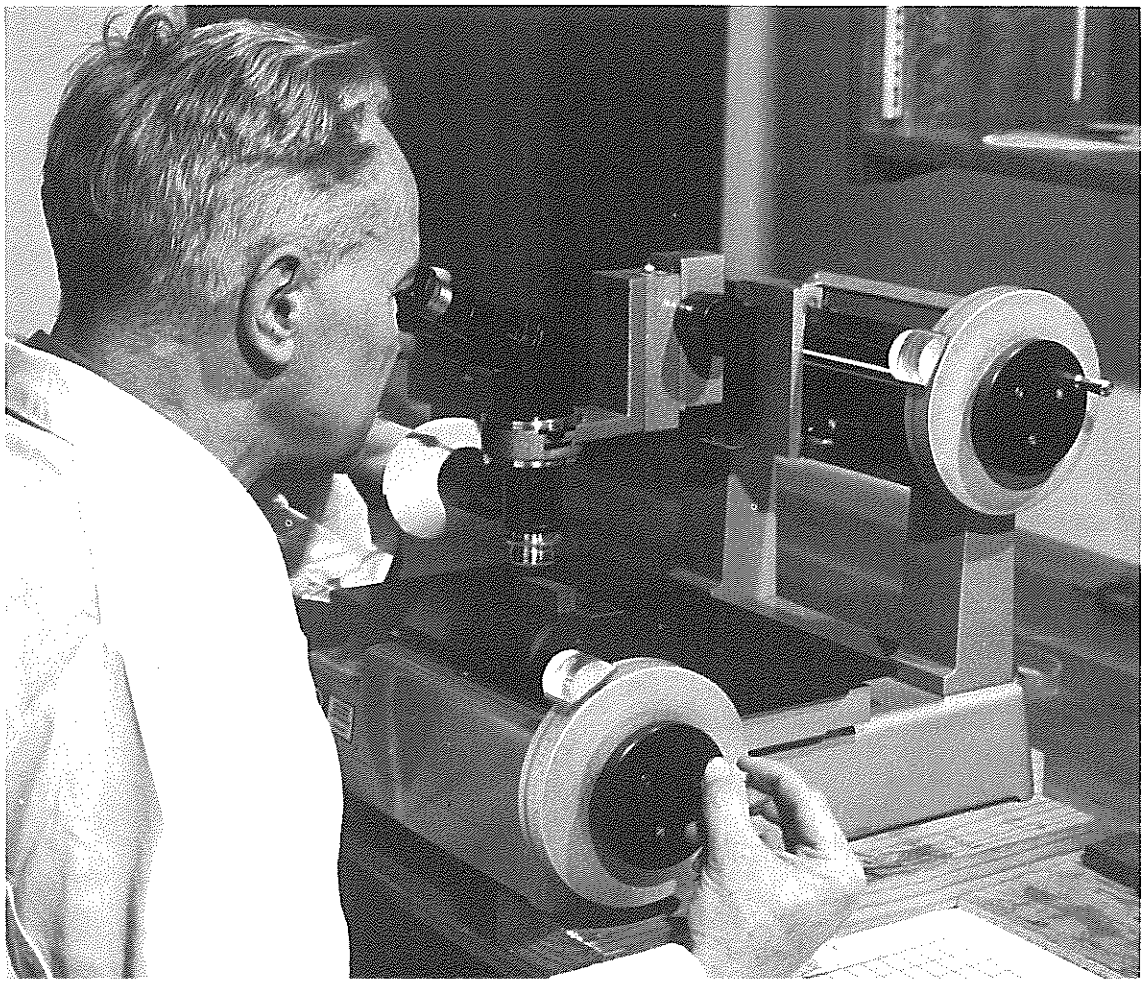
At the request of industry a system of quality assurance for factories manufacturing finger joints is being developed and introduced.

Timber drying

It was shown conclusively that warp, especially twist, can be reduced considerably by restraining timber during drying. The beneficial effect of restraint increases as the drying temperature rises. The effect of restraint at a high temperature is not lost by warpage after drying. The weighting of stacks is a suitable method of restraint.

A study to determine whether high-temperature drying affects timber strength adversely revealed that if there were any such effect it is small and overshadowed by the influence of natural defects in South African pine timber.

A dual-linear micrometer for measuring cross-sectional dimensions of fibres in solid wood.



Delamination in glulam
Research has shown that delamination does not always affect the strength of glulam critically and that much depends on the degree of delamination, on whether delamination is static or progressive, and on the span-depth ratio of beams. The structural adequacy of a delaminated beam can be checked by comparing its design shear stress with the maximum calculated shear stress at the neutral axis.

Veneer lamination
Instead of sawmilling pine logs to convert them into structural timber they can be rotary-peeled into quite thick veneer and laminated into wide sheets of the desired thickness and length. The sheets can then be ripped into widths suitable for structural timber. The technical and economical feasibility of this system has been investigated and it seems to have distinct advantages as regards yield and product quality. The laminated veneer is more costly to produce than sawn timber, but it could be justified economically if its superior quality is fully utilized.

Sugar-cane bagasse
An expected shortage of pulpwood is the most important limiting factor in the long-term development of the pulp, paper and paperboard industry in South Africa. The possibility of using local sugar-cane bagasse for making paper is therefore being assessed with the object of using it to supplement wood fibre.

The survey was recently expanded to include a study of the suitability of bagasse for the preparation of soluble pulp for rayon manufacture.

Preservation of paper
Most documents on modern paper last only a few decades owing to chemical deterioration of the cellulose in the paper. Research is now aimed at finding an effective method for the preservation of archival documents and developing a permanent type of paper that will not require special preservation methods.

Short-term timber trend analysis
During the year four quarterly bulletins on supply of and demand for softwood sawn timber were published. The demand remained low during the year resulting in an over-supply. The main causes of the low demand were the general economic conditions and the shortage of money for building.

Cost studies
Two cost studies, on stock glulam manufacture and on sawmilling, were completed. Although the cost of producing stock glulam increased slightly over the past three years, manufacturers were able to compete with the price of imported timber. The study of sawmilling production showed that the unit cost of production decreases as the size of the sawmill increases. In spite of this general tendency some of the smaller mills were producing at competitive costs.

Techno-economic studies
A comprehensive survey of the stock glulam industry showed that 95 per cent of all stock glulam is used in the building industry. The main aim of the study was to identify consumers' needs and preferences. This information is now applied in formulating specifications.

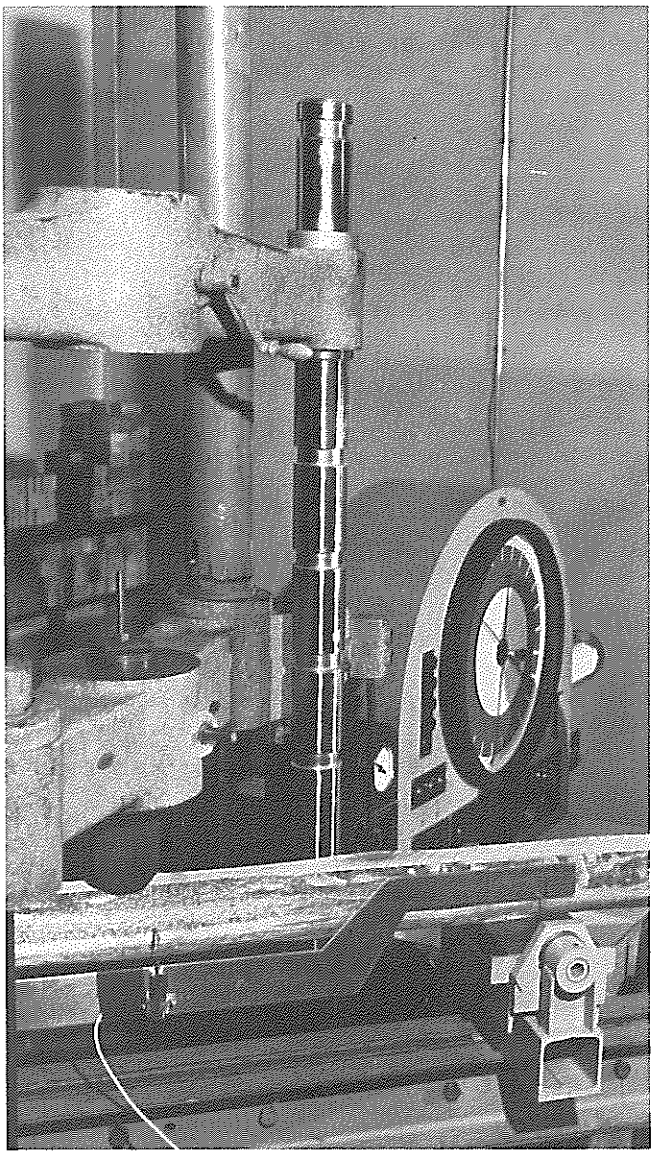
A techno-economic survey of pallets and palletization was initiated, which covers both the production and the use of pallets. Although this study is not yet complete it has already been found that there is a lack of standardization and co-ordination in the pallet industry. There seems to be a need for regional and national pallet pools where standard pallets can be exchanged. In future this aspect will also receive attention.

Right: **Wool fibres being spun around a core of continuous nylon filament**

1: Wool

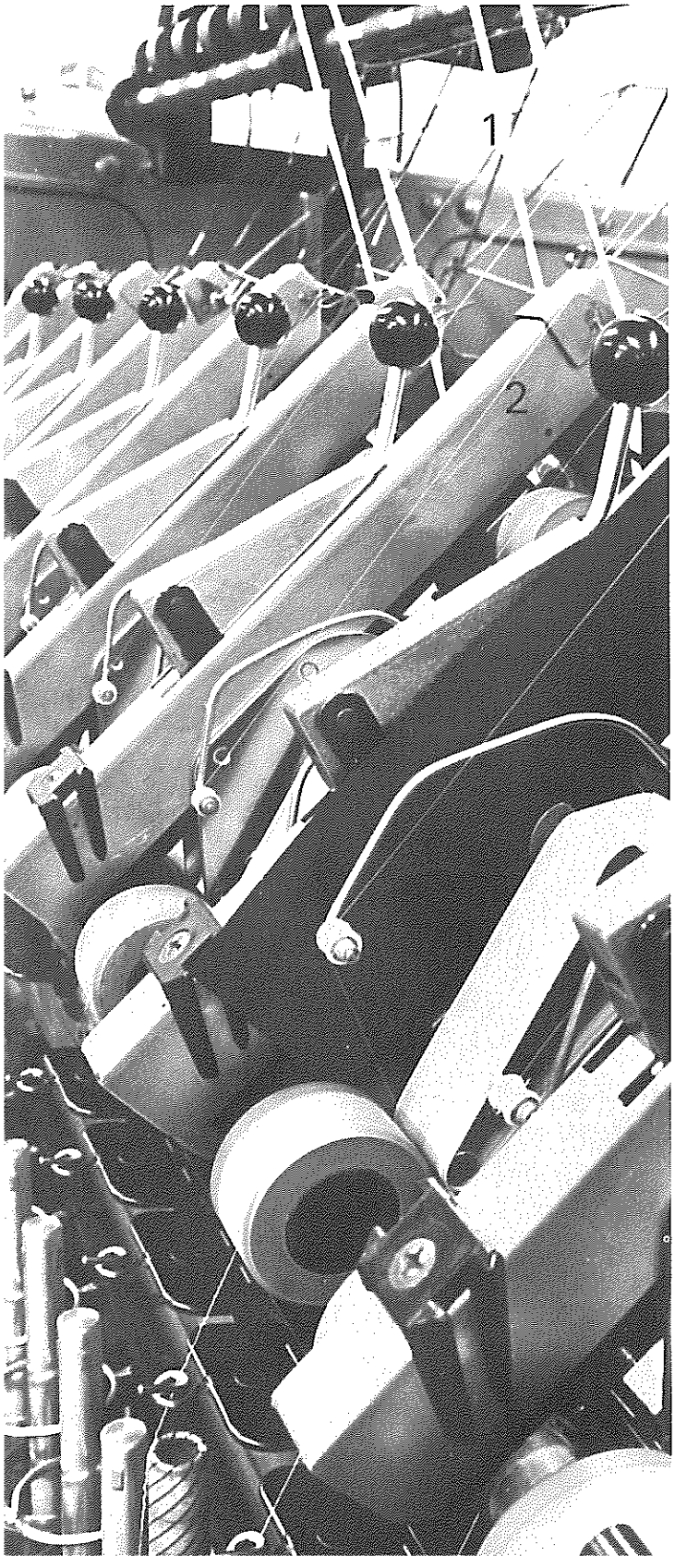
2: Nylon filament.

A timber beam being loaded to determine its strength and stiffness.



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 evaluation of mohair clip

SAWTRI was set the task of objectively evaluating the South African mohair clip because overseas mohair buyers are increasingly demanding accurate information, especially on the mean fibre diameter and other parameters. Classing of mohair by subjective assessment of these parameters is sometimes considered unsatisfactory. The human element introduces problems which are costly to the industry especially as modern processing methods require greater accuracy in the evaluation of mohair for specific purposes. The first part of this project which dealt with the summer clip has been completed.

The results revealed that the variation in fibre diameter within a specific bale of kid mohair is remarkably small, an indication that the producer is classing well. Even the variation between bales is small. In determining the value relating to clean fibre (mohair base), it was found that the variation within bales was small but the variation between bales was relatively higher. Core tests on samples drawn from the caps and butts of the bales yielded consistent results for both mohair base and diameter.

The pattern changes somewhat with regard to young goat mohair. In a specific bale the variation in diameter and mohair base is small. Between bales the variation in

fibre diameter is relatively larger and the variation in mohair base is smaller than in the case of kid mohair. In adult mohair it was found that the variation in diameter within a bale is slightly larger than in young goat and kid mohair. Between bales the variation in diameter is smaller than in young goat. The variation in mohair base within a bale is larger than in the other types of mohair.

The South African mohair summer clip, with regard to variation in clean yield, is very close to the ASTM standards set for the South African wool clip. The variation between bales is, however, significantly smaller, most probably because of the high clean yield and the consistency of classing.

Fibre friction and handle

It is sometimes necessary to distinguish between the components of blends of animal fibres. When the fibres look very much the same, as in the case of Buenos Aires wool and mohair, this is a difficult task. Techniques using the microscope and other methods have not been entirely successful in routine quantitative analyses of such blends.

SAWTRI has investigated the relationship between fibre friction and the handle of wool. After an extensive study of a range of wool and other keratin fibres it became apparent that handle is influenced by fibre friction. An important result of this study was a new method of distinguishing between wool and other keratin fibres of similar fibre diameter.

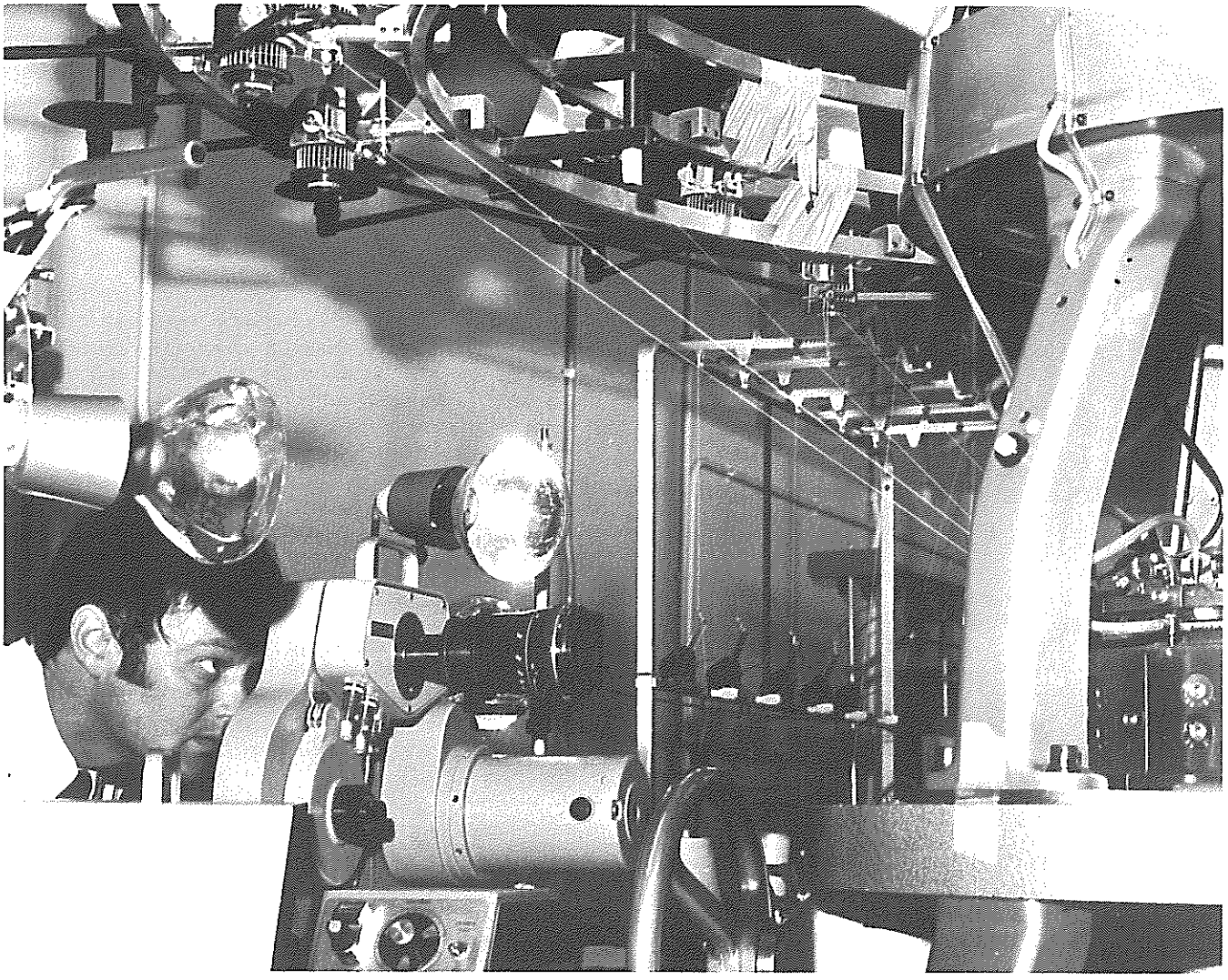
Individual fibres drawn from a series of wool and mohair samples were drawn over an ebonite rod in an anti-scale direction and the frictional force exerted was measured. Independent judges assessed the handle of the different samples subjectively and the friction results were compared with the subjective assessments. It was found that, in addition to mean fibre diameter and resistance of the fibres to compression, the anti-scale frictional force also accounted for some of the variation in handle. This frictional force may also be used to differentiate between mohair fibres and other types of keratin fibres in a blend containing mohair.

Removal of wool grease from scouring effluent

All over the world the aqueous scouring of raw wool has always been associated with the treatment or disposal of noxious effluents. The greatest difficulties in effluent treatment arise from the presence of wool grease which may constitute up to 4 per cent of the effluent. Although wool grease discharged in waste causes pollution, it has considerable commercial value if recovered.

Pilot-plant work and laboratory experiments have shown that wool grease can be removed simply and

A high-speed motion picture camera being used to photograph the action of the dial and cylinder needles of a circular knitting machine.



effectively by extracting the grease from the effluent with an organic solvent (e.g. petroleum spirit). About 1 per cent (per volume) of the organic solvent is emulsified in the greasy scouring effluent. The emulsion is then separated in a disc separator, yielding wool grease dissolved in the petroleum spirits.

The method was tested in a laboratory, then on pilot-plant scale and finally in a factory. In the latter an industrial separator designed for centrifugal grease recovery was used without modification. The separated effluent (degreased and desludged) contained only about 0,27 per cent residual grease and with the treatment described above could be re-used at least six times for scouring wool.

By distilling the separated grease-containing solvent the organic solvent can be recovered for re-use, leaving the wool grease as a valuable by-product.

Fibre breakage during combing of wool

The preparation of wool for spinning involves a number of processes during which fibre breakage occurs to a greater or lesser extent. A substantial part of SAWTRI's research is devoted to tracing the stages at which fibre breakage occurs and determining the extent of fibre breakage.

One of the processes known to cause fibre breakage is rectilinear combing. During an investigation into the extent to which fibre breakage occurs it was found that fibre breakage was linearly related to the setting of the gauge of the comb.

Noil, (short fibres removed from the sliver during combing) was found to depend on gill-feed especially at large gauge settings of the comb. There is an optimum value for gill-feed which, at larger gauge settings, depends on the production of minimum noil. The influence of gill-feed on the percentage fibre breakage seems to be limited as only a slight decrease in fibre breakage occurs with increasing gill-feed (for constant gauge setting).

Continuous shrinkproofing of wool slivers

Some success has been achieved in the continuous shrinkproofing of wool sliver by the application of an aminoplast resin. Fabrics were made of yarns spun from wool so treated. When the fabrics were washed the felting shrinkage was within the limits laid down by the International Wool Secretariat's superwash specification no. 132. The handle of the treated tops was also highly satisfactory.

Yarn breakage in knitting

Experiments were carried out on a 22-gauge knitting machine to identify the courses in knitted structures responsible for yarn breakage at different machine settings.

Attention was paid to three important variables — dial height, feeder sequence and run-in-ratio. A Punto-di-Roma structure was knitted with two possible feeder sequences, firstly interlock, interlock, dial only, cylinder only and secondly interlock, interlock, cylinder only, dial only.

With a run-in-ratio of 1,5:1 it was observed that —

- the total number of holes decreases as dial height increases, irrespective of feeder sequence
- the largest number of holes occurs when the second feeder sequence described above is followed
- the largest number of holes occurs in the courses in which only cylinder needles are used.

When the Punto-di-Roma structure was knitted at a run-in-ration of 1:1 it was found that —

- there is an optimum dial height for obtaining a minimum number of holes for both the feeder sequences
- the total number of holes formed is significantly less than when a run-in-ratio of 1,5:1 is used, while the stitch length is about the same.

The preliminary results obtained on an 18-gauge machine have already revealed some deviations from the findings on the 22-gauge machine. This implies that machine construction in the knitting zone may have a strong influence on where yarn breakage actually occurs. The investigation is being continued.

Finishing of wool-rich double jersey fabrics

Punto-di-Roma fabrics from core-spun yarns or knitted according to the technique whereby wool yarn is plated onto flat filament nylon, were decatised in an autoclave, dry-cleaned, treated with a poly-urethane resin and placed in an autoclave to cure the resin. The samples so treated were washed according to specifications for machine washability and finally subjected to abrasion and deformability tests. In both cases the double jersey fabrics satisfied the set requirements.

In piece dyeing of such fabrics care should be taken that the nylon component does not dye darker than the wool by carefully selecting the dyestuffs and adding pre-determined quantities of nylon retarding agents.

Mechanical properties of woven fabrics

The increasing use of wool blended in various proportions with synthetic fibres prompted investigations into the mechanical properties of various woven blends.

Intimate blending of wool and polyester fibres involves blending in staple form before spinning whereas core spinning entails the spinning of wool fibres around a core of continuous nylon filament. Fabrics woven from yarns spun according to these two methods were subjected to a number of tests.

Three types of polyester fibres were intimately blended with wool in proportions of 20, 40 and 60 per cent of the polyester component. It was found that —

- the breaking strength and flexural rigidity of the woven fabrics increased with increasing percentages of polyester
- the wrinkle resistance of washed fabrics improved with increasing amounts of polyester (also at high humidity)
- the low pilling type of polyester used in one of the blends yielded a fabric with somewhat better wrinkle resistance than did the fabrics made from other blends
- the wrinkle resistance of all the fabrics tested was improved by autoclave decatising.

It also appeared that fabric made from intimate-blend yarns containing 20 per cent polyester was better than

fabric made from core-spun yarns, while the latter fabric was much stronger than pure wool fabrics. Permanent pleating of fabrics made of blends was more lasting than pleating of pure wool fabrics. From the investigations it became clear that, except for abrasion resistance, there were no significant physical differences between fabrics woven from core-spun yarns with either textured or untextured continuous nylon filament.

Pretreatment in shrink-resist finishing of wool

The application of resin to wool fibres to make them shrink-resistant is common practice and various types of resin have been successfully used for this purpose. To ensure optimum results, however, the resin must be spread evenly over the fibre. A prerequisite for success is that the critical surface tension (CST) of the fibre must be higher than that of the resin. Untreated wool fibres do not have this high critical surface tension and must be chlorinated to achieve the necessary CST level. In the course of a thorough study of the factors affecting the CST of chlorinated wool fibres, the Institute has shown that —

- the CST of tips, middle portions and roots of wool fibres differ, the highest CST occurring in the tips
- to obtain the highest CST the fibres must be thoroughly cleansed before chlorination
- fibre crimp has no bearing on the CST
- 1,3 to 1,4 per cent chlorine was the minimum required to raise the CST of wool to the level necessary for spreading the epichlorhydrin-polyamide resin evenly over the fibre.

Flameproofing of cotton

In a modified technique to render cotton fabrics flame retardant, various fabrics were treated with titanium tetrachloride and antimony oxide. It was encouraging to find that this treatment not only made the cotton fabric flame retardant, but that the effect persisted even after a considerable number of washing cycles in a conventional household washing machine. The severity of laundering was actually in excess of AATCC standards for laundering durability. An added advantage was that certain mechanical properties such as breaking strength and abrasion resistance were not impaired by the flame-proofing treatment. In most cases these properties were actually improved.

Bleaching of textiles

In order that the consumer may be satisfied with regard to the brightness of fabric — or the whiteness if the fabric is to be used undyed — it is necessary to make it as white as possible. This is achieved by chemical bleaching or fluorescent brightening. Chemical bleaching, however, especially of wool, damages the fibre to a greater or lesser degree, thereby adversely affecting other desirable properties such as drape, resistance to abrasion, etc.

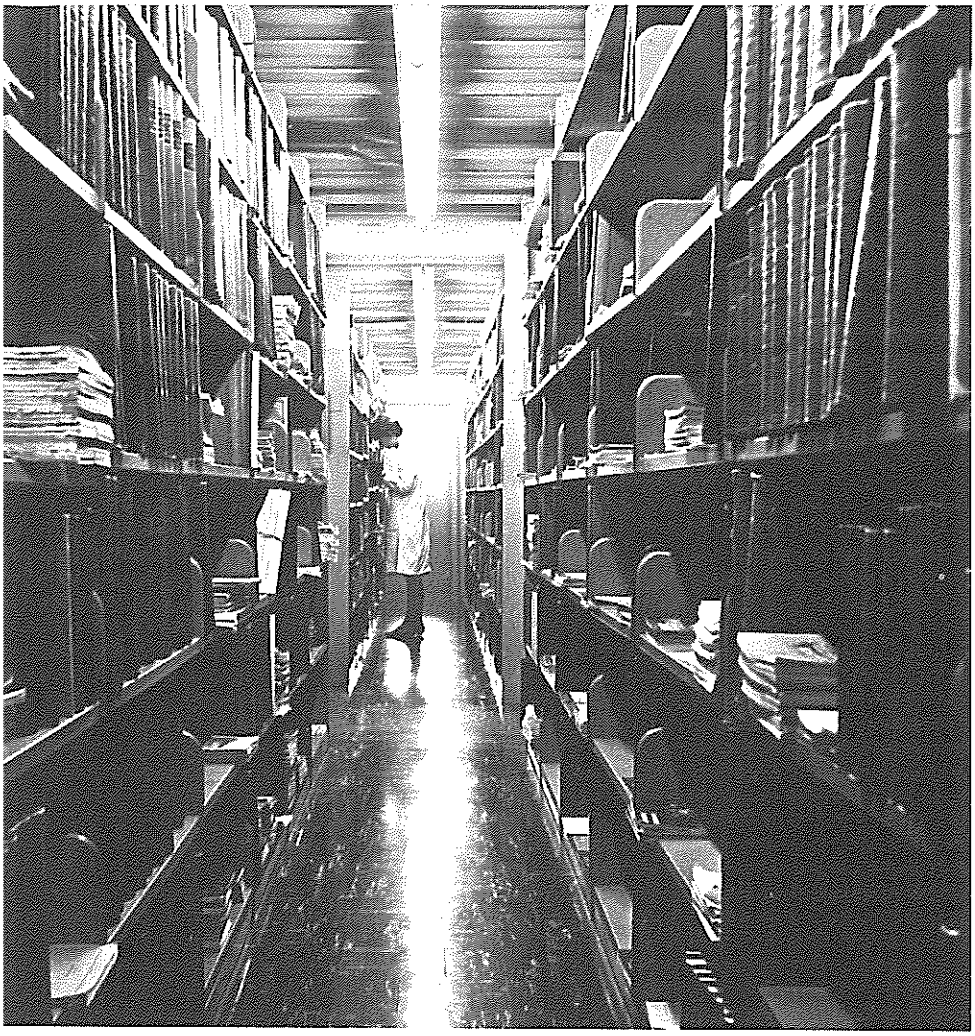
In the quest for a bleaching agent, the effect of which on the whiteness of wool could compare to that of hydrogen peroxide which is an oxidizing agent, the Institute found that a certain commercial reducing agent could make wool whiter than conventional reducing agents could and that the results compared favourably with those obtained by the use of hydrogen peroxide. Although the reducing agent was more detrimental to wool than hydrogen peroxide or conventional reducing agents, there was no significant difference in the abrasion resistance of the various fabrics used in the investigation. When steamed or exposed to sunlight, wool bleached with the special reducing agent yellowed to more or less the same degree as did wool treated with conventional bleaching agents.

Because chemical bleaching damages wool fibres it is necessary to be able to determine the extent of the damage. One method of doing this is by using the alkali solubility method which is, however, time-consuming and tedious. Wool bleached with peroxide is stained when treated with lead acetate and it was found that there is a correlation between the intensity of the staining, i.e. the darkening of the wool, and the alkali solubility of the wool. Staining with lead acetate could thus conceivably be used as an alternative method to the alkali solubility method to determine damage caused by peroxide bleaching.

Further experiments revealed that wool could be bleached successfully in emulsions of optical bleaching agents in perchlorethylene. This organic solvent can be used in bleaching wool with hydrogen peroxide by emulsifying the peroxide in it. Furthermore, this process was just as successful when used on an industrial scale in a commercial solvent dyeing apparatus.

Durable press, crease-resistant wool/cotton blend fabrics

As part of an investigation into the possibilities of creating fabric from blends of wool and cotton that would satisfy consumer requirements, the mechanical properties of two resin-treated wool/cotton fabrics (with 55 and 75 per cent wool respectively) were studied, as well as the effect of certain kinds of durable press treatment on the mechanical properties of these blend fabrics. On the whole resin treatment improved the wet wrinkle resistance of the fabrics. Further investigation into the stiffness of the fabrics, yellowing and loss of mechanical strength led to the conclusion that after resin treatment they may be regarded as wash-and-wear fabrics and as such should be commercially acceptable. It is, however, not recommended that the wool/cotton fabrics be chlorinated prior to resin treatment because, although the wash-and-wear performance is initially improved, this improvement disappears after laundering.



Information and Research Services

Director: D.G. Kingwill

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

- **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

There is a steadily increasing demand for the services rendered by the CSIR's central library — from CSIR staff as well as from individuals and organizations throughout the country. Over the past five years expenditure on books and periodicals increased by nearly 50 per cent.

As in past years, the reference service has continued to assist enquirers in obtaining information. Enquiries are received by mail and by telephone and as a result of personal visits to the library.

Source guides

The publication of the second edition of *Periodicals in South African Libraries* is nearing completion. By the end of the year the letters A to R had been published. Consideration is being given to techniques using computer output on microfilm for the third edition. *Current Literature on Water,* the current-awareness service to the National Institute for Water Research, has expanded considerably in the past year and plans have been made to improve the service.

Foreign language information

The pattern of demand for translations in the past year showed a shift of emphasis which is characteristic of this type of service. Compared to the previous year, there was more work in the Slavonic and less common Romanic languages and there were fewer requests for German and French translations.

The interpreting assignments included languages such as French and Spanish as well as Portuguese. Liaison work in connection with scientific and technical co-operation with Portuguese Africa increased as a result of more frequent visits from these states and greater interest shown by local scientists in research opportunities and contacts in the neighbouring Portuguese territories.

Non-conventional documentation systems

Further progress was made during the year in planning the establishement of a service for the selective dissemination of information (SDI) from magnetic tape data bases supplied by overseas organizations. A survey was carried out to determine the potential demand for such a service in South Africa and the results indicated that the demand is considerable, particularly in the fields of chemistry, engineering and technology, and the biological sciences. A similar survey is being carried out on behalf of the South African Medical Research Council to determine the demand for SDI services covering the medical sciences.

The CSIR intends providing an SDI service on a national basis early in 1973.

The computerized system developed on behalf of the State Library to produce the *South African National Bibliography* was used to produce the 1972 issue of the Bibliography. The system makes provision for printing via the CSIR's photo-typesetting machine. The first catalogue for the South African Library for the Blind has been produced by means of a similar computerized system.

Programming for a computerized system designed to eliminate routine manual work in the storage and sorting of dictionary material has been finalized and the system is being used by the compilers of a bilingual dictionary of textile terminology. Provision has also been made in this system for final typesetting on the CSIR's photo-typesetter.

Information for industry

Liaison between the CSIR and industry was improved as a result of the appointment in April of a technical liaison officer in Durban, in addition to those in Pretoria, Cape Town and Port Elizabeth. Firms in many sectors of industry were visited to acquaint them with the CSIR and its facilities.

An increased number of technical enquiries from industry were handled during the year. The monthly publication, *T I — technical information for industry,* is again being published regularly after a break caused by staff changes.

The literature current-awareness service (CAS) for industry completed a successful twelve-month trial period in December. The reaction of the 100 firms participating in the trial was most encouraging and this service will be launched on a full scale in April 1973.

Liaison in the field of documentation

The CSIR was represented at the annual conference of the International Federation for Documentation in Budapest and at the annual conference of the Association of Libraries and Information Bureaux which took place in Sheffield. Many personal contacts with documentation centres in North America, Europe and Australia were renewed and new contacts were made.

Publications

A revised edition of the booklet, *The CSIR — its organization and activities,* is due to be published early in 1973. This booklet contains information on the functions and fields of work of the various divisions of the CSIR, the names of senior staff, addresses, telephone numbers, etc.

Good progress was made with the preparation of a completely revised and updated edition of the computer-produced *Index to CSIR Publications* which is due to be published during the first half of 1973. Future editions will be published at approximately five-yearly intervals while supplementary lists will be issued quarterly. These quarterly lists will supersede the six-monthly list currently published under the title *CSIR Research Review.*

The three directories, *Scientific research organizations in South Africa, Scientific and technical societies in South Africa,* and *Scientific and technical periodicals published in South Africa,* were also extensively revised. The *Calendar of scientific and technical meetings in South Africa,* is now published six-monthly — with meetings listed up to eighteen months in advance.

Editorial services

In addition to its normal editorial and publishing services the central publishing office also produces and distributes the *South African journal of Antarctic research* for the South African Scientific Committee for Antarctic Research. The second issue of this journal was published at the end of 1972.

On behalf of the Scientific Advisory Council this service also produces a quarterly review of scientific developments in South Africa. Entitled *Scientific progress,* this review is intended mainly for the interested layman and is widely distributed.

Textile dictionary

Steady progress was made with the compilation of a standard bilingual dictionary (English and Afrikaans) in the field of textile technology, a project commenced some years ago in collaboration with various interested bodies, including the South African Bureau of Standards and the Bureau for Technical Terminology of the Suid-Afrikaanse Akademie vir Wetenskap en Kuns. The use of a computerized system is greatly facilitating certain routine aspects of the work.

Publicity services

The public is kept informed of the work of the CSIR through the bi-monthly journal *Scientiae* and through various mass media. During 1972 some 60 press releases were issued and 10 feature articles were contributed to newspapers and magazines. Numerous press and radio interviews were also arranged.

Increasing attention was given to the use of audiovisual media including ciné films and slide programmes. A number of slide programmes (with recorded commentary) dealing with various aspects of the work of the CSIR are being prepared. In July a new 14-minute documentary film in the series *Science in your Service* was released. This film, entitled *Walk our Land,* featured a variety of CSIR research activities in the context of the human environment. Newsreel programmes on the public cinema circuit featured two short CSIR news films. One of these dealt with the production of radio-isotopes for medical use and the other was about the test flights of the autogyro developed by the CSIR.

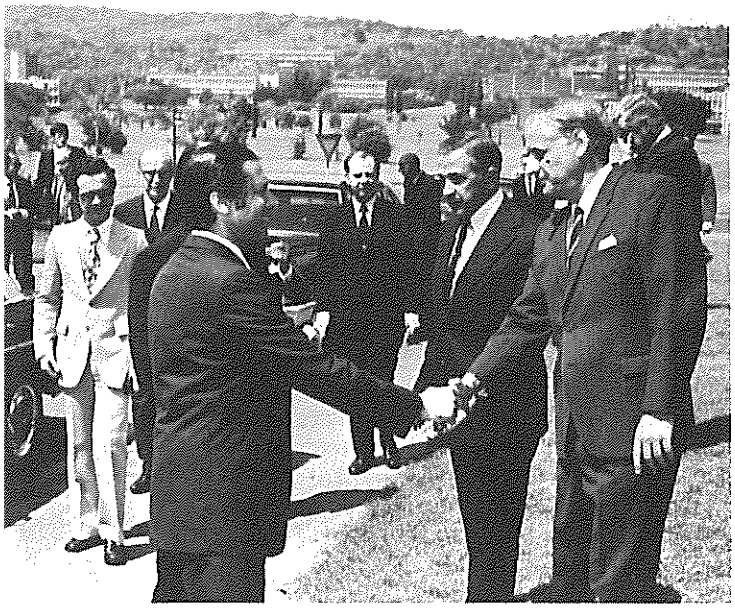
A staff member attended the 19th International Technical Communications Conference which was held in Boston, USA, in May. This conference, which covered various aspects of the communication of scientific and technical information, was arranged by the Society for Technical Communication (STC) of which the CSIR is a member.

Industrial research and development

One of the main objectives of the CSIR is to promote industrial research and it is guided in this by its Advisory Committee for the Development of Research for Industry (ACDRI).

Surveys of expenditure on research and development (R & D) in South Africa were continued on behalf of the Scientific Advisory Council. A report on R & D expenditure for the financial year 1968/69 was completed and a survey of expenditure for the financial year 1969/70 was begun.

Studies in connection with the relationship between scientific research and economic growth were also continued. One of the major projects, a study of the



Dr R. Patricio (front left), Portuguese Foreign Minister, on the occasion of a visit to the CSIR.

process of technological innovation in South Africa, was initiated by ACDRI, and is aimed specifically at identifying possible impediments and disincentives to the process of technological innovation in South Africa. The first phase of this study has been completed.

An experimental investigation into the relationship between weather, weather services and the primary economic sectors was undertaken in collaboration with the Weather Bureau. Valuable experience was gained in applying some of the newer techno-economic techniques in South Africa.

Techno-economic contract studies on behalf of private firms have become an important activity. These studies, which are aimed at informing management of new or improved products or processes, are a logical extension of the technological industrial research services at present offered by CSIR institutes, and include industrial market analyses, cost studies and economic feasibility studies. This service provides very good contacts with private industry and could result in even closer collaboration between private industry and the CSIR in the field of industrial R & D.

Automation and production technology services (APTS) to industry are now reviewed regularly by an internal steering committee. Whilst these services remain organizationally decentralized within the various CSIR institutes, the Industrial Research and Development Group acts as a central contact point with industry.

International science co-operation

Activities related to the CSIR's responsibilities as the South African body adhering to several of the ICSU (International Council of Scientific Unions) organizations continued their upward trend. On the recommendation of its Advisory Committee on International Co-operation in Science (ACICS), the CSIR voluntarily increased its ICSU membership category from III to IV, commensurate with the increasing importance of South African participation in the activities of ICSU and its affiliates. South Africa, which now shares category IV with Australia, Canada, the East African Academy, India, Poland and Sweden, was represented at the ICSU General Assembly in Helsinki in August by the President of the CSIR, Dr C. van der Merwe Brink.

The President also attended the 11th General Meeting of the Scientific Committee on Oceanic Research (SCOR) in Oban, Scotland, in September and the Deputy President, Dr F.J. Hewitt, attended the 15th Meeting of the Scientific Committee on Space Research (COSPAR) in Madrid in May, in the dual capacity of South African delegate and representative of ICSU's Scientific Committee on Antarctic Research (SCAR).

National programmes

The CSIR's membership of international organizations has the effect of 'catalyzing' certain national scientific research programmes. These are organized and co-ordinated by the Science Co-operation Division as the South African contribution to international programmes in the following broad fields of science related to the global and exospheric environment: geological and earth sciences, atmospheric and space sciences, Antarctica, marine sciences and biological and environmental sciences.

South African research organizations, each with their own primary functions, and university research groups participate in these national research programmes.

Geological and earth sciences

ICSU's Inter-Union Commission on Geodynamics (ICG) recently set the International Geodynamics Project (IGP) going, with a view to stimulating research into processes occurring in the earth's interior and leading to phenomena such as continental drift. The South African Scientific Committee for the International Union of Geological Sciences (SACUGS) under the chairmanship of the President of the CSIR, recommended South African participation in the IGP and defined specific areas of research in Southern Africa which could be included in a South African national programme within the framework of the IGP.

Antarctic research

The South African Scientific Committee for Antarctic Research (SASCAR) is now advised by three committees of specialists in the fields of biological sciences, earth sciences, and upper atmosphere physics.

SASCAR supported the recommendation of its Biological Committee that the programme of ecological energetics on Marion Island should be extended to include programmes on global monitoring as well as research in ornithology and on seals. Funds for this purpose have been provided by the Department of Transport in the third five-year programme 1973-78.

SASCAR also supported the recommendation of the Earth Sciences Committee that air transport should be provided for leading South African geologists and geophysicists to enable them to take part in field expeditions during the summer. Funds have been provided for continuation of the current programme in the third five-year programme 1973-78.

Current programmes in upper atmosphere physics will be continued in the third five-year period and extended by the addition of ionosphere and geomagnetic observations on Marion Island. With a view to promoting collaboration between the university and other research groups carrying out research programmes in upper atmosphere physics in Antarctica, two meetings were held which took the form of specialist symposia — one in Pretoria and the other in Hermanus. These meetings promoted a greater awareness of the interrelationship of programmes carried out in different centres and concerned with different phenomena. South Africa was represented at the meeting of the international Scientific Committee for Antarctic Research (SCAR) in Canberra, Australia, by Mr D.G. Kingwill and at the meetings of the Working Group on Biology by Prof. E.M. van Zinderen Bakker, who was also convener of a meeting of the Group of Specialists on Quaternary Studies.

Oceanography

The management and scientific co-ordination of the national programme on oceanography are handled by the South African National Committee on Oceanographic Research (SANCOR), its Executive Committee (EXCOR) and three specialist advisory committees for physical oceanography, marine biology and marine geology and geophysics. The present budget is R220 000.

A national programme of marine biological and sea fisheries research, prepared by SANCOR's Advisory Committee for Marine Biology, was recently finalized and distributed to all marine biologists in the country and other interested parties.

Environmental sciences

The main objective of the National Programme for Environmental Sciences is to promote and facilitate collaboration between scientists and scientific organizations in South Africa in the identification of future environmental problems and in finding solutions to these problems.

The Inland Waters Section of the National Programme has several working groups active in various fields of research. One of these, for instance, is concerned with aquatic weeds. Another is concerned with eutrophication, the accumulation of plant nutrient substances in rivers and dams.

The Terrestrial Biology Section also has several working groups. The work of one new group is aimed at furthering the many hundreds of rare plant species in South Africa which are threatened with extinction. Another new working group is concerned with terrestrial weeds and poisonous plants, especially their biological control through such agents as, for example, insects which attack the seeds. Exotic weeds in South Africa are spreading at an alarming rate and pose a very real threat to the natural vegetation. No effective means for their control yet exists.

A symposium on marine pollution was held during March to coincide with the visit to South Africa of Capt. Luis Capurro, Assistant Secretary of the UNESCO Intergovernment Oceanographic Commission (IOC). A symposium was held during July on environmental problems of man in Southern Africa.

Through the newly-created South African Committee for the Conservation of the Environment, the National Programme for Environmental Sciences acts as the technical advisory body on environmental matters to the Government. From the National Committee for Nature Conservation, the National Programme has also acquired the important function of co-ordinating research relating to nature conservation in South Africa.

The National Programme also provides for South African participation in world environmental scientific programmes, of which SCOPE (Scientific Committee on Problems of the Environment) is the most important.

University research

During the year under review the University Research Grants Division made a total of more than R1 385 000 available to research workers at universities and museums working in the pure and applied sciences.

This amount consisted of a grant of R1 244 000 from the Treasury and an accumulated saving of almost R140 000 which for various reasons was not used the previous year.

The Council is continually striving to improve the scheme and to do justice to all the fields of university research in its care. The system of university representation on the various awards committees and the fact that the same standards of scientific merit of persons as well as projects are maintained throughout, ensure a high standard of research.

It is impossible for the Council to satisfy all the applications which its referees and specialist committees consider meritorious. Although this shortage of adequate funds may understandably lead to some frustration on the part of university staff who are keen to extend their research activities faster than they are at present, it must be acknowledged that the Government has always been ready to consider well-motivated requests for additional funds.

Visitors

Special itineraries were arranged for Capt. Luis Capurro, Assistant Secretary of the Intergovernmental Oceanographic Commission, for Prof. Dr R. Haul, Director of the Institute for Physical and Electrochemistry at the Technical University of Hanover in West Germany, and for Dr G. Giermann, Acting Secretary of the Intergovernmental Oceanographic Commission.

Altogether 82 foreign visitors were received at Scientia during the year, including the Governor General of Mozambique, Engº Manuel Pimentel dos Santos and his party.

A one-day visit was arranged for committee members of the Planning Groups of the Nationalist and United Parties. The Minister of Planning, the Hon. J.J. Loots was also present on this occasion.

Conferences and symposia

During the year 467 industrialists and scientists working in industry or at research organizations active in the fields of, for example, spectroscopy, electronics and timber, attended one-day or two-day meetings at the CSIR. Assistance was rendered with the organization of conferences such as the Second South African Corrosion Conference, the Symposium on the Application of Computer Methods in the Mining Industry and the Symposium on Powder Coatings, which were held at centres other than Pretoria and were attended by approximately another 800 delegates.

Technical Services Department

Director: J. van der Staaij

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.

Extension of facilities and services

The section responsible for the manufacture of printed circuit boards is now fully equipped to manufacture very accurate multilayer boards.

The interest in low cost automation increased so much that the Department presented five basic and two advanced courses at its Advice Centre for Low Cost Automation during 1972. A further five basic courses as well as a symposium are planned for 1973. Approximately 300 industrialists, among whom were 60 members of the South African Institute of Production Engineering, visited the Centre and several articles on the activities of the Centre have already been published. Various factories have been visited at the request of industrialists and annual savings of between R1 800 and R6 000 per factory have been achieved by means of low cost automation techniques. Several industrialists have since requested that the layout of their factories be studied with a view to further automation.

A practical course in numerical control, which was presented in collaboration with the National Research Institute for Mathematical Sciences and was attended by production managers, programmers and technicians from industry, stimulated so much interest that a further two courses have been planned for 1973.

Training

To satisfy more adequately the increasing demand for technicians who can develop and manufacture apparatus, the facilities of the Training Centre for Scientific Instrument Makers have been extended. At present 58 apprentices are being trained.

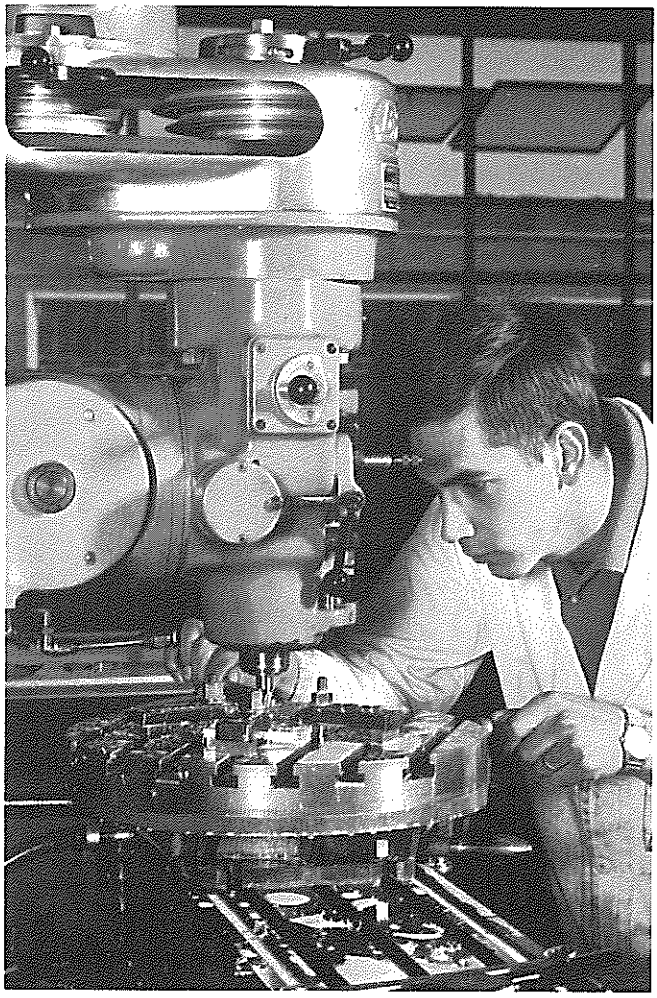
The Department's policy for the training of apprentices and artisans is based on the manufacturing requirements of institutes and certain bodies outside the CSIR, and keeps pace with technological development overseas. A technician of the department has recently been overseas to obtain the latest information on training and on numerically controlled and other automated manufacturing methods.

Projects

The design and workshop personnel assisted research institutes and other bodies with numerous projects, a few of which are briefly mentioned below:

Research Institutes

- Wire rope test apparatus
- Impact roller
- Variometer
- Absolute radiometer
- Rotating all-sky camera
- Crystal scanning device for S-ray diffractometer



- Device for handling radio-active isotopes
- Laying of electric shark barrier at Margate
- Curved sewer gauge
- Various components that required numerically controlled machining.

Other bodies

- Vacuum vessels
- Automatic rain gauges
- Device for carrying samples in liquid nitrogen
- Sampler for exhaled air
- Various programmes for numerically controlled machining
- Various components that required numerically controlled machining.

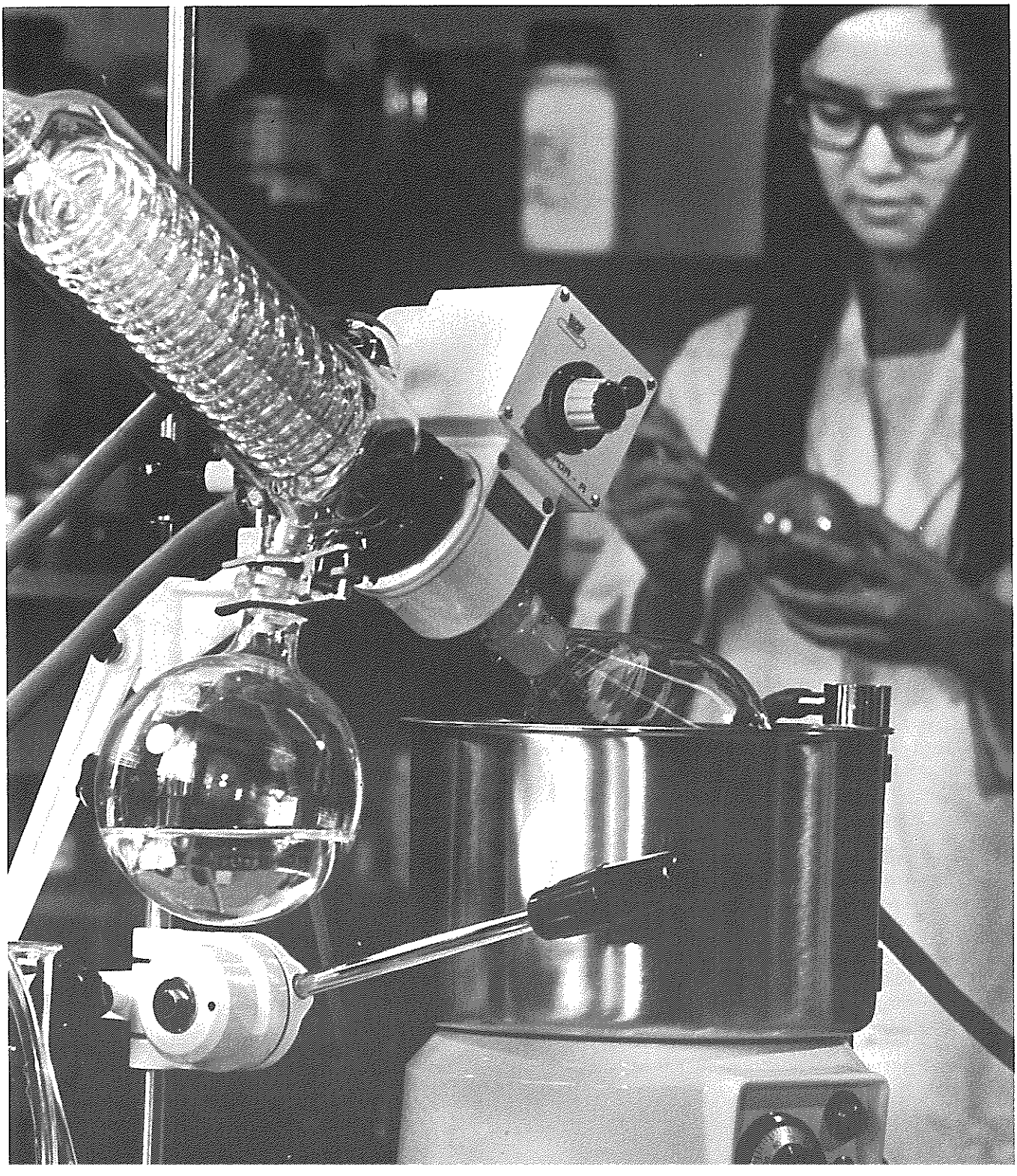
co-operative industrial research

Leather Industries Research Institute

Director: Dr S.G. Shuttleworth

The Leather Industries Research Institute (LIRI), which developed in 1936 from the Chemistry Department of Rhodes University and was founded in 1941, originally received financial assistance from the government through the Department of Agriculture, the Research Grant Board and the Department of Education. When the CSIR came into being in 1946, LIRI became its first industrial research institute.

Preparing wattle-based adhesives.



The functions of LIRI have been based more on those of European industrial research institutions than on those of the British. The main difference lies in the fact that most of the British research associations are independent of the technological and post-graduate training and research organizations at universities and technical colleges. These receive substantial government aid and the British research associations therefore have no organized educational and training outlets for their accumulated experience and know-how. In Europe on the other hand combined activities eliminate overlapping and rivalry. Many Continental industrial research organizations are closely associated with universities and, like LIRI, help to bridge the gap between the academic and the industrial spheres.

A feature of the past year has been the practical recognition of the high international standing of the Institute. The Director was invited to address the American Tanners Council on environmental problems at their Spring Convention in April. A chief research officer was invited to deliver a paper on methods of avoiding tannery effluent problems at the convention of the American Leather Chemists Association in June. In September the Director delivered the first Atkin Memorial Lecture to the British Leather Chemists Society at Leeds University and was presented with an inscribed gold medal awarding him honorary life membership in recognition of his services to the leather industry. Nearer home, he has been awarded the 1972 gold medal of the South African Chemical Institute. He has also been invited to deliver the John Arthur Wilson Memorial Lecture at the 1973 convention of the American Leather Chemists Association in Ottawa, Canada.

In the training field the demand for LIRI correspondence courses in footwear technology and management has increased to 340 students from 23 countries. The first-year courses are now also available in French.

Hides and skins

The curing or temporary preservation of hides and skins with salt is under critical review at present because of the difficulties associated with salt in effluent, both at the point of curing and at the tannery. Salt is one of the most difficult pollutants to remove from industrial waste water. Tanners in South Africa, and especially in the concentrated industrial areas of Europe, America and Japan, are being forced to use raw materials other than salted hides and skins in order to eliminate both salt and beamhouse effluent. Exporters of raw material in South Africa will therefore have to consider marketing semi-processed forms of leather.

The Institute is for this reason studying the short-term preservation of hides and skins, using antiseptics and no salt, as an intermediate stage between the raw material and semi-processed or fully processed leather.

This method will probably not be suitable for shipping hides and skins overseas, since at the present stage of development the period of preservation is limited to approximately two weeks.

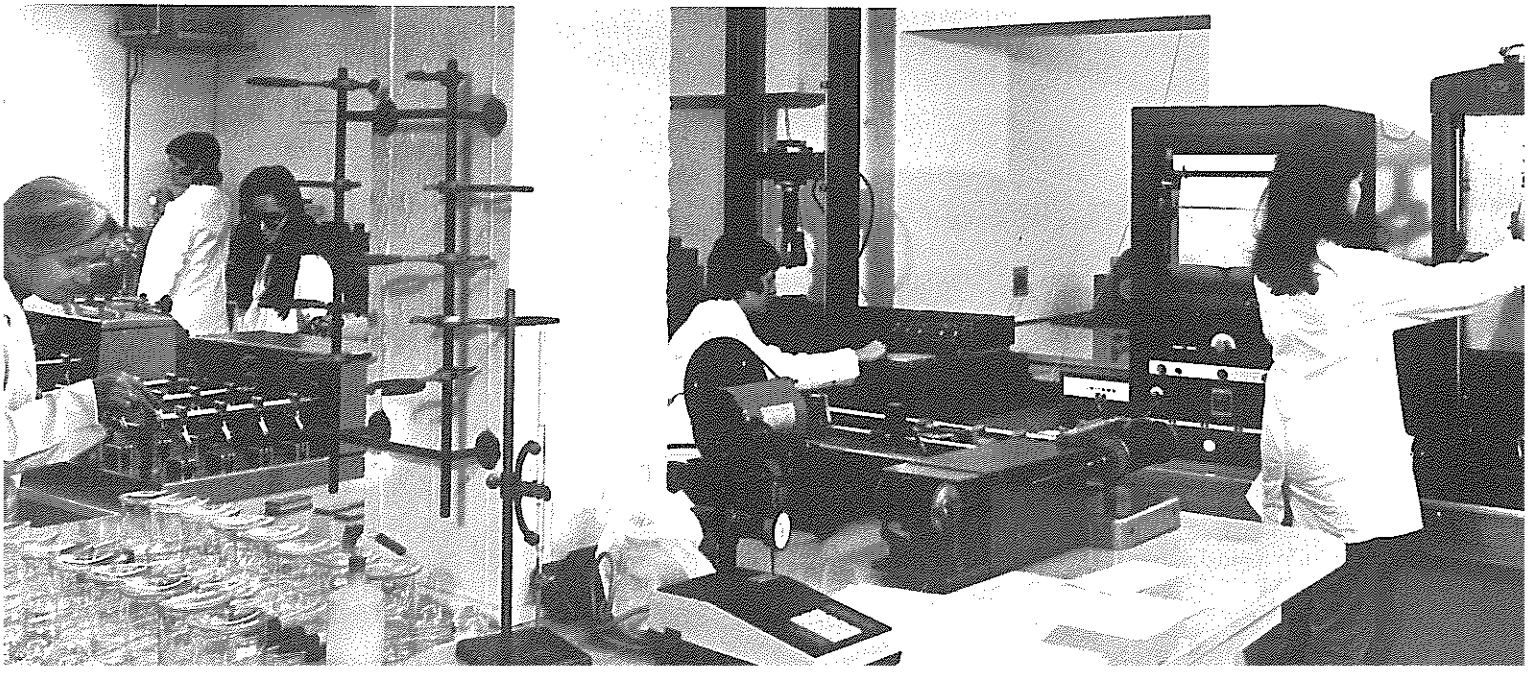
The relation between hide quality, hide curing methods and upper leather quality is still an important area of study. This has resulted in a systematic study of the occurrence of draw on hides and leather, a defect which causes considerable concern to tanners.

Protein research

Fundamental studies on interactions between hide collagen and its aqueous environment continued. These studies are directed at elucidating the nature of the variety of multiple, weak interactions which occur when collagen is exposed to various aqueous environments. These considerations are relevant to the wet processing of hides and its interaction with tanning agents and other technological materials. In addition, changes in protein properties which result from systematic alteration in the composition of the solvent environment, provide an insight into the factors governing the structure and stability of collagen, the basic leather-making substance.

Examination of activity patterns in aqueous solutions of alcohols, glycols, ketones, nitriles, amides and derivatives has been extended to include the effects of solvents on the thermal stability of the salt-precipitated form of acid-soluble collagen for comparison with previous results. Since salt-precipitated collagen shows the same aggregation mode as mature, insoluble collagen, as seen in electron microscope studies, the precipitated form may be taken as representative of insoluble collagen without intermolecular crosslinks. Several papers on this work have been published in recognized scientific journals.

Part of the laboratory where properties of shoe-making materials are evaluated.



Wattle-based adhesives

Strong emphasis has been placed on the development of wattle-based wood adhesives. A large-scale trial of a cold-setting wattle adhesive was conducted in Natal. A few tons of the glue were manufactured in several batches and samples are being evaluated by the South African Bureau of Standards.

The Institute has developed a single-component, cold-setting adhesive for use in small workshops. This instant glue stores well and is very simple to use.

Great improvements have been made in the bonding of thermosetting plywood adhesives. Several different wood veneers have been used with these wattle-based formulations.

Results of a recent plywood production trial showed conclusively that marine plywood could be produced with wattle-based glues and suitable wood veneers.

The use of wattle-based resins in the manufacture of corrugated cardboard containers for the food industry is being investigated. The wattle resins make the containers, which are subject to dew formation when removed from refrigerated storage, weatherproof to a certain extent.

Oil-well drilling

Samples of the wattle-based mud thinner, Kr6D, developed by the Institute, were made available to an American company for evaluation. As a direct result of their favourable findings a large amount of the material has been ordered for full-scale drilling trials which are to be held soon.

Plans are well advanced to market Kr6D in Australia and New Zealand.

Metal-tannin complexes

An extensive study has been made of the complexes formed between wattle tannins and their monomeric precursors, and metal ions such as copper, zinc, cobalt, manganese, lead, magnesium, calcium, strontium, boron, aluminium, germanium, tin, titanium, zirconium and molybdenum. Spectrophotometric and potentiometric methods have been used in these investigations.

Two novel methods of tannin analysis have been proposed. One is based on the stannate-wattle complex, while the other makes use of the orange-red molybdate-wattle complexes.

This fundamental study has shed new light on the potential use of wattle extract in the froth flotation of ores and as complexing agent for trace elements in plants with certain deficiencies.

Vegetable leather tannage

Three visits have been made to United States and Canadian vegetable leather tanners who are adopting the Liritan no-effluent system of vegetable tanning because of problems in meeting the increasingly stringent requirements for effluent. The success of this and other procedures which have been introduced in the American leather industry resulted in invitations to staff of the Institute to address management and technical personnel at conferences in the United States. The export of this technical know-how is regarded as extremely valuable and of direct importance to the wattle industry.

Water and air pollution

The prevention of the pollution of natural water resources by industrial effluent is of prime importance in all developed countries. The Institute has made significant contributions to the treatment of tannery waste. In a pilot-plant aerobic digester experiments are being conducted on the elimination of sulphide and biochemical oxygen demand from segregated beamhouse effluent. The possibility of converting solid waste to compost is also being investigated. Air and water pollution by tannery effluent remain difficult problems throughout the world. Tanners are striving to reduce the polluting load by adopting procedures which reduce the chemical content of the waste water.

The Institute has developed a number of new processes, which have already been adopted in South Africa and overseas, to reduce or eliminate liquid and solid wastes.

Beamhouse effluent

Effluent from the beamhouse contains more than 70 per cent of the polluting substances in tannery effluent. Much of this consists of the non-leather components of the hide and the chemicals used for their removal. Work at the Institute is aimed at reducing the consumption of chemicals which contribute to the sludge problem. The elimination of the costly curing process would reduce the neutral salt load in effluent water. If the experiments at the Institute are successful, treated tannery effluent will be low in total dissolved solids and biochemical oxygen demand.

Leather finishing

Shoe upper leather is being challenged by a multitude of synthetic materials. Leather is meeting the challenge and maintaining its popularity by enhancing its aesthetic appeal and by being in the forefront of fashion. Much of the development work in the past has been in the essential but utilitarian field of improving performance. Consumer preference, however, places aesthetics and comfort far above durability and performance. Current work at the Institute places emphasis on the former whilst maintaining the latter.

Perspiration accumulation in footwear

The Institute has developed a new method of assessing the transfer of moisture from the foot to the outside atmosphere. This makes it possible to evaluate the foot health and comfort properties of shoes for the first time. The contribution of all the components, including lining and upper materials and inner and outer soles, can now be assessed and their additive effect judged. This work is of special importance in view of the flood of new synthetic materials being offered to the footwear industry.

co-operative industrial research

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 R215 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.

New fish products

Investigation into the utilization of filleting waste, undersized white fish and unusual species continued.

For instance, John Dory *(Zeus faber)*, which is landed in fair quantities and usually converted to fish meal, can be mechanically de-boned and canned as an attractive jellied fish loaf. It can also serve as the base for a high-quality milk substitute for calves.

In collaboration with members of the industry it was shown that rock lobster body meat can be separated from the shell and viscera and, after suitable treatment, successfully canned or frozen without losing its distinctive delicate flavour.

By hydrolyzing and concentrating fish juice collected during the canning of pilchards, a palatable extract was prepared. It has no fishy flavour and after adjustment of salt content can be used in place of meat extract.

Objective quality tests for fresh and frozen hake

In spite of an intensive search, extending over many years, for an objective test for the freshness of fish, no substitute for sensory tests, i.e. smell and taste, has yet been found. Nevertheless several new approaches to the problem have been suggested, and are currently being investigated by the Institute.

For frozen hake the hypoxanthine test and the dimethylamine test have shown promise. Information is being collected on the seasonal fluctuations in hypoxanthine and dimethylamine base levels and the effect of their rate of formation on the sensitivity of the

test. Differences in the response of the related hake species, *Merluccius capensis* and *M. paradoxus*, are also being studied.

Can corrosion

Some factories reported that a certain type of can used for fish canning developed abnormally severe external corrosion. Equipment for accelerated corrosion tests was built in the laboratory, and it was established that the type of corrosion observed in practice could not be attributed to shortcomings in the specifications for the cans. The evidence points to corrosion being aggravated by the presence of chlorides in the water used for cooling the cans. To eliminate this special measures for the continuous purification of the water, which is recirculated, will have to be taken.

Microbiology

Batches of fish meal, with and without anti-oxidant, were artificially inoculated with salmonella. When the fish meal was stored at room temperature the salmonella died off more slowly in the meal treated with anti-oxidant than in the untreated meal. Closer investigation revealed that the oxidation products in the unstablized meal appeared to have bactericidal properties. In meal in which the lipid oxidation was inhibited by anti-oxidants, bacteria survived for longer periods.

The introduction of compulsory specifications for frozen marine products has focused attention on their microbiological status and on the rate at which certain micro-organisms die off during frozen storage. It was shown that the initial total count on the surface of fish can be reduced far more effectively by subjecting the fish to a strong water spray rather than by merely dipping it in a stream of running water.

Packaging of fish meal

Uncertainty about the supply of jute has reawakened interest in the use of woven plastic bags for packaging fish meal. Laboratory tests indicate that although these bags are strong they weather rapidly when exposed to sunlight. When stacks of these bags have to be stored in the open for a long time it is essential that they be chemically stabilized against ultra-violet radiation. Accelerated weathering tests conducted in the laboratory revealed that bags supplied to the industry differed widely in their resistance to ultra-violet radiation.

Analysis of fish meal volatiles

There is sometimes uncertainty about the origin of certain volatile (odour) compounds of fish meal, which indicate for instance that the meal was made from stale fish or that it got wet and underwent microbiological degradation after production. Fairly sophisticated techniques for collecting fish meal volatiles and for separating them by gas chromatography have been perfected. Selected chromatographic peaks are being correlated with the known history of different samples of meal.

Protein chemistry

Since the acquisition of new equipment of advanced design considerable progress has been made in the isolation and identification of amino acids by gas chromatography. Close contact is being maintained with overseas research workers in this field, and FIRI's contribution to the development of this new application of gas chromatography has been acknowledged.

Claims that dye-binding of protein is a useful quality index are being investigated. A correlation appears to exist between dye-binding and the chemically determined 'available' lysine in fish meal. As a by-product of the investigation useful insight is being obtained into the chemistry of dye-binding.

Effluent clarification

Fish processing, on the scale customary in South African fish meal plants and fish canneries, involves the use of large quantities of sea water which carry back to the sea varying amounts of organic matter.

A survey in progress at Walvis Bay for nearly two years has shown that the natural digestive processes in the sea are so efficient that the zone showing a rise in ammonia content is relatively small and confined to the vicinity of the effluent outfall. This does not, however, apply to the fatty fractions of the factory effluent, which float and can become a nuisance when wind or current carry them in the wrong direction.

Several factories have installed settling tanks with special scum traps which largely eliminate the return of oily wastes to the sea and recover much of the suspended solids in the effluent. The Institute is collaborating with the industry in testing these and other mechanical devices designed to reduce the loss of valuable raw materials to a minimum.

Milk substitutes

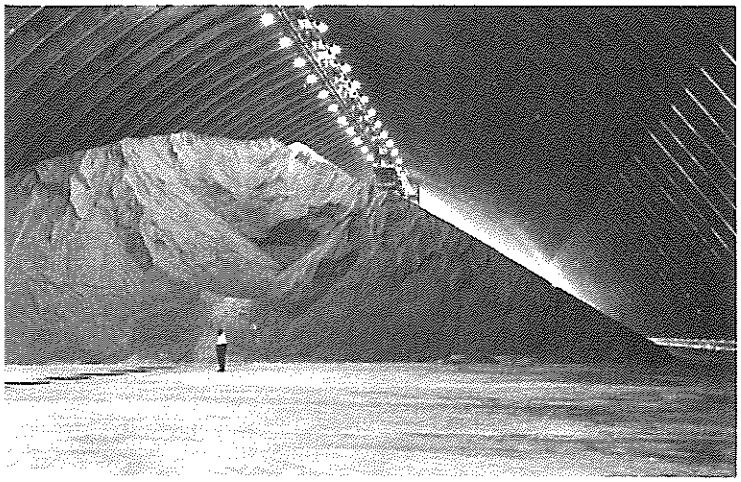
The inadequate and fluctuating production of milk powder, particularly in Europe, has promoted interest in non-milk proteins for calf feeding. Fish protein is nutritionally and economically a particularly suitable raw material for milk substitutes. The requirements for such products are that they must either be soluble or so finely ground that they will remain in suspension for extended periods, and have a low ash as well as a low iron content.

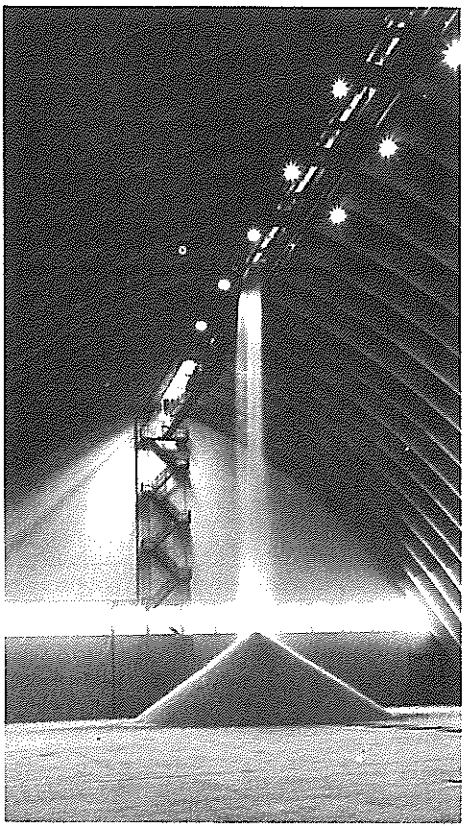
By enzyme digestion of certain fractions of fish material obtained in the production of fish meal, the Institute has produced samples which, according to preliminary tests, conform to the specifications for an acceptable milk substitute.

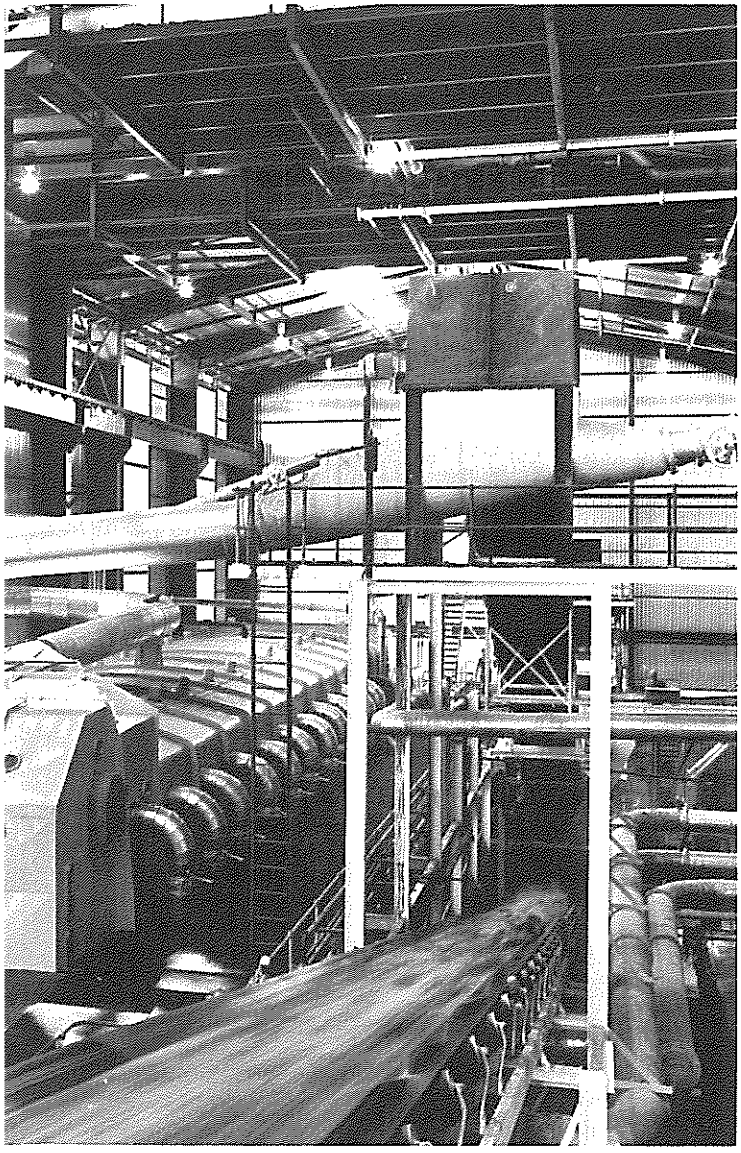
co-operative industrial research

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, trouble shooting, 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.)

The De Smet diffuser in operation in a factory

Diffusion

Work has begun on the evaluation of the extraction performance of commercial diffusers used in South Africa.

The major practical difficulty in this evaluation which prevents meaningful comparison of performances, is the lack of a suitable index for expressing cane preparation. It is also difficult to obtain representative samples, especially of bagasse, at the diffuser outlet.

Evaluation runs have been made at two factories using different diffusers and the relative extraction of the first mill, diffuser and dewatering mills has been measured. Results obtained are in keeping with the overall extraction at these factories. However, more runs will have to be made before the results are representative of operations under different conditions. This work will be extended to other diffusers.

In conjunction with the above investigation, it was decided to determine separately the washing and diffusion effects in the diffuser and for this purpose a method was developed to estimate 'bound' or 'difficult' sucrose in bagasse. The 'easy' or 'washable' sucrose is then determined by the difference from total sucrose.

Leaching in cold water for an hour, a method used in cell breakage determinations, was tried but it appeared that some diffusion took place during leaching. A new procedure was developed in which 'easy' sucrose was washed out with an excess of cold water for four minutes. The reproducibility of this method is satisfactory for diffuser feed but reproducibility is not as good for diffuser discharge bagasse because of the low pol of the extract.It is, however, considered acceptable as the experimental error involved is still lower than the sampling error.

As is to be expected the percentage of 'difficult' sucrose in feed depends to a certain extent on preparation. The diffusers also appear to be flexible in the percentage of 'difficult' sucrose which they can extract. A deterioration in cane preparation will not result in a proportional decrease in overall extraction as more of the 'difficult' sucrose is then extracted, probably by diffusion. It is proposed to continue this work with the accent on determining at what point in each diffuser diffusion replaces washing as the major extraction mechanism.

Organic acids in molasses

Since the introduction of diffusion in the cane industry it has been assumed that more molasses is produced by this process than by conventional milling. This assumption, however, has always been based on some factory observations and has never been investigated properly. It is to be expected that if more molasses is obtained in the diffusion process, the composition will also differ from that of molasses in a factory-operating mill. Organic acids especially, being decomposition products from sugars, should be present in a different proportion. In order to test this hypothesis, an analytical method had to be worked out based on ion exchange followed by separation on a silica gel column.

The acids were recovered by passing a dilute sample in the carbonate form through an Amberlite IR 400 column. Subsequently the acids were eluted with 2N ammonium carbonate. The eluate containing the ammonium salts of acids and excess of ammonium carbonate was then passed through a cation exchange resin in H form and the resulting solution was evaporated in a vacuum rotary evaporator until all water was removed. The residue was mixed with 0,5 ml 0,5N sulphuric acid and transferred to a silica gel column. The identities of the isolated acids were confirmed by running paper chromatograms using various eluants.

Since the eluate of the ion exchangers had to be concentrated in vacuo it was assumed that volatile acids might be lost during processing. For this reason all samples were analysed for volatile acids by means of gas chromatography. From the combined results of silica gel and gas chromatography no significant difference in acid composition could be found between molasses samples from diffusion factories and from milling factories.

This investigation was extended to acids formed during alkaline degradation of sucrose. A 15 per cent sucrose solution, containing small amounts of glucose and fructose was brought to pH 10 and boiled. The residual solution was passed through the ion exchangers in the same way as the molasses samples and the recovered acids were separated by liquid-liquid chromatography using silica gel.

The reaction mixtures resulting from alkaline decomposition of sucrose and reducing sugars contained mainly lactic, succinic and glycollic acids, none of which were predominant in the molasses samples investigated.

Exhaustion of final molasses

The proper exhaustion of molasses is of great financial interest to the sugar industry. For this reason many overseas sugar industries use target formulae which enable them to determine the practical limit to which sugar can be recovered from a particular molasses sample.

An investigation into the exhaustion of final molasses has been completed and a regression formula, valid for South African conditions, for purity, reducing sugar and ash has been established. The method of molasses exhaustion on which the regression formula is based, is as follows.

Molasses under investigation is diluted and slowly heated in a laboratory vacuum pan provided with a stirrer. After the entrapped air has escaped the calandria temperature is kept at 90° C to prevent overheating and the molasses is concentrated until the viscosity at 60° C is 500 to 600 poises. A sample of molasses is taken out of the pan and the viscosity is determined accurately with a Brookfield viscometer.

Baking sugar is then introduced into the pan and the contents are boiled for a few more minutes. The massecuite is then transferred into a thermostatically controlled crystallizer and allowed to equilibrate for 24 hours at 40° C. Crystals are then separated from the mother liquor by pressure filtration and the latter is analysed for dry solids, sucrose, reducing sugars and ash.

The best relationship was obtained between purity and the reducing sugars-ash ratio. The final regression formula, based on 29 observations, is as follows:

True purity $=$ 51,02 $-$ 10,89 r/a in which r/a $=$ reducing sugar/ash

Multiple correlation coefficient $=$ 0,842

Standard deviation of residuals $=$ 1,356

F test (variance ratio) $=$ 65,67

Statistically these results compare favourably with those obtained for other published relationships.

Water pollution

Early results from the pilot aerated pond system at a sugar factory indicated that unsatisfactory sludge was produced from effluent containing only carbohydrates. It was

therefore decided to carry out laboratory tests using activated sludge digesters developed by the National Institute for Water Research.

Two six-litre digesters, one of which had a quiescent zone to give a degree of sludge thickening, were seeded with acclimatized sewage sludge, and fed with mill dunder water. Initially neither digester was given any additional nutrient, and it was found that under these conditions sludge did not build up beyond a level of approximately 200 mg/l, and that fairly extensive polysaccharide formation took place, causing foaming.

It was evident that addition of nutrients was necessary and nitrogen and phosphorus were added in increasing amounts in the ratio 5:1 (N:P) to one digester. The other digester was kept as a control. The content of organic matter in the discharge of the digester was monitored in the conventional way. The biochemical oxygen demand (BOD), the sludge volume index (SVI) and the chemical oxygen demand (COD) were determined. It was found that both the BOD and the SVI decreased as nutrients were added. A minimum was obtained when the ratio COD:N:P in the feed to the digester was adjusted to 100:2:0,4. The SVI reached in this case a value of 53. This represents a sludge with excellent settling characteristics. The main difficulty in adapting the purification of activated sludge to sugar (or any other high carbohydrate effluent) namely, the production of light and unsettleable sludges which render secondary clarification ineffective, was therefore overcome.

It was also found that in order to build up sufficient sludge, a sludge return system was necessary. Next, the limiting load factor, that is, the mass of daily incoming COD divided by the mass of sludge in the digester, was investigated. It was shown that by slowly increasing the feed a load factor of 1,3 could be obtained without seriously reducing the effectiveness of the process. This is a very high load factor as the normal load factor for a sewage works using this type of process is about 0,3 to 0,5.

The results of this work were applied to the pilot-scale plant at the factory concerned, where the sludge return facility had been completed. The sludge settled very well and an excellent final effluent was obtained.

This investigation is being carried out in collaboration with the National Institute for Water Research.

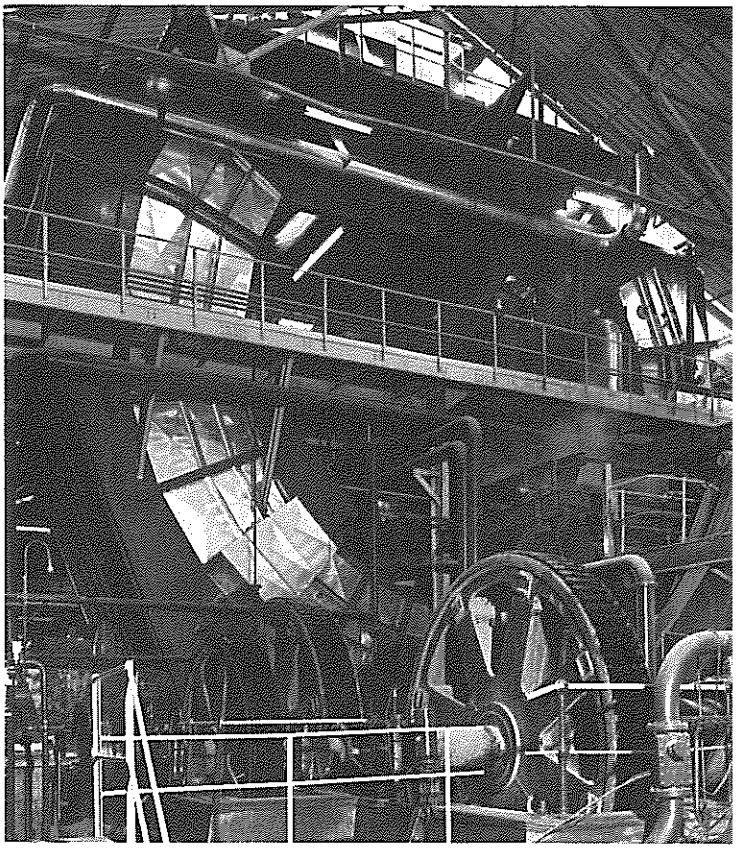
Preparation of kestoses

Kestoses, which are fructosyl sucroses, have been claimed to influence the shape of sucrose crystals if they are present in the mother liquor as impurities. It is also known that the presence of kestoses in factory products results in errors in sucrose determinations by polarization because of their dextrorotation. For research in these fields it is important to have pure reference samples and for this reason such samples were prepared.

The method for preparing 6- and neo-kestose by the action of yeast invertase on a sucrose solution was essentially that used by Gross. However, the reaction yield was further investigated as a function of pH and time. It was found that a better yield of kestose could be obtained by maintaining the reaction mixture of pH 7 at 5°C for 4 hours, instead of the recommended 45 minutes at 20°C, before inactivating the enzyme by boiling. The mixture of 6- and neo-kestose could be effectively concentrated by carbon-'celite' chromatography using graded concentrations of aqueous alcohol for elution. Eight grams of kestose concentrate has been obtained in this manner. The concentrate contains as an impurity a compound that is most probably a tetrasaccharide. A small sample of concentrate was further fractionated on a smaller carbon-'celite' column and 64 mg and 43 mg respectively of apparently pure 6- and neo-kestose were obtained. These samples have not yet been crystallized.

The method for preparing 1-kestose by the action of mould invertase on a sucrose solution is similar to the method of Gross. However, the recommended time of the reaction (48 hours at 20°C) was far too long, with the result that most of the kestose that had formed was decomposed. A satisfactory method of preparing 1-kestose is to use one-fifth the quantity of enzyme recommended by Gross, to maintain the reaction mixture at 30°C and to terminate the reaction after 40 minutes. Although the maximum concentration of 1-kestose was formed after 2½ hours, neo-kestose and an unknown oligosaccharide were also present in significant amounts. When the reaction was terminated after 40 minutes the 1-kestose was still free of other oligosaccharides.

The Saturn diffuser in operation in a factory.



South African Paint Research Institute

Director: Prof. D.W.S. Evans

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 these involve using apparatus, the cost of which would be uneconomical for individual members. A well-stocked library is available to subscribers, and technical reports and abstracts of published papers in the surface-coating field are issued.

Facilities are provided for outside and accelerated-weathering studies of paint films, and a sea raft is maintained 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.

At the Corrosion Exhibition organized by the South African Corrosion Council in Johannesburg during September 1972, the Institute's staff manned the stand of the South African Paint Manufacturers' Association. The theme of the stand was that correct mixing, correct application and, in particular, adequate cleaning and preparation of the surface to be painted ensured very good results, whereas failure to take these precautions gave bad results.

The Institute has been admitted to associate membership of the Paint Research Station, Teddington, England, and receives confidential reports from the station. This ensures that in future work done at Teddington will not be duplicated in Durban and *vice versa*

Hydroxyl value of resins

Four properties of resin were investigated, namely, infra-red spectra, conductivity, dielectric constant and nuclear magnetic resonance. Each of these properties varies significantly with the diminishing hydroxyl content of the resins as reaction proceeds, but in each case the actual quantitative value obtained for the hydroxyl content is characteristic of the particular resin composition used. This is markedly so with measurements of conductivity and dielectric constant but values for infra-red and nuclear magnetic resonance are more satisfactory. The results have been reported to members.

Assessment of fungicides

It is common practice to incorporate a fungicide in aqueous emulsion coatings to combat attack by fungi. Numerous fungicides of widely differing chemical composition are on the market. The Institute has begun a long-term programme to compare the performance of a large number of fungicides in both laboratory and field tests, and to investigate the effect of the addition of fungicides on the properties and performance of a variety of coatings.

Solvent retention by paint films

Most coating compositions contain mixtures of volatile components. While the films are 'wet' these solvents evaporate rapidly, the rate of loss of each component being determined by its vapour pressure. As soon as the film becomes 'dry' on the surface, a surface barrier prevents free evaporation and the volatile components are transported to and through the surface by diffusion. The rate of loss then depends on molecular dimensions. The properties of a film may be greatly affected by the type of volatile material present and the Institute is attempting to correlate properties such as intercoat adhesion with the composition and amount of solvent retained in the film after it becomes 'dry'.

Quantitative determination of rosin in tall-oil alkyds

Large quantities of rosin in coatings may impart undesirable properties to the film but small quantities have no adverse effects. It is easy to detect qualitatively the presence of rosin, but at present there is no satisfactory method for the quantitative estimation of rosin present in paints with an alkyd resin base. Tall oil with a low rosin content is a relatively cheap raw material from which good alkyd resins can be manufactured. The Institute is investigating possible analytical methods.

Financial Statements

Balance sheet

as at 31 March 1972

Statement No. 1
South African Council for Scientific and Industrial Research

	General Fund R	Building Fund R	1972 R	1971 R
ACCUMULATED FUND				
Balance – 31.3.71.	23 050 255,16	14 255 421,95	41 423 815,82	37 305 677
Inter-fund transfers	(–) 10 102,00	10 102,00		
	(–) 27 500,00	27 500,00		
SUB-TOTAL	23 012 653,16	14 293 023,95		
CAPITAL RECEIPTS				
Parliamentary Grants:				
CSIR	1 424 500,00	1 100 000,00		
Grants	142 800,00			
Donations:				
CSIR	4 310,00	3 748,44		
Grants	23,00			
Interest		232 496,42		
Sale of assets written off:				
CSIR	16 062,11			
Grants	-			
Investigations and services . .	647 142,19	81 518,29		
SUB-TOTAL	2 234 837,30	1 417 763,15		
ADD:				
Excess income	716 711,76			
Fixed assets acquired . . .	206,00			
LESS:				
Physical items relinquished .		84 648,79		
Cost of assets written off:				
CSIR	141 106,02			
Grants	25 624,69			
SUB-TOTAL	2 785 024,35	1 333 114,36		
TOTAL	25 797 677,51	15 626 138,31	41 423 815,82	37 305 677
Current liabilities				
Advances for investigations and services			798 981,02	445 131
Sundry creditors and credit balances			1 609 261,39	1 510 583
TOTAL			R2 408 242,41	1 955 714
GRAND TOTAL			R 43 832 058,23	39 261 391

Notes – * Contractual obligations against the General and Building Fund as at 31st March, 1972 was R973 247 and R1 285 814 respectively.

ϕ Value of assets transferred: *To:* University of Natal, Durban R84 648,79. *From:* Nutrition Research Unit R66,00; Dr Hamilton R140,00.

C. v.d.M. Brink, *President*

J.H. Visagie, *Secretary/Treasurer*

PRETORIA 11.8.72.

	1971/1972 Nett Additions					
	Grants R	CSIR R	Written off R	Phys. assets transferred ø R	1972 R	1971 R
FIXED ASSETS (at cost)						
Land and buildings		1 843 087,97		84 648,79(–)	15 182 193,72	13 423 755
SUB-TOTAL		1 843 087,97		84 648,79(–)	15 182 193,72	13 423 755
Laboratory and workshop equipment	150 053,65	2 302 054,41	104 782,35	140,00(+)	19 460 064,88	17 112 599
Furniture, fittings and office equipment	314,27	122 775,17	18 921,87	66,00(+)	1 265 350,62	1 161 117
Vehicles and cycles		93 602,68	29 353,35		819 847,90	755 599
Books and journals	628,62	130 448,02	13 227,34		1 118 143,14	1 000 294
Prefabricated structures		4 910,00	445,80		15 384,83	10 920
Shares in S A Inventions Development Corporation					140 000,00	140 000
Stores stock		68 832,16			460 693,49	391 861
SUB-TOTAL	150 996,54	2 722 622,44	166 730,71	206,00(+)	23 279 484,86	20 572 390
TOTAL	150 996,54	4 565 710,41	166 730,71(–)	84 442,79(–)	38 461 678,58	33 996 145
Current assets						
Saleable stock					81 488,34	106 522
Sundry debtors and debit balances					1 337 890,86	694 491]
Investigations and tests in progress						525 942]
Advances and deposits:						
Research grants				512 295,74		
Other				417 749,94	930 045,68	566 125
Investments					2 719 542,67	3 180 849
Cash:						
At S A Reserve Bank				254 131,30		
Petty cash imprests				47 280,80	301 412,10	191 317
TOTAL					R5 370 379,65	5 265 246
GRAND TOTAL					R43 832 058,23	39 261 391

The above Balance Sheet has been audited in accordance with the provisions of section 56 of the Exchequér 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
5.10.1972

F.G. Barrie
Controller and Auditor-General

Operating account

for the year ended 31 March 1972

Statement No. 2
South African Council for Scientific and Industrial Research

Expenditure	1971/72 Grants R	CSIR R	Total R	1970/71 R
Salaries, wages and allowances	76 121,40	15 067 061,32	15 143 182,72	12 480 069
Consumable stores and services	7 725,81	5 109 290,01	5 117 015,82	4 604 968
Subsistence and transport	9 682,88	729 309,74	738 992,62	652 774
General expenses	32 243,54	2 594 429,95	2 626 673,49	1 885 130
Grants	873 952,64		873 952,64	729 558
Subsidies: Research by Industry		326 111,46	326 111,46	307 550
SUB-TOTAL	999 726,27	23 826 202,48	24 825 928,75	20 660 049
LESS:				
Income for internal services	2 962,55	3 098 711,51	3 101 674,06	2 534 967
SUB-TOTAL	996 763,72	20 727 490,97	21 724 254,69	18 125 082
Balance transferred to Accumulated Fund (–)	10 259,62	726 971,38	716 711,76	752 485
TOTAL	R986 504,10	21 454 462,35	22 440 966,45	18 877 567

PRETORIA
11.8.1972

C v.d.M Brink, *President*

Income	1971/72 Grants R	CSIR R	Total R	1970/71 R
Parliamentary grant	984 800,00	11 612 700,00	12 597 500,00	10 872 500
Investigations and services		8 891 784,18	8 891 784,18	7 317 588
Contributions to CSIR projects		879 139,74	879 139,74	614 680
Publications	1 704,10	15 244,24	16 948,34	11 283
Sundry		55 594,19	55 594,19	61 516
TOTAL	R 986 504,10	21 454 462,35	22 440 966,45	18 877 567

J.H. Visagie, *Secretary/Treasurer*

CSIR Budget 1972/73

Statement No. 3

A. OPERATING EXPENDITURE

ACTIVITIES	EXPENDITURE								FUNDS	
	Salaries R	Supplies and Services R	Subsistence and transport R	Scientific services R	Awards and subsidies R	General expenditure R	Amount internally recovered R	Total R	Parliamentary grant R	Recoverable expenditure R
CSIR laboratories and departments . . .	16 791 419	5 242 484	765 158	714 881	-	1 763 403	3 206 933	22 070 412	11 825 600	10 244 812
Grants and subsidies . . .	224 020	13 995	24 400	43 792	1 652 784	62 767	85 630	1 936 128	1 883 600	52 528
Total	17 015 439	5 256 479	789 558	756 673	1 652 784	1 826 170	3 292 563	24 006 540	13 709 200	10 297 340

B. CAPITAL EXPENDITURE

ACTIVITIES	EXPENDITURE							FUNDS	
	Books/ Journals R	Technical equipment R	Furniture/ office equipment R	Vehicles R	Stores Stock R	Buildings R	Total R	Parliamentary grant R	Recoverable expenditure R
CSIR laboratories and departments . . .	107 330	1 604 074	101 220	70 180	40 000	1 310 000	3 232 804	2 239 700	993 104
Grants to universities etc	-	30 917	183	-	-	-	31 100	31 100	-
Total	107 330	1 634 991	101 403	70 180	40 000	1 310 000	3 263 904	2 270 800	993 104
						Grand totals	27 270 444	15 980 000	11 290 444

Selected publications

National Chemical Research Laboratory

Albrecht, C.F., Liebenberg, N. v.d.W., Ball, Frances L. & Harrel, Betty W. Electron microscopic studies of RNA-containing particles in rat liver and hepatoma nuclei. In: *Proceedings of the South African Electron Microscopy Society,* Pretoria, 1971, (CSIR Symposium S63), pp. 21-22.

Botes, D.P. Snake venom toxins. The amino acid sequences of toxins b and d from *Naja melanoleuca* venom. *J. biol. Chem.,* vol. 247, 1972, pp. 2866-2871.

Botes, D.P., Strydom, D.J., Strydom, A.J.C., Joubert, F.J., Christensen, P.A. & Anderson, C.G. The purification and amino acid sequence of three neurotoxins from the Cape cobra (*Naja nivea*) venom. *Toxins of Animal and Plant Origin,* vol. 1, 1971, pp. 281-292.

Bull, J.R., Enslin, P.R. & Lachmann, H.H. Steroidal analogues of unnatural configuration. Part III. Reactions of the Δ^5-bond in 4,4,14α-trimethyl-19-nor-10α-pregn-5-ene derivatives. *J. chem. Soc.* (C), 1971, pp. 3929-3934.

Clark, R.C. Sephadex fractionation of phosvitins from duck, turkey and ostrich egg yolk. *Comp. Biochem. Physiol.,* vol. 41B, 1972, pp. 891-903.

Dijkstra, J. The so-called red impurity of trypan blue. *Sep. Experientia,* vol. 28, 1972, pp. 252-253.

Dijkstra, J. & Weide, Suzanne S. Solubilization and fractionation of rat liver chromatin. *Expl Cell Res.,* vol. 71, 1972, pp. 377-387.

Freeman, R., Pachler, K.G.R. & La Mar, G.N. Quenching the nuclear Overhauser effect in NMR spectra of carbon-13. *J. chem. Phys.,* vol. 55, 1971, pp. 4586-4593.

Haines, L.M. & Singleton, E. Cationic oxygen adducts from rhodium and iridium carbonyl salts. *J. organometal. Chem.,* vol. 30, 1971, pp. C81-C83.

Haylett, T., Swart, L.S., Parris, D. & Joubert, F.J. The primary structure of some high-sulphur proteins of reduced wool. *Appl. polymer Symp.,* no. 18, 1971, pp. 37-44.

Hough, J.J. & Singleton, E. Cationic complexes of ruthenium (II). *J. chem. Soc., Chem. Comm.,* 1972, pp. 371-372.

Jordaan, A. & Lourens, G.J. Reaction of isocyanatosulphonyl chloride with unsaturated sugars. The preparation of 3-amino-3-deoxy-D-glucal-derivatives. *J. chem. Soc., Chem. Comm.,* 1971, p. 581.

Joubert, F.J. The fractionation of the high-sulphur proteins from reduced mohair. *Die Makromolekulare Chemie,* vol. 146, 1971, pp. 257-266.

Kistner, A. Fluctuations in the levels of enzymes in bacteria in continuous culture. *S. Afr. med. J.,* vol. 46, 1972, p. 230.

Nagel, D.W., Steyn, P.S. & Scott, D.B. Production of citreoviridin by *Penicillium pulvillorum. Phytochemistry,* vol. 11, 1972, pp. 627-630.

Rathbone, E.B., Stephen, A.M. & Pachler, K.G.R. P.M.R. spectroscopy of trimethyl ethers of D-galactopyranose and its derivatives. *Carbohyd. Res.,* vol. 21, 1972, pp. 83-90.

Reiman, R.H. & Singleton, E. A simple route to some carbonyl and metal phosphine salts using $NOPF_6$. *J. organometal. Chem.,* vol. 32, 1971, pp. C44-C46.

Steyn, P.S. Ochratoxin and other dihydroisocoumarins. Chapter in vol. VI of *The Treaties on Microbial Toxins,* Academic Press, 1972.

Strelow, F.W.E., Victor, A.H., van Zyl, C.R. & Eloff, Cynthia. Distribution coefficients and cation exchange behaviour of elements in hydrochloric acid-acetone. *Analyt. Chem.,* vol. 43, 1971, pp. 870-876.

Strydom, D.J. Phylogenetic relationships of proteroglyphae toxins. *Toxicon,* vol. 10, 1972, pp. 39-45.

Van der Walt, S.J. & Joubert, F.J. Studies of puff adder (*Bitis arietans*) venom – III Ultracentrifuge and ORD studies on protease A. *Toxicon,* vol. 10, 1972, pp. 351-356.

National Physical Research Laboratory

Anderson, F.P. Circulation patterns along the east coast (coastal zone and open ocean) in relation to pollution. *S. Afr. J. Sci.,* vol. 68, no. 5, 1972.

Anderson, F. & Hitchins, P.* A radio tracking system for the black rhinoceros. *Journal of the Southern African Wildlife Management Association,* vol. 1, 1972, pp. 26-36.

Büger, P.A., Malan, O.G. & Kunze, O.A. The spectral response of PbS films. *Z. Naturf.,* vol. 26a, 1971, pp. 1995-1997.

Carte, A.E. Raindrop spectra in Pretoria. *S. Afr. geogr. J.,* vol. 53, 1971, pp. 100-103.

Carte, A.E. Hail studies in South Africa. *J. de Rech. Atmos.,* vol. V, 1971, pp. 107-110.

Fink, W. Multicolour spatial frequency analysis by optical multiplexing. *Opt. Commun.,* vol. 5, no. 1, 1972, pp. 20-22.

Fourie, J.T. The soft surface effect in plastic deformation and fatigue of metals and alloys. *Proceedings of International Conference on Corrosion Fatigue in metals and alloys.* Storrs, Conn., USA, 1971.

Halleck, P.M.*, Jamieson, J.C.* & Pistorius, C.W.F.T. $B_1 - B_2$ phase change of AgF at high pressure. *J. Physics Chem. Solids.,* vol. 33, 1972, pp. 769-773.

Jäger, H. & Butler, L.R.P. The glow discharge source applied to the analysis of gold. *XVI Colloquium Spectroscopicum Internationale,* vol. II, 1971, pp. 204-209.

Jäger, H. Spectrometric determination of the fineness of gold. *Anal. Chim. Acta,* vol. 60, 1972, pp. 303-308.

Kok, C.J. & Boshoff, M.C. New spectrophotometer and tristimulus mask colorimeter. *Applied Optics,* vol. 10, no. 12, 1971.

Kok, C.J. Absolute ratiometry and the unit of light. *S. Afr. Engr electr. Rev.,* vol. 63, no. 647, 1972, pp. 17-23.

Kruger, G.J. & Gafner, G. The crystal structures of polymorphs I and III of sulphathiazole. *Acta crystallogr.,* vol. B28, pp. 272-283.

Neirinckx, R.D. Extraction separation of carrier-free bismuth from lead and zinc. *Anal. Chim. Acta,* vol. 54, 1971, pp. 357-358.

Neirinckx, R.D. Separation of cyclotron-produced ^{109}Cd from the silver matrix, copper and zinc. *Anal. Chim. Acta,* vol. 58, 1972, pp. 237-238.

Norval, E. & Butler, L.R.P. Determination of lead in blood by atomic absorption with the high temperature graphite tube. *Anal. Chim. Acta,* vol. 58, 1972, pp. 47-56.

Pistorius, C.W.F.T. Solid-solid phase transformations of some groups of simple inorganic substances up to 60kb and the question of the predictability of phase diagrams. *Engineering Solids under Pressure,* Edited by L. Pugh, (British Institute of Mechanical Engineers, London), 1971, pp. 95-101.

Richter, P.W. & Pistorius, C.W.F.T. Effect of pressure on the phase relations of some n-paraffins. *Molecular Crystals and Liquid Crystals,* vol. 16, 1972, pp. 153-170.

Strasheim, A., Jackson, P.F.S., Coetzee, J.H.J., Strelow, F.W.E., Wybenga, F.T., Gricius, A.J., Kokot, M.L. & Scott, R.H. Analysis of lunar samples 14163, 14259, 14321 with isotopic data for $^{7}Li/^{6}Li$. *Proceedings of the 3rd Lunar Science Conference,* vol. II, 1972.

Turner, R. & Marais, W.M.P. The South African standard of voltage. *S. Afr. elect. Rev.,* vol. 62, no. 643, 1971, pp. 5-9.

Van Zijl, J.S.V. & Huyssen, R.M.J. Some aspects of seismic refraction investigations for water in arid zones of Southern Africa. *Trans. geol. Soc. S. Afr.,* vol. LXXXIV, 1971, pp. 33-43.

Vogel, J.C. & Beaumont, P.B.* Revised radiocarbon chronology for the Stone Age in South Africa. *Nature,* vol. 237, 1972, pp. 50-57.

Smith, H.J. *Trapping of metal ions injected into metals.* D.Sc. thesis, University of Pretoria, 1971.

Magnetic Observatory

Currie, R.G. A note on the geomagnetic spectrum. *J. geophys. Res.* (In press, Dec. 1972).

Rossouw, D.J. & van Wijk, A.M. *Hermanus neutron monitor data, 1971.* CSIR Report MAG D7, Hermanus, South Africa, CSIR, 1972, iii + 36 p.

Van Wijk, A.M. *Magnetic observations at Hermanus, 1971.* CSIR Report MAG A 20, Hermanus, South Africa, CSIR, 1972, x + 50 p.

* Members of other institutes or organizations.

National Research Institute for Mathematical Sciences

Fairweather, Graeme. *Galerkin methods for differential equations.* CSIR Special Report WISK 96, Pretoria, 1972, 121 p.

Gorringe, H.P. *Kinematic graphic displays using a computer in a multiprogramming environment.* CSIR Special Report WISK 95, Pretoria, 1972, 3 p.+ vii.

Greggor, K.N. An integrated computing system using relaxation adjustment methods. In: *Proceedings of the International Conference of Surveyors, (Federation Internationale des Geometres), Tel Aviv, May 1972,* pp. 151-195. (Published by Association of Licensed Surveyors in Israel).

Greggor, K.N. Current NC methods and programming techniques. Parts I and II (Lecture delivered at CSIR/SACAC Symposium on Numerical Control, Pretoria, November 1971.) *South African Engineer and Electrical Review,* vol. 63, nos. 644 and 645, Jan. and Feb. 1972, pp. 4-12 and 11-19.

Laubscher, Nico F. The South African multidisciplinary Venda study: a multivariate statistical analysis. In: *Human Biology of Environmental Change, Proceedings of a Conference held in Blantyre, Malawi - April 5-12, 1971,* D.J.M. Vorster, Editor, London, 1972, pp. 199-204.

Laubscher, N.F., Steffens, F.E. & Vrba, E.S. Statistical evaluation of the taxonomic status of a fossil member of the Bovidae (Artidactyla). *Annals of the Transvaal Museum,* vol. 28, no. 2, 31 Aug. 1972, pp. 17-26.

Louw, M.E.J., Du Plessis, J.P. & Laubscher, N.F. A biochemical evaluation of the nutrition status of rural and urban Pedi males. *South African Medical Journal,* vol. 46, no. 32, 12 August 1972, pp. 1139-1142.

Lück, H., Laubscher, N.F. & Andrew, M.J.A. Sample size determination for estimating the mean butterfat content of milk. *Milchwissenschaft,* vol. 27, no. 5, May 1972, pp. 286-290.

Meston, Sybil. *Periodicals with mathematical content in South African libraries.* CSIR Special Report WISK 93, Pretoria, Oct. 1971, 101 p. + xvi.

Szeptycki, P. *Equations of Euler and Navier-Stokes on compact Riemannian manifolds.* CSIR Special Report WISK 98, Pretoria, June 1972, 67 p.

Steffens, F.E. On confidence sets for the ratio of two normal means. *South African Statistical Journal,* vol. 5, no. 2, 1971, pp. 105-113.

Torr, D.G., Laurie, D.P. & Torr, Marsha R. *Algorithm for the solution of the general ionospheric reaction-rate equations.* CSIR Research Report no. 309, Pretoria, 1971, 4 p.

Wassermann, H.P., Muller, M.A.K. & Laubscher, N.F. Ethnic and sex differences in an interracial study of direct basophil counts. *South African Medical Journal,* vol. 46, no. 7, 12 Feb. 1972, pp. 143-145.

National Institute for Telecommunications Research

Gubbay, J.S., Legg, A.H., Robertson, D.S., Croske, N. & Nicolson, G.D. The structure of PKS 1934-63. *Astronomical Journal,* vol. 76, no. 10, Dec. 1971, pp. 965-969.

Gubbay, J.S., Legg, A.H., Robertson, D.S., Nicolson, G.D. & Moffet, A.T. Asymmetries in compact sources at 2298 MHz. *Nature Physical Science,* vol. 235, no. 60, February 21, 1972, pp. 147-149.

Nicolson, G.D. Radio sources similar to BL Lac. *Nature Physical Science,* vol. 233, no. 43, October 25, 1971, p. 155.

Torr, D.G. & Torr, M.R. Problems in explaining the behaviour of the F1 layer. *S. Afr. J. Antarctic Res.,* no. 2, 1972.

Torr, M.R. & Torr, D.G. Ionization enhancements in the post-midnight hours at some Antarctic stations and the diurnal excursion of the auroral oval. *S. Afr. J. Antarctic Res.,* no. 2, 1972.

Torr, M.R. & Torr, D.G. Night-time enhancements in the 6300Å line at Sanae and the relation to the movement of the auroral oval. *Annls Géophys,* vol. 27, no. 2, 1971, pp. 201-204.

Torr, D.G., Torr, M.R. & Laurie, D.P. Diurnal and seasonal model of the F1 layer at medium-high latitudes. *J. geophys. Res.,* vol. 77, no. 1, 1972, pp. 203-211.

Tritton, K.P. & Nicolson, G.D. A new identification for PKS 2204-54. *Astrophysical Letters.*

National Mechanical Engineering Research Institute

Denkhaus, H.G. The load deformation behaviour of rock in uniaxial compression. *20th Colloquium on Geomechanics.* Salzburg, September 1971.

Denkhaus, H.G. Who are we? — Some observations and thoughts on engineers and engineering. Presidential address SAIME. *S. Afr. mech. Engr.* vol. 22, no. 6, 1972, pp. 170-177.

Hodgson, T. Air velocity distribution in carcass-chilling rooms. *13th International Congress of Refrigeration,* Washington, August-September 1971.

Hodgson, T. Clean booth concept for operating theatres. *13th International Congress of Refrigeration,* Washington, August-September 1971.

Hodgson, T. The design of abattoir refrigeration systems. *Rhodesian Engineer,* vol. 10, paper no. 128, January 1972, pp. 3-7.

Hodgson, T., van Zwieten, P. Changing to SI units. *Heating Air Conditioning and Refrigeration,* vol. 4, January 1972, pp. 5-13.

Jordaan, J.M. Study of Durban harbour silting and beach erosion. *Proc. XIIth Coastal Engineering Conference,* Washington, September 1970.

Laubscher, B., Sauermann, H.B. Performance of hydro-lift feeder. *Proc. 2nd Hydrotransport Conference,* Coventry, September 1972.

Muller, J.L. Assessment of annoyance due to transient noise with particular reference to aircraft noise. *Journal of Sound and Vibration,* vol. 19, 1971, pp. 287-298.

Paul, G. Service failure investigations. *S. Afr. mech. Engr.,* October 1972.

Paul, G. The role of interfacial energies in the crystallisation of graphite in cast iron. *Jl. S. Afr. Inst. Min. Metall.* vol. 72, no. 6, January 1972, pp. 165-170.

Paul, G. The value of non-destructive testing in the foundry. *Non-destructive Testing Symposium of the South African Institution of Foundrymen,* 27th July, 1972. *F.W.P. Journal,* vol. XII, no. 9, September 1972, pp. 31-38.

Stacey, T.R. Three-dimensional finite element stress analysis applied to two problems in rock mechanics. *Jl. S. Afr. Inst. Min. Metall.,* vol. 72, no. 10, May 1972, pp. 251-256.

Van Niekerk, C.G. Aircraft anti-noise techniques. *Build International,* May/June 1972, pp. 141-144.

Zwamborn, J.A., Russell, K.S., Nicholson, J. Coastal engineering measurements. *Proc. XIIIth Conference on Coastal Engineering,* Vancouver, July 1972.

National Electrical Engineering Research Institute

Abrahams, J. Analogue computer for Laplace equations. *Transactions of the South African Institute of Electrical Engineers,* vol. 63, part 10, October 1972 (supplement), pp. 253-257.

Anderson, R.B. *The lightning discharge (Part 1).* Special Report ELEK 12, Pretoria, CSIR, October 1971, 70 + 44 p.

Bredenkamp, G.L. More data on display. Letter to the Editor, *Electronic Engineering,* vol. 44, no. 534, August 1972, p. 11.

Eriksson, A.J. Recent developments in the field of electrical insulation. In: *Proceedings of the Association of Municipal Electricity Undertakings of Southern Africa, Volume 1, Technical Meeting, 25 and 26 May 1972,* pp. 4-11.

Hill, D.G. Medical radio telemetry in South Africa. *Electronics and Instrumentation,* vol. 3, no. 3, June 1972, pp. 7-9.

Lutsch, A.G.K. The design of electronic circuits for biotelemetry. In: *Proceedings of a Symposium on Biotelemetry, 29 November - 2 December 1971,* Pretoria, CSIR, 1972, pp. 365-380.

Verster, T.C. The transistor as a temperature probe. *Electronics and Instrumentation,* vol. 3, no. 4, July 1972, pp. 9 & 11.

National Institute for Water Research

Cillié, G.G. The use of water in the iron and steel industry. *Founding, Welding, Production Engineering Journal,* January 1971, (CSIR Reprint RW 409).

Cillié, G.G. *The composting of urban refuse.* CSIR Technical Guide K19, Pretoria, CSIR, 1971, viii 29 p.

Chutter, F.M. An empirical biotic index of the quality of water in South African streams and rivers. *Water Research,* vol. 6, 1972, pp. 19-30. (CSIR Reprint RW 422).

Davies, T.R., du Toit, P.J. & Toerien, D.F. Selection patterns in a denitrifying population. *Water Research,* vol. 5, 1971, pp. 353-363. (CSIR Reprint RW 405).

Davies, T.R. & Toerien, D.F. Population description of a denitrifying microbial system. *Water Research,* vol. 5, 1971, pp. 553-564. (CSIR Reprint RW 406).

Drews, R.J.L.C., Malan, W.M., Meiring, P.G.J., & Moffat, B. The orbal extended aeration activated sludge plant. *Water Pollution Control Federation Journal,* vol. 44, no. 2, Feb. 1972, pp. 221-231. (CSIR Reprint RW 435).

Funke, J.W. & Henzen, M.R. Industrial effluent pollution control. *S A Chemical Processing,* Pt.I,vol. 4, no. 4, Aug.-Sept. 1969, pp. CP. 100-CP 103. Pt.II: vol. 4, no. 5, Oct./Nov. 1969, pp. CP 122-125. (CSIR Reprint RW 416).

Goldman, J.C., Porcella, D.B., Middlebrooks, E.J., & Toerien, D.F. The effect of carbon on algal growth — Its relationship to eutrophication. *Water Research,* vol. 6, June 1972, pp. 637-679. (CSIR Reprint RW 443).

Grabow, W.O.K. Transductional analysis of methionine genes in *Proteus mirabilis. Heredity,* vol. 28, Pt. I, Feb. 1972, pp. 129-139. (CSIR Reprint RW 433).

Henzen, M.R. *Mineral pollution: South Africa's greatest problem in water quality protection.* Paper delivered at a Convention on Water for the Future, Pretoria, 16-20 November 1970. (Republic of S A — Water Year 1970). (CSIR Reprint RW 414).

Kemp, P.H. Chemistry of natural waters I. Fundamental relationships. *Water Research,* vol. 5, 1971, pp. 297-311. (CSIR Reprint RW 402).

Kemp, P.H. Standardized water analysis and their application to river surveys in Natal. *Water Research,* vol. 5, 1971, pp. 291-295. (CSIR Reprint RW 403).

Kemp, P.H. Chemistry of natural waters II. Alkalinity. *Water Research,* vol. 5, 1971, pp. 413-420. (CSIR Reprint RW 404).

Kemp, P.H. Chemistry of natural waters III. Carbonic acid. *Water Research,* vol. 5, 1971, pp. 611-619. (CSIR Reprint RW 408).

Kemp, P.H. Chemistry of natural waters IV. Saturation pH value. *Water Research,* vol. 5, 1971, pp. 735-740. (CSIR Reprint RW 410).

Kemp, P.H. Chemistry of natural waters V. Hardness. *Water Research,* vol. 5, 1971, pp. 933-941. (CSIR Reprint RW 417).

Kemp, P.H. Chemistry of natural waters VI. Classification of waters. *Water Research,* vol. 5, 1971, pp. 943-956. (CSIR Reprint RW 418).

Odendaal, P.E. Sources of information on use of water by industry. *Power and Plant in Southern Africa,* Nov. 1971. (CSIR Reprint RW 419).

Pretorius, W.A. Anaerobic digestion of raw sewage. *Water Research,* vol. 5, 1971, pp. 681-687. (CSIR Reprint RW 411).

Pretorius, W.A. Some operational characteristics of a bacterial disc unit. *Water Research,* vol. 5, 1971, pp. 1141-1146. (CSIR Reprint RW 420).

Simpson, D.E. Investigations on a pilot-plant contact digester for the treatment of a dilute urban waste. *Water Research,* vol. 5, 1971, pp. 523-532. (CSIR Reprint RW 407).

Stander, G.J., Wiechers, S.G. & Dalton, G.L. Recent developments in water desalination. *South African Journal of Science,* vol. 67, no. 3, March 1971, pp. 86-100. (CSIR Reprint RW 398).

Chemical Engineering Research Group

Peters, D.L. & Nicole, F.J.L. Efficient programming for cost-optimized heat exchanger design. *Chem. Engr Lond.,* vol. 259, 1972, pp. 98-111.

Rouillard, E.E.A. *Determination of the particle content of flowing gases. An annotated bibliography.* CSIR Subject Survey O/CHEM 5, Pretoria, CSIR, 1972, pp. 1-119.

Scott, K.J. *Automatic thickener control.* CSIR Special Report CHEM 202, Pretoria, CSIR, 1972, pp. 1-37.

Scott, K.J. *The CSIR rotary powder sample divider.* CSIR Special Report CHEM 206, Pretoria, CSIR, 1972, pp. 1-14.

Skubnik, M. & Peters, D.L. *Rheology of non-Newtonian fluids; review with special reference to particle suspensions.* CSIR Review O/CHEM 6, Pretoria, CSIR, 1972, pp. 1-57.

Verbaan, B. *Flow and pressure distributions for turbulent flow through dividing and combining manifolds.* CSIR Special Report CHEM 193, Pretoria, CSIR, 1971, pp. 1-158.

National Food Research Institute and Microbiolgoy Research Group

Ballschmieter, H.M.B. Neben den Einfluss von Lagerung und Verpackung auf leichtflüchtige Verbindungen gerösteter Erdnüsse. *Die Ernährungsindustrie,* vol. 74, 1972, pp. 112-119.

Du Bruyn, D.B. Nephrocalcinosis in the white rat. Part II. The relationship between dietary magnesium, calcium and phosphorus content and kidney calcification and bone magnesium. *S. Afr. med. J.,* vol. 46, 1972, pp. 1588-1593.

Du Plessis, L.M. The fatty acid composition and tocopherol content of S.A. yellow margarines and butter. *Fd Inds S. Afr.*

Purchase, I.F.H., Steyn, M., Rinsma, R. & Tustin, R.C. Reduction of the aflatoxin M content of milk by processing. *Food & Cosmet. Toxicol.,* vol. 10, Pergamon Press, Printed in Great Britain, 1972, pp. 383-387.

Scott, D.B. & van der Walt, J.P. *Hansenula dryadoides* sp.n., a new species from South African insect sources. *Antonie van Leeuwenhoek,* vol. 37, 1971, pp. 171-175.

Scott, D.B. & van der Walt, J.P. *Pichia cicatricosa* sp.n., a new auxillary ambrosia fungus. *Antonie van Leeuwenhoek,* vol. 37, 1971, pp. 177-183.

Schweigart, F., Vlietstra, H. & van Twisk, P. The preparation and application of kaffir corn grits for Bantu beer brewing. *Fd Inds S. Afr.,* vol. 24, no. 11, March 1972, pp. 27, 29 & 33.

Torline, P. & Ballschmieter, H.M.B. The influence of lipids on flavour. *Fd Inds S. Afr.*

Torline, P. & Ballschmieter, H.M.B. Volatile constituents from guava. A comparison of extraction methods. *Food Science and Technology.*

Van der Walt, J.P. & Scott, D.B. *Pichia xylopsoci,* a new yeast from South African insect sources. *Mycopath. Mycol. appl.,* vol. 44, 1971, pp. 321-324.

Van der Walt, J.P., Scott, D.B. & van der Klift, W.C. Five new *Torulopsis* species from South African insect sources. *Antonie van Leeuwenhoek,* vol. 37, 1971, pp. 461-471.

Van der Walt, J.P., Scott, D.B. & van der Klift, W.C. Four new, related *Candida* species from South African insect sources. *Antonie van Leeuwenhoek,* vol. 37, 1971, pp. 449-460.

Van der Walt, J.P. The yeast genus *Ambrosiozyma* gen. nov. (Ascomycetes) *Mycopath. Mycol. appl.,* vol. 46, 1972, pp. 305-316.

Van der Walt, J.P., Scott, D.B. & van der Klift, W.C. Six new *Candida* species from South African insect sources. *Mycopath. Mycol. appl.,* vol. 47, 1972, pp. 221-236.

Van Niekerk, P.J. & Strydom, E.S.P. Preparation of cooked potatoes for vitamin C determination. *Joernaal van die Suid-Afrikaanse Chemiese Instituut.*

Van Niekerk, P.J. The direct determination of free tocopherols in plant oils by liquid-solid chromatography. *Analytical Biochemistry.*

Van Niekerk, P.J. Die tokoferolinhoud van plantaardige olies. *Fd Inds S. Afr.*

Van Twisk, P. Die gaarmaak van mieliemeel. *Mielienuus,* vol. 9, no. 6, November 1971, pp. 7-9.

Air Pollution Research Group

Halliday, E.C. & Venter, G.P.N. Discussions — a numerical experiment in simulating the transport of sulphur dioxide through the atmosphere. *Atmospheric Environment,* vol. 5, 1971, pp. 815-818.

Kemeny, E. & Halliday, E.C. Statistics on smoke and sulphur dioxide pollution in South Africa. *Public Health,* vol. 72, no. 2, 1972, p. 35.

Kemeny, E. & Halliday, E.C. The influence of yearly weather variations on smoke and sulphur dioxide pollution in Pretoria. *Arch. Met. Geophys. Bioklim.,* ser. B, vol. 20, 1972, pp. 49-78.

Kemeny, E. & Briggs, A.B. Die meting van rookmis met outomatiese versamelaar. *News Letter no. 276, South African Weather Bureau,* 1972, pp. 37-42.

Louw, C.W. & Richards, J.F. The determination of fluoride in sugar cane by using an ion-selective electrode. *The Analyst,* vol. 97, 1972, pp. 334-339.

Venter, G.P.N. & Halliday, E.C. & Prinsloo, L.A. The determination of the parameters in the Sutton equation for application on the Highveld of South Africa. *Atmospheric Environment,* 1972.

National Institute for Personnel Research

Baran, S. *A study of the relation between the dimensions of field-dependence and degree of acculturation with special reference to the Zulu.* Ph.D. thesis, University of the Witwatersrand, Johannesburg, 1971, 365 p.

Deppe, A.H. Performance criteria in diver training. *Percept. Mot. Skills,* vol. 32, 1971, p. 718.

Galitz, W.O. *Automation: 1952-1971.* Annotated bibliography submitted to NIPR Library, 1971, 3 files.

Hall, S.K.P. *Motivation among a rural and an urban employed group of adult Pedi males.* PERS. 154, Johannesburg, CSIR, NIPR, 1971, 51 p.

Hall, S.K.P. *A comparative study of labour stability and productivity among male employees at a border and an urban textile factory. Submitted to the Industrial Development Corporation.* Confidential Report, C/PERS, 198, Johannesburg, CSIR, NIPR, 1972, 135 p.

Humphriss, D. & Wortley, W. Two studies of visual acuity. A. An attempt at the accurate measurement of visual acuity of illiterates and an evaluation of accepted norms. B. Study of acuity of vision of South African Whites, Bantu and Bushmen. *Psychol. Afr.,* vol. 14, no. 1, 1971, pp. 1-19.

Kendall, I.M. *The organization of mental abilities of a Pedi group in cultural transition.* PERS. 156, Johannesburg, CSIR, NIPR, 1971, 167 p.

Lessing, B.C. *The development of training programmes for first-line supervisors. Submitted to Siemens S.A. (Pty) Ltd.* Confidential Report, PERS. 146, Johannesburg, CSIR, NIPR, 1971, 11 p.

Lessing, B.C. *et al. Productivity of Bantu labour: Operational survey conducted at Orange-Fish Tunnel (inlet section) — General findings. Submitted to Batignolles-Cogefar-African Batignolles.* Confidential Report, C/PERS. 199 (a), Johannesburg, CSIR, NIPR, 1972, 42 p.

Liddicoat, R. & Griesel, R.D. A scale for the measurement of African urban infant development: Preliminary report. *Psychol. Afr.,* vol. 14, no. 1, 1971, pp. 65-75.

Poortinga, Y.H. *Cross-cultural comparison of maximum performance tests: Some methodological aspects and some experiments with simple auditory and visual stimuli.* Doctor of Social Sciences thesis. Amsterdam, De Vrije Universiteit, 1971, 100 p. and *Psychol. Afr. Monogr. Suppl.* no. 6, 1971, 100 p.

Retief, T., Krige, H.L. & Gouws, J.S. The development and validation of a programmed course in mathematics. *Psychol. Afr.,* vol. 14, no. 1, 1971, pp. 45-64.

Reuning, H. Observations on conceptual reasoning at early stages of literacy, pp. 182-189. In: *Science Education in Africa,* P.G.S. Gilbert and M.N. Lovegrove, Editors. London, Fakenham and Reading, Cox and Wyman, 1972.

Schmidt, H.E. *Creativity in student architects.* Ph.D. thesis, University of the Witwatersrand, Johannesburg, December, 1971, 232 + p.

Schmidt, H.E. The relationship between anxiety, creativity and academic success in student teachers. *Psychol. Afr.* vol. 14, no. 2, 1972, pp. 130-136.

Steyn, D.W. & Hall, R.S. A description of the test battery for computer programmers. *South African Computer Bulletin,* vol. 12, 1971, pp. 14-17.

Taylor, T.R. *Personality and behavioural correlates of field-dependence/independence. Literature survey and evaluation.* PERS. 145, Johannesburg, CSIR, NIPR, 1971, 46 p.

Templer, A.J. A study of the relationship between anxiety and extraversion-introversion. *Psychol. Afr.,* vol. 14, no. 1, 1971, pp. 20-31.

Trethewey, N.D. & Lessing, B.C. *Productivity of Bantu labour: Operational survey conducted at Orange-Fish Tunnel (inlet section) — Personnel Management findings. Submitted to Batignolles-Cogefar-African Batignolles.* Confidential report. C/PERS. 199 (b), Johannesburg, CSIR, NIPR, 1972, 29 p.

Van der Nest, M.D. *Die menslike faktor in padveiligheid. Fisiologiese en psigologiese eienskappe van swaarvoertuigbestuurders. Submitted to NIRR, CSIR.* Confidential Report. PERS. 160, Johannesburg, SACSIR, NIPR, 1972, 72 p.

Vorster, D.J.M. Taxonomies and criteria for curriculum evaluation pp. 167-181. In: *Science Education in Africa*, P.G.S. Gilbert and N.M. Lovegrove, Editors, London, Fakenham and Reading, Cox and Wyman, 1972.

National Institute for Road Research

Basson, J.E.B., Dehlen, G.L., Phillips, R.G. & Wyatt, P.J. The measurement of traffic axle load distributions for pavement design purposes. In: *Proceedings of the 3rd International Conference on the Structural Design of Asphalt Pavements,* vol. 1, London, Sept. 1972, pp. 17-26.

Brown, R.F. *The identification and improvement of accident black spots.* CSIR Technical Manual K21, Pretoria, CSIR, 1972, 48 p.

Burton, R.W. & Walker, R.N. *A method of dealing with the uncertainties involved in the consideration of various alternatives in the provision of asphalt overlays.* Paper presented to 50th Municipal Engineering Conference, Port Elizabeth, 24-28 April 1972.

Cillié, F.P. *Road statistics 1971. Padstatistiek.* CSIR Special Report PAD 26, Pretoria, CSIR, 1972.

Curtayne, P.C. & Walker, R.N. A fresh look at the interpretation of pavement serviceability and an experiment to measure the riding quality of roads in South Africa. In: *Proceedings of the 3rd International Conference on the Structural Design of Asphalt Pavements,* vol. 1, London, Sept. 1972, pp. 776-785.

Freeme, C.R. & Marais, C.P. The structural behaviour of bituminous surfacings in an experimental asphalt pavement. In: *Proceedings of the 3rd International Conference on the Structural Design of Asphalt Pavements,* vol. 1, London, Sept. 1972, pp. 812-822.

Grant, M.C. The development of overlay design procedures based on the application of elastic theory. In: *Proceedings of the 3rd International Conference on the Structural Design of Asphalt Pavements,* vol. 1, London, Sept. 1972, pp. 1155-1166.

Kühn, S.H. *Quality control in highway construction.* CSIR Research Report No. 294 (NIRR Bulletin 11), Pretoria, CSIR, 1972.

Kühn, S.H., Walker, R.N. and Savage, P.F. Rational quality assurance. *Highway Research Record No. 385,* Washington, D.C., Highway Research Board, 1972, pp. 36-51.

National Institute for Road Research. *Annual Report 1971.* CSIR Special Report, PAD 25, Pretoria, CSIR, 1972.

Van Vuuren, D.J. Pavement performance in the S12 road experiment; an AASHO satelite test road in South Africa. In: *Proceedings of the 3rd International Conference on the Structural Design of Asphalt Pavements,* vol. 1, London, Sept. 1972, pp. 938-945.

Williamson, R.H. Effects of environment on pavement temperatures. In: *Proceedings of the 3rd International Conference on the Structural Design of Asphalt Pavements,* vol. 1, London, Sept. 1972, pp. 144-160.

Wium, D.J.W. *Code of practice: Traffic control during research operations on public roads.* CSIR Technical Manual K20, Pretoria, CSIR, 1972, 12 p.

Wium, D.J.W. *First aid for accident spots. Eerstehulp vir gevaarplekke op paaie.* CSIR Special Report, PAD 24, Pretoria, CSIR, 1972, 11 p.

National Building Research Institute

Ahrens, H.W. Plastics in building. *Plan,* vol. 57, no. 6, June 1972, pp. 33-35.

Blight, G.E. & Brackley, I.J. The stability of hillside dumps of anthracite duff. *Civ. Engr. S. Afr.,* vol. 13, no. 2, Sept. 1972, pp. 307-312.

Chinnery, D.N.W. *Keeping high-rise buildings dry.* CSIR Special Report BOU 20, Pretoria, CSIR, 1971, 35 p.

Chinnery, D.N.W. Causes and effects of moisture movement in buildings. *Construction in Southern Africa,* vol. 17, no. 2, May 1972, pp. 72, 77, 79, 81.

Crabtree, P.R. *Sewer measurement and design criteria.* Paper presented at Seminar for CIB Commission Meeting, London, September 1972.

Crabtree, P.R. Kitchen food waste disposers and the sewerage system. *Municipal Engineer,* vol. 3, no. 1, Jan./Feb. 1972, pp. 5-11.

Dobson, D.E. The fire risk of parking garages. *Build International,* vol. 5, no. 6, Sept./Oct. 1972.

Dobson, D.E. Timber housing and building regulations: the approach in developing and developed countries. *Municipal Administration and Engineering,* April 1972, pp. 23-31.

Evenwel, J.K. *Modern building methods.* CSIR Special Report BOU 25, Pretoria, CSIR, 1971, 183 p.

Frank, D., Low, C, & Vorster, O.C. *Investigations into the painting of wire-brushed steel.* CSIR Research Report 301, Pretoria, CSIR, 1971, 35 p.

Frank, D., Low, C. & Vorster, O.C. *Investigations into coatings for timber in South West Africa.* CSIR Research Report 304, Pretoria, CSIR, 1971, 28 p.

Frank, D., Low, C. & Vorster, O.C. *Investigations into coatings for structural metal in South West Africa.* CSIR Research Report 308, Pretoria, CSIR, 1971, 20 p.

Krüger, J.E. & van Rensburg, J.J.J. *Influence of variation in moisture content on dimensional change characteristics of mortar made with a sand coated with organic matter.* CSIR Research Report 313, Pretoria, CSIR, 1972, 9 p.

Loubser, P.J. & Bryden, J.G. An apparatus for determining the thermal expansion of rocks, mortars and concretes. *Mag. Concr. Res.* vol. 24, no. 72, June 1972, pp. 97-100.

Low, C. Painting problems in the building industry. *South African Builder,* vol. 52, no. 6, June 1972, p. 29.

Meyer, D.E. *Performance of gypsum plasterboard as a drywall material.* CSIR Research Report 299, Pretoria, CSIR, 1971, 20 p.

National Building Research Institute. *Film loan service: catalogue and guide.* CSIR Technical Manual K22, Pretoria, CSIR, 1972, 21 p.

Scott, T.W. Technological considerations in a new approach to Non-White housing. *Proceedings of Annual Council Meeting, South African Institute for Race Relations,* Jan. 1972.

Stevenson, A. Educational change – architectural consequence. In: *Proceedings of Symposium on Automation in Education,* University of the Witwatersrand, Johannesburg, Sept. 1972.

Stubbs, R.E. & Putterill, K.E. *Expansion of brickwork.* CSIR Research Report 259, Pretoria, CSIR, 1972.

Van Deventer, E.N. *Climatic and other design data for evaluating heating and cooling requirements of buildings.* CSIR Research Report 300, Pretoria, CSIR, 1972, 136 p.

Van Deventer, E.N. Computation of solar angles for sunlight and shade design of buildings. *Build International,* vol. 5, no. 5, Aug. 1972.

Van Deventer, E.N., Dold, T.B. & Wessels, J. *Diffuse solar radiation on vertical surfaces.* CSIR Research Report 303, Pretoria, CSIR, 1971, 11 p.

Van Dijk, J. Die bepaling van die kubusdruksterkte van beton na 28 dae op 'n ouderdom van 24 uur. *Civ. Engr. S. Afr.* vol. 13, no. 10, Oct. 1971, pp. 349-353.

Webb, T.L. Housing in South Africa today. *Supplement to the Standard Bank Review,* Sept. 1972, pp. 3-15.

Timber Research Unit

Bosman, D.L. *The management of research and development for the achievement and application of results.* Paper presented at the Second Annual Symposium of the Crop Science Society of Rhodesia, Salisbury, June 1971, 5 p.

Bosman, D.L. *Research for the sawmilling industry.* Paper presented at the Timber Industry Symposium organized by Mobil Oil Southern Africa Ltd, Sabie River Bungalows, 27 October 1971, 9 p.

Bryant, P.A.V. *Some uses and abuses of timber in structures.* Talk presented to the Symposium on Timber Engineering organized by the S A Lumber Millers' Association, Pietermaritzburg, 17 June 1971, 10 p.

Bryant, P.A.V. Arthur Hallett Memorial Lecture No. 29, *Timber Engineering,* to the Institution of Certificated Mechanical and Electrical Engineers, Johannesburg, October 1971.

Gonin, C.R. *The utilization of sugar-cane bagasse in the pulp and paper industry.* CSIR Subject Survey O/HOUT 15, Pretoria, CSIR, April 1972.

Scharfetter, H. *The effect of contamination of the gluing of wood.* CSIR Special Report HOUT 37, Pretoria, CSIR, November 1971, 36 p.

Van Vuuren, M.J.C. *Cost accounting and cost control in the South African sawmilling industry.* CSIR Special Report HOUT 45, Pretoria, CSIR, April 1972.

Venter, J.S.M. and Scharfetter, H. *The pitch problem in pulping and papermaking.* CSIR Subject Survey O/HOUT 14, Pretoria, CSIR, May 1971, 36 p.

South African Wool Textile Research Institute

Aldrich, De V. & Kruger, P.J. *The influence of gill-feed on the percentage noil and fibre breakage in the rectilinear combing of wool.* S. Afr. Wool Text. Res. Inst. Techn. Rep., no. 168, June 1972.

Buys, J.G., Wolfaardt, C. & Hunter, L. *The influence of various machine settings on the knitting performance of all-wool yarn in the Punto-di-Roma structure.* S. Afr. Wool Text. Res. Inst. Techn. Rep., no. 179, Nov. 1972.

Hanekom, E.C., Shiloh, Miriam & Slinger, R.I. *The effect of some durable press treatments on the properties of wool/cotton and cotton fabrics.* S. Afr. Wool Text. Res. Inst., Techn. Rep., no. 173, Sept. 1972.

Jamison, E.R. *The extraction of wool grease from raw wool scouring liquors with solvents, Pt. I : Laborabory-scale investigations.* S. Afr. Wool Text. Res. Inst. Techn. Rep., no. 165, April 1972.

Jamison, E.R. *The extraction of wool grease from raw wool scouring liquors with solvents, Pt. 2 : Pilot Plant Work.* S. Afr. Wool Text. Res. Inst. Techn. Rep., no. 175, Sept. 1972.

Kruger, P.J. & Aldrich, De V. Fibre breakage in rectilinear combing. *Applied Polymer Symposium* no. 18, 1971, pp. 1375-1388.

Robie, G.J., Slinger, R. & Veldsman, D.P. Objective evaluation of the South African mohair clip: Part 1 : Summer clip. *SAWTRI Bulletin,* vol. 6, no. 3, Sept. 1972.

Shiloh, Miriam, Kruger, P.J. & Slinger, R.I. *Properties of some fabrics from wool/nylon core spun yarns.* S. Afr. Wool Text. Res. Inst. Techn. Report, no. 176, Sept. 1972.

Smuts, S. & Slinger, R.I. *The influence of fibre friction on the handle of wool and mohair.* S. Afr. Wool Text. Res. Inst. Techn. Rep., no. 163, March 1972.

Van der Merwe, J.P. & Silver, H.M. *The finishing of wool-rich double jersey fabrics containing nylon filament.* S. Afr. Wool Text. Res. Inst. Techn. Rep., no. 174, Sept. 1972.

Van Rensburg, N.J.J. *A durable flame-retardant treatment for cotton fabrics.* S. Afr. Wool Text. Res. Inst. Techn. Rep., no. 183, Dec. 1972.

Van Rensburg, N.J.J. *The bleaching of cotton with emulsions of hydrogen peroxide in a perchlorethylene medium.* S. Afr. Wool Text. Res. Inst. Techn. Rep., no. 172, Aug. 1972.

Van Rensburg, N.J.J. *The reductive bleaching of wool.* S. Afr. Wool Text. Res. Inst. Techn. Rep., no. 162, March 1972.

Weideman, E. *The critical surface tension of chlorinated wool.* S. Afr. Wool Text. Res. Inst. Techn. Rep., no. 178, Oct. 1972.

Wolfaardt, C. Comments on the plating technique in double jersey fabric manufacture. *SAWTRI Bulletin,* vol. 6, no. 2, June 1972, p. 16.

Leather Industries Research Institute

Cooper, D.R., Russell, A.E. & Hart, G.J. The effects of glycols on the renaturation of soluble collagen. *Biochemical Journal,* vol. 125, 1971, p. 1069.

Du Preez, I.C., Rowan, A.C., Roux, D.G. & Feeney, J. Hindered rotation about the sp^2-sp^3 hybridized C-C bond between flavanoid units in condensed tannins. *Chemical Communications,* 1971, p. 315.

Ferreira, D., Hundt, H.K.L. & Roux, D.G. The stereochemistry of a tetraflavanoid condensed tannin from *Rhus lancea L.F. Chemical Communications,* 1971, p. 1257.

Haigh, J.M., Slabbert, N.P. & Thornton, D.A. Adducts of nickel (II) acetylacetonate with substituted anilines and pyridines. *J. molec. Struct.,* vol. 7, 1971, p. 199.

Hart, G.J., Russell, A.E. & Cooper, D.R. The effect of certain glycols, substituted glycols and related organic solvents on the thermal stability of soluble collagen. *Biochemical Journal,* vol. 125, 1971, p. 599.

Johnston, J.B. & Williams-Wynn, D.A. The Liritan semi-rapid sole leather tannage. *J. Soc. Leath. Trades Chem.,* vol. 55, 1971, p. 192.

Russell, A.E. & Cooper, D.R. Comparison of lyotropic and chromatographic effects of polar organic solvents on collagen and cellulose. *Biochemistry,* vol. 10, 1971, p. 3890.

Saayman, H.M. & Shuttleworth, S.G. Wattle bark aids oil search. *Scientific Progress,* vol. 4, no. 3, July 1971, p. 4.

Williams-Wynn, D.A. Adaptation of the Liritan no-effluent sole leather tanning process to the production of strap, harness and belting leather. *J. Soc. Leath. Trades Chem.,* vol. 55, 1971, p. 188.

Williams-Wynn, D.A. & Pickering, R.C. The effect of easy-care finishes on the properties of leather. *J. Soc. Leath. Trades Chem.,* vol. 8, 1971, p. 263.

Woods, D.R., Welton, R.L. & Cooper, D.R. The microbiology of curing and tanning processes. Part V. Anaerobic studies on halophobic and halophilic bacteria from cured hides. *J. Am. Leath. Chem. Ass.,* vol. 66, 1971, p. 496.

Fishing Industry Research Institute

Nachenius, R.J. *Interim report on variations in nitrogen content of Walvis Bay harbour water.* FIRI Progress Report no. 142, Cape Town, FIRI, 1972.

Nachenius, R.J. *Effluent clarification.* FIRI Memorandum, no. 207, Cape Town, FIRI, 1972.

Nachenius, R.J. *FIRI Research Review.* FIRI Memorandum no. 209, Cape Town, FIRI, 1972.

Nachenius, R.J. & Rowan, A.N. *Standards for fish factory effluent.* FIRI Memorandum no. 210, Cape Town, FIRI, 1972.

Nachenius, R.J. & Spark, A.A. *Non-uniformity of ethoxyquin dosage.* FIRI Memorandum no. 211, Cape Town, 1972.

Spark, A.A. *The effect of iron as a contaminant in commercial alum on UV sterilisation of sea water after flocculation.* FIRI Progress Report no. 143, Cape Town, FIRI, 1972.

Wessels, J.P.H. *The use of fish oil in yellow margarine.* FIRI Memorandum no. 208, Cape Town, FIRI, 1972.

Sugar Milling Research Institute

Allan, G.N. & Fitzgerald, J.R. Air pollution control for bagasse fired boilers. In: *Proc. S. Afr. Sug. Technol. Ass.,* 1972, pp. 79-91.

Bruijn, J. & Vanis, M. The determination of nitrogen free organic acids in Natal cane molasses. In: *Proc. S. Afr. Sug. Technol. Ass.,* 1972, pp. 64-67.

Bruijn, J., Fitzgerald, J.R., Koenig, S. & MacGillivray, A.W. Exhaustion of South African final molasses. In: *Proc. S. Afr. Sug. Technol. Ass.,* 1972, pp. 103-109.

Kemp, P.H. & Cox, S.M.H. Pollution and pollution abatement in the Natal sugar Industry. In: *Proc. 14th Congress I.S.S.C.T.,* 1971, pp. 1517-1528.

Lamusse, J.P. Forty-seventh annual review of the milling season in Southern Africa, 1971/1972. In: *Proc. S. Afr. Sug. Technol. Assoc.,* 1972, pp. 1-20.

Matic, M. Starch determination in raw sugar by colorimetric methods. In: *Proc. 14th Congress I.S.S.C.T.,* 1971, pp. 1434-1443.

Murray, J.P. Filtering quality of raw sugar: influence of starch and insoluble suspended matter. In: *Proc. S. Afr. Sug. Technol. Ass.,* 1972, pp. 116-132.

Simpson, D.E., Hemens, J. & Cox, S.M.H. Aerobic treatment of sugar mill effluent with the addition of nutrients. In: *Proc. S. Afr. Sug. Technol. Assoc.,* 1972, pp. 40-53.

South African Paint Research Institute

Evans, D.W.S. & Wheeler, E. The isolation and identification of bacteria from water-based materials. *S. Afr. Paint Res. Inst. Bull.,* no. 21, Durban, Aug. 1972, 10 p.

Lacy, P.D.A. Viscosity measurements in the paint industry and their interconversion (Part 1), *S. Afr. Paint Res. Inst. Bull.,* no. 19, Durban, May 1972, 20 p.

Milner, A.M. Amine-induced yellowing of white alkyd enamel. *S. Afr. Paint Res. Inst., Laboratory report* no. 1, Durban, Aug. 1972, 3 p.

Milner, A.M. & Hopper, C.E. Measurement of the adhesion of coatings to substrates. A literature survey, *S. Afr. Paint Res. Inst. Bull.,* no. 20, Durban, May 1972, 23 p.

S. Afr. Paint Res. Inst. Literature digest, vol. 23, no. 1, Durban, 1972, 26 p.

S. Afr. Paint Res. Inst. Literature digest, vol. 23, no. 2, Durban, 1972, 19 p.

Subject index

ORGANIZATION OF THE CSIR