

Dr. S.M. Naude,  
President,  
W.N.N.R.,  
SCIENTIA.



# ANNUAL REPORT 1968

P.O. Box 395  
PRETORIA  
1st June, 1969

*Sir,*

*I have pleasure in presenting to you the Twenty-fourth Annual Report of the Council for Scientific and Industrial Research. This Report covers the period 1st January, 1968 to 31st December, 1968.*

*Balance sheets and statements of income and expenditure for the financial year ended 31st March, 1968, certified by the Controller and Auditor-General, are included.*

*Yours faithfully,*

S. M. NAUDÉ

*President: Council for  
Scientific and Industrial Research*

Dr. the Hon. Carel de Wet, M.P.  
Minister of Planning  
Private Bag 9034  
CAPE TOWN

*Copies of this report (in English and Afrikaans) can be obtained from*

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# CSIR 1968

## TWENTY-FOURTH ANNUAL REPORT



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**COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH**

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*MIDDLE (left to right): Prof. C. A. du Toit, Prof. of Zoology, University of Stellenbosch; Dr A. J. A. Roux, Chairman, AEB; Mr J. D. Roberts, Chairman, Murray and Roberts Holdings Ltd.; Dr J. N. van Niekerk, Head Basic Research Division, Research Department, Iscor; Prof. E. T. Woodburn, Head, Department of Chemical Engineering, University of Natal; Mr G. C. V. Graham, Managing Director, Fine Wool Products of S A Ltd., Uitenhage; Dr B. Gaigher, Member of the Board of Trade and Industries; Chairman, Standards Council; Chairman, Fuel Research Institute of South Africa.*

*BACK (left to right): Mr J. H. Visagie, Secretary/Treasurer, CSIR; Dr N. Stutterheim, Deputy President, CSIR; Dr C. v. d. M. Brink, Vice-President, CSIR; Dr F. J. Hewitt, Vice-President, CSIR.*

# EXECUTIVE OF THE CSIR

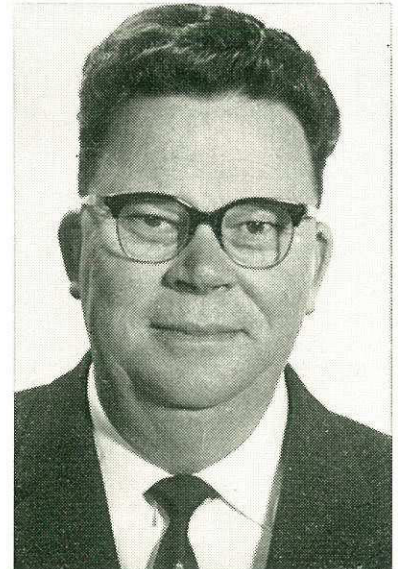
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President



Dr N. Stutterheim,  
Deputy President



Dr F. J. Hewitt, Vice-President



Prof. C. v. d. M. Brink, Vice-President

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# INTRODUCTION

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In this review of the activities of the CSIR for 1968, the emphasis again falls on research in the national interest. This has included the investigation of various problems affecting the State as a whole, industry and the community in general, such as the environmental factors of air and water pollution, public health, nutrition, housing, etc., as well as the utilization of manpower.

One of the most noteworthy aspects of research on environmental factors has been the progress made with the purification of sewage to supplement water supplies, as evidenced by the successful water reclamation project at Windhoek.

More than one institute of the CSIR is actively engaged in work to control marine and coastal pollution, a problem which is becoming ever more acute. The commissioning in 1968 of its own research vessel, the "Meiring Naudé" has provided the CSIR with an essential facility for this work and for oceanographic research generally.

Work is also continuing on problems of air pollution. The degree of air pollution is being measured in various centres, while steps are being taken to control air pollution at its source.

The results of years of research on the planning of housing for the aged were made available during the year in the form of a comprehensive guide. This work has followed the research into low-cost housing and school and hospital design, in which the CSIR has made important contributions.

In the field of public health and nutrition, the CSIR's research on nutritional deficiency diseases, such as kwashiorkor, is well known. Attention is also being given to the increasing incidence of cardio-vascular diseases and a significant development of the past year has been the acquisition of additional facilities for research into its possible relation to diet. With a generous grant from a large South African insurance company, a centre for primates to be used as experimental animals, has been established at the National Nutrition Research Institute. This centre was officially opened by the Minister of Health in August 1968.

One of the highlights of 1968 was the establishment of a National Training Centre for Scientific Instrument Makers at the CSIR. The official opening of this Centre by the Minister of Planning coincided with a visit to the CSIR by leading industrialists. With the establishment of this Centre the training of



highly skilled scientific instrument makers, started by the CSIR as far back as 1950 to meet its own needs, has been placed on a national basis. As the CSIR itself will absorb only some 20 per cent of the trained technicians, the rest will become available to industry and other research organizations. The CSIR is also concerned with the training of electronics technicians and textile technologists in collaboration with the appropriate educational authorities, while it has compiled programmed courses of instruction in mathematics for the National Technical Examinations.

Although every endeavour is made to recruit and train suitable technical staff locally, the CSIR (like many other organizations) is still forced to seek staff overseas to meet its urgent manpower requirements. An important development has been the placing of a qualified testing officer in the office of the South African Scientific Counsellor in Cologne, for the purpose of applying the full testing procedure of the CSIR to candidates recruited in Europe.

The overseas offices continue to provide a valuable service, not only to the CSIR but also to the other South African research organizations and the universities. Besides interviewing technical personnel interested in employment in South Africa, these offices play an important part in acquiring scientific and technical information through personal contact. The fourth of these offices, located in Paris, was opened at the beginning of the year and is now fully operational.

The CSIR, fully aware of the value of direct contact for keeping informed on local requirements, has made provision for regional representation in various centres in the Republic and in South West Africa by establishing regional research committees and regional offices and laboratories. During 1968 a regional office for the Cape Midlands was opened in Port Elizabeth, while a regional office for the National Building Research Institute was established in Durban in addition to the CSIR Natal Regional Office which has been operating there for some years.

Knowledge of the requirements and pattern of research on a national basis is essential to the planning authorities. In order to provide the necessary data for this purpose, the CSIR has for some years been carrying out surveys to identify the research needs of specific sectors of the national economy and to determine the extent of research expenditure in both the public and private sectors. During the year, analysis of the data obtained from the survey of research expenditure was completed, and this will provide the first complete information on expenditure on research and development for South Africa as a whole.

The material in this report is arranged according to the various institutes, laboratories or other organizational units of the CSIR. The activities on behalf of specific economic sectors (and in other fields of application) can be traced by consulting the subject index at the back of the report.

Dr T. L. Webb,  
Director of the  
National Building  
Research Institute

## THE NATIONAL BUILDING RESEARCH INSTITUTE



**I**N South Africa about R900 million is spent annually on building and construction (excluding roads), and the chief objectives of the National Building Research Institute (NBRI) are to serve the industry and the professions behind this multi-million-rand investment. The NBRI is in essence a practical, applied-research organization, maintaining close contact with the building and construction industries and with related professions and organizations. Its research is directed towards improving building design and services, structural and foundation engineering, lighting, ventilation and heating and cooling in buildings. Another aspect of the work is aimed at improving the performance of building materials such as concrete, stone, paint and plastics, and at research which will bring about a better understanding of the effects of climate and weather on both building materials and the environment within a building. Special service is rendered to the community by research on the planning of schools, hospitals and housing for all population groups. Investigations are also carried out in the broad fields of management, organization and industrialization in the building industry. The NBRI earns between a quarter and a third of its income by undertaking contract work for sponsors. Research findings are actively applied by means of publications, lectures and central and regional information activities.

The links between the NBRI and the building industry and professions were further strengthened during the year. A few of the noteworthy events and developments will be mentioned here to highlight the value and importance of this policy.

Financial sponsorship by the private sector for both research and related activities has increased considerably. Substantial grants-in-aid have been made by both private and public bodies towards research in the fields of building ceramics, housing and building statistics, documentation, sewers, planning requirements for audio-visual aids in educational institutions, and also towards the costs of running the

Institute's three Regional Offices at Cape Town, Durban and Windhoek. Special mention must be made of the generous financial support given by the National Development Fund for the Building Industry, inaugurated by the Building Industries Federation (SA).

A most important event during the year was the establishment by the Government of the Building and Construction Advisory Council, which falls under the Minister of Public Works and to which the Director of the NBRI was appointed as a member of the Council and of its Executive Committee. This event brought to fruition the work by the Institute's Building Research Advisory Committee in pursuing ways and means of implementing the resolution, made by the Building Research Congress in 1964, that such a council be established. This Council is already giving energetic attention to several matters of far-reaching importance to building and construction throughout the country, and the Institute is providing what assistance it can to help the Council in its work. Thus, for instance, the Institute is closely associated with the work of the Council's sub-committees which are dealing with metrication, modular co-ordination, and the organization of a formal procedure for the evaluation of new forms of construction. The last project arose as a result of the proposals made in 1967 by the Institute's Building Research Advisory Committee for the establishment of such an evaluation procedure on a nationally recognized basis — proposals that were passed through the CSIR to the Government.

A successful symposium on plastic flooring, which was arranged in collaboration with the Cape Town Master Builders' Association and the Cape Provincial Institute of Architects, was held in Cape Town. The NBRI conference on aspects of research, materials and management, which was held during the 1968 South African Building Exhibition in Johannesburg, was also very well attended. In addition, the Institute's staff participated in 18 other South African conferences and symposia and presented over twenty papers at these meetings. Members of staff also gave formal lectures and addresses at many meetings at the request of various organizations.

Preparations for the Second South African Building Research Congress to be held in Johannesburg from 5th to 8th May, 1969, are well in hand. It is being organized by the Institute, with guidance from a sub-committee of the Building Research Advisory Committee.

A handbook on South African natural building stone was published in March 1968 in both official languages. This is a publication which has evoked high praise from many sources; it was prepared and published in collaboration with the National Development Fund for the Building Industry and the Stone Mason's and

Quarry Owners' Association. A Special Award of Merit was presented to the NBRI by the Fund in recognition of the Institute's contribution to this work.

Work was carried out on just under 150 contract investigations, which is about 20 more than for the previous year; most of these were requested by the private sector.

Because of the very successful work carried out through the NBRI Regional Offices in Cape Town and Windhoek, and to meet the growing demand from many persons and organizations for similar services in Natal, a third Regional Office was opened in Durban in August, 1968. A regional sub-committee of the Building Research Advisory Committee was formed to guide the work and to advise on problems of local importance which require research. This committee meets every quarter in Durban.

Although a considerable amount of staff time is taken up by activities in connection with committee meetings, such activities are nevertheless very important for the purpose of keeping close contact with the professions and industry, of disseminating information and providing assistance. During the past year staff participated in the work of nearly 100 committees which serve the interests of different facets of the building and construction industry.

Following on the success of the Institute's first educational film, three others on sewer corrosion, heaving soils, and solar radiation in relation to building design were completed during the year. A heavy demand for the loan of copies of these films has been received from all parts of the country.

Because of the growth in the number of staff of the Materials Division and in the variety of its work over the past five years, it has become necessary to split that division into two — an Inorganic Materials Division and an Organic Materials Division. Also, because of the growing importance of and demand for work in the fields of building statistics, economics, management, organization and industrialization, it was decided to remove these activities from the Building Research Application Division and to form a new division called the Methods and Applied Economics Division to handle them.

#### **Communications in the building industry**

Considerable attention has been paid in recent years to the flow of information during the building process. In a building project there is a continuous two-way flow of data between client, design team and builder and it is now realized that greater efficiency in building is in many ways dependent on how problems of communication can be overcome.

In the case of builders, data from the design team are usually conveyed through the medium

of documents, i.e. drawings, specifications and bills of quantities. Numerous builders, however, have complained that data essential for specific operations on site are not always made available; in particular, it has been felt that the bill of quantities could be made a much more useful document in this respect. The NBRI was asked to investigate this particular aspect of communication, and a detailed report on the feasibility of "annotated" bills of quantities as a means of disseminating information was prepared as a result.

#### **Housing requirements**

The building industry has for years been experiencing a shortage of meaningful, reliable and timely statistics. The lack of such statistics will hamper the future development of the building industry and inhibit the process of planning which is so important in all spheres of economic endeavour.

There has recently been much speculation concerning housing requirements in South Africa which has unfortunately led to a considerable amount of confusion. Because of this situation, the building industry requested the NBRI to analyse available data in order to obtain additional information on current and expected housing requirements as far as the White population group was concerned. The availability of funds and the changing pattern of family incomes were also taken into account.

The findings of this investigation have confirmed the need for suitable statistics in the field of housing, and suggested improvements have now been brought to the notice of the appropriate authorities. In South Africa, in contrast with many other countries, the provision of housing (Whites) is largely the responsibility of the people themselves. It is therefore important to differentiate between the need for housing, in terms of minimum acceptable stan-

dards, and the potential and active demand for housing which is directly influenced by the cost of building, land and money. A significant factor in the future will be an increased demand for independent dwelling units for the non-family sector of the population.

#### **Hospital planning**

An investigation was carried out on behalf of the Transvaal Provincial Administration to determine the future provincial hospital building requirements in the Pretoria metropolitan area for the next 20 to 30 years. The present and possible future population distribution, as well as the various categories of patients, doctors and nurses were considered in terms of a geographical sub-division into "sectors of accessibility". The methodology of this investigation is applicable to similar town-planning problems in other cities.

#### **Special schools**

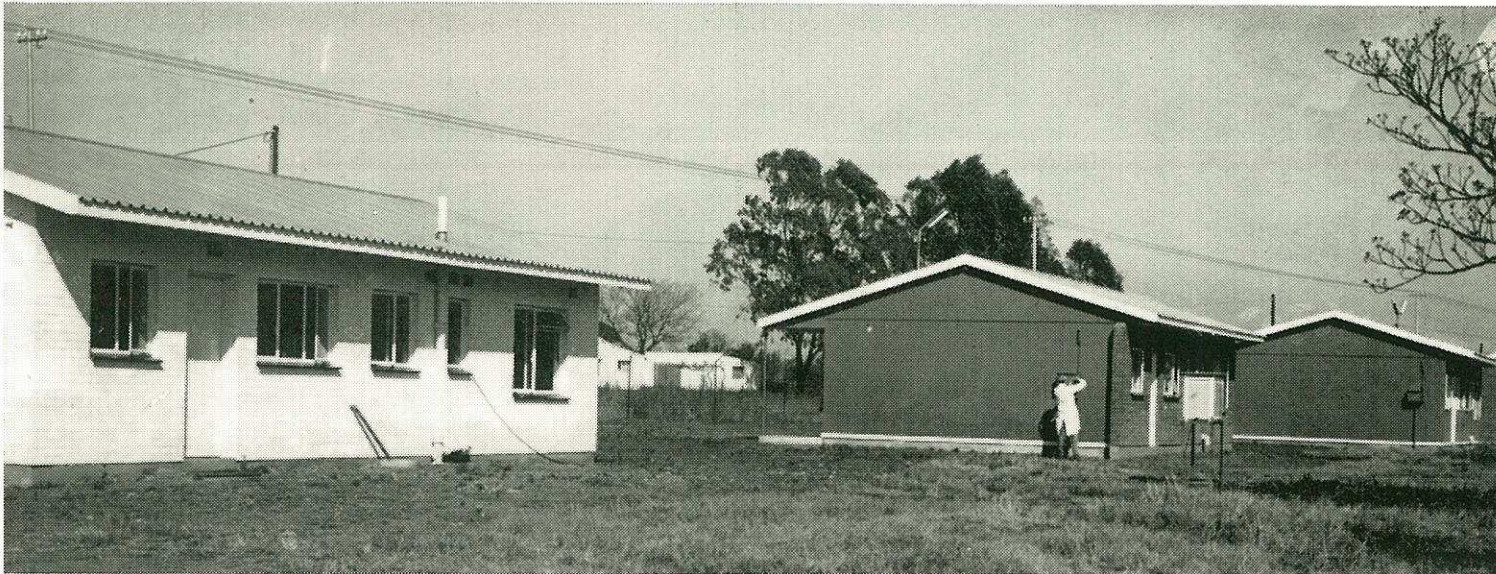
A study on the design of special school buildings for handicapped children was also completed. This deals with the problems encountered in the education of physically handicapped children, those with cerebral palsy, the deaf, hard of hearing, blind, partially sighted and mentally retarded children. The resultant publication is intended to furnish an insight into the nature of these disabilities and their implications in terms of the design requirements of special school buildings.

#### **Housing for aged people**

A comprehensive guide to special housing for aged people has been published. This represents the summation of research carried out by the NBRI over a period of eight years. The design approach to special housing for aged people is made in terms of three categories of accommodation, related to the resident's physical abilities and needs, in a housing group of limited size. Accommodation requirements for the different



An example of the routine series of photographs taken at the sky vault to record the nature and extent of clouds



Light-weight industrialized houses used for thermal performance studies

categories are given in detail, and matters concerned with the physical indoor environment, engineering services and furniture are dealt with.

#### Daylighting design and sun control

Much research has been done to provide design principles and data for the natural lighting of buildings, but the fact that most of this work relates to overcast sky conditions remains a basic shortcoming for daylighting design in sunny climates where overcast conditions are fairly rare. Finding a more suitable basis for design requires a systematic investigation of the outdoor illumination conditions and sky brightness distribution for a variety of sky conditions, and such measurements are now being made on a continuous basis at the NBRI.

Daylighting of buildings is always coupled with the danger that the uncontrolled penetration of sunlight and solar heat can lead to uncomfortable glare and thermal conditions indoors. Although several aids are already available for the design and planning of buildings for sun control, their application is often time-consuming. It was consequently decided to prepare and release the basic information necessary for this in tabular form. With the aid of nomograms, coupled to the tabulated data, the design procedure is relatively simple.

#### Thermal behaviour of light-weight houses

At the request of the Department of Community Development comprehensive research is being done in order to find methods to improve the thermal conditions in light-weight industrialized forms of house construction. Although sufficient thermal insulation is essential, it is on its own not enough to prevent big daily variations in indoor temperatures. Heavy components such as brick and concrete, for example, are necessary for storing some heat.

Preliminary measurements taken in several full-scale light-weight houses indicate that the thermal behaviour of such houses can be improved considerably by the application of one or more of the following procedures:

- using solid concrete floors with some sort of tile finish instead of ventilated wooden floors
- ensuring that all the windows face north or south
- using heavy-weight inside walls
- using a heavy-weight exterior cladding such as a 4½ in. brick veneer.



Burn-out test in progress on a light-weight form of house construction

#### **Fire research**

The behaviour in fire of the various combinations of materials and components met with in non-traditional constructions is being investigated. Valuable information on the likely behaviour of building components in their actual position in a house is being obtained from these investigations.

#### **Moisture movement under buildings**

The behaviour of foundation soils under buildings is greatly influenced by the moisture content of the soil. Some soils tend to lose their strength rapidly with increase in moisture content, while other soils swell and shrink with changes in moisture content. The moisture content in the soil is influenced by a number of factors such as climate, surface vegetation, surface drainage, internal drainage or permeability, depth to water-table, and the availability of water from sources like water furrows or leaking pipes. The activities of man in building structures or roads alters conditions to a large extent and thus the soil moisture content is altered. It is therefore important to know how the various factors influence the soil moisture regime.

Initially the effects of various surface covers and treatments were studied at a test site near Onderstepoort, Pretoria. In order to study the effects of different climatic conditions, the Republic and South West Africa have been divided into 20 different climatic zones, in each of which an experimental site will be instrumented for studying moisture conditions. The instru-

mentation of experimental sites has been completed at Leeuhof, Vereeniging, in the highveld zone, at Mariental in South West Africa in an arid semi-desert zone, and at Magoebaskloof in a high rainfall area.

#### **Stresses in anchor piles**

One of the most effective ways of countering the effects of expansive soil is to carry the building clear of the ground on anchor piles. In this foundation system the piles are anchored in stable soil below the layer which is expanding and they have to be designed to withstand the uplift forces which will be transferred to them by the swelling soil. A theory for calculating the uplift forces was developed in 1954 as a result of a study on the failure of an anchor pile. While this approach has been used, most practising engineers have felt that the uplift forces were being exaggerated. Various attempts to measure the actual stresses developed in an anchor pile failed because it was not possible to find reliable instrumentation which would remain serviceable after burial in a pile for several years.

In 1964 a measuring core for inclusion in an anchor pile was designed and built at the NBRI. This core was designed to withstand the uplift force on a 9in. diameter pile as calculated by the existing theory. In 1966 the core was installed in an anchor pile at Vereeniging. Later the soil around the pile was flooded to accelerate swelling and the development of uplift forces was recorded. The uplift force exceeded the design force and the instrumentation failed at

that stage. The experiment proved that the uplift forces are indeed as large as those predicted and also proved that the measuring system was reliable. Further tests can now be conducted to investigate the effectiveness of different treatments for reducing the magnitude of the uplift forces.

#### **In situ soil testing procedures**

Possibly the greatest problem confronting the designer of foundations or any other structure affected by the strength of soil is the determination of that strength. One of the major difficulties in laboratory determinations, however, lies in obtaining truly undisturbed samples which can be said to represent the state of the soil *in situ*. Correlations of shear strengths developed during actual failures and shear strengths measured in the laboratory have therefore been unsatisfactory. This Institute has therefore made considerable use of the *in situ* vane shear apparatus for determining the *in situ* shear strengths of a number of materials such as rolled earth fill, hydraulically placed gold mine slimes, hydraulically placed ash, dumped gypsum waste and natural soils. These results are being compared with those obtained in laboratory tests.

In order to meet the need for a simple, effective and portable apparatus for determining the bearing capacity of sandy soils, a light penetrometer attachment for a cross-country vehicle was also developed and built. This apparatus was used to carry out a survey of foundation conditions in the town of Walvis Bay. Where the soil strength exceeded the range of the apparatus, the conventional deep-sounding apparatus was used. This latter apparatus was also used to investigate the foundations for a new radio tower at Pelican Point.

Another *in situ* technique is the use of deep drilled-in loading plates for studying the settlement of granular materials. Such tests were used for the second time in South Africa at the site of the new station for Durban.

#### **Brick veneer house construction**

Brick veneer construction is comparatively new to South Africa. The general principles for building houses by this method were investigated by studying literature on relevant aspects of overseas construction methods, and observing current local practice. This form of construction is likely to play an increasingly important role in the future, for it enjoys the accepted good appearance and low maintenance qualities of conventional brick buildings — and in these respects it will have an advantage over other forms of light-weight construction. A publication on brick veneer construction for South African conditions has been produced.

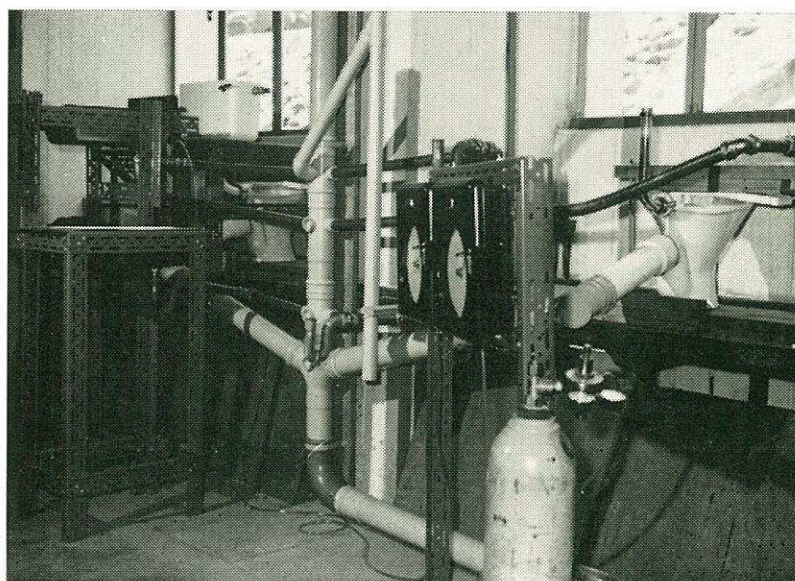
#### **Fired clay products in industrialized building**

An investigation into fired clay products in industrialized building is being sponsored by the South African Brick Association. A study was completed of overseas systems that included a study tour in France under the auspices of the French Association for Technical Co-operation, visits to various factories and building sites in other European countries and attendance at an international conference on masonry structural systems in Texas. A development programme for manufacturing full-scale brick walls by mechanized methods has been started.

#### **Plumbing research**

In Great Britain, sanitary plumbing installations have been simplified and economies have been effected by the use of the "single-stack" system of plumbing. Benefits in terms of savings of cost and, perhaps more important, of valuable duct space in multi-storey buildings, could possibly be obtained by the use of this system in South Africa. However, the system is not permitted everywhere in South Africa and the Institute has therefore investigated its suitability for use in this country. To this end studies of the frequency of use of various sanitary appliances have been undertaken and, with the support of the Department of Community Development, a trial installation was

Test rig for single-stack plumbing



constructed in a seventeen storey building erected by the Department. Information on the practical performance of the system was also obtained during an overseas study tour.

As a result of these investigations the Institute is satisfied that this system could be used with advantage in South Africa, and has suggested to major local authorities that they should consider amending their by-laws to permit the "single-stack system".

#### Ceramic products

Owing to their exceptional durability, ceramic products are still finding many uses in the building industry. A considerable amount of research has been done during the past few years on the rapid firing of ceramic products, on the development of glazes and of light-weight ceramic building units. Two methods have been developed to colour bricks, viz. colouring by means of heavy metal salt solutions and by means of sinter engobes. These methods ought to be especially valuable in those regions of this country where the clays are not suitable for the production of face bricks but where the fired bricks otherwise comply with face brick quality. Investigations have also been carried out on approximately forty commercially available raw materials of South African origin including kaolin, bentonite, silica and feldspars, which are used mainly in the building industry but also in the glass industry. The properties of each raw material have been set out in individual data sheets which will serve as reference works for use in the ceramic industry.

#### Cement and cement products

In the field of hydraulic cement, the mechanism of attack on cements by sulphates such as those found in sulphate-bearing soil and water is being investigated, and a paper on the work was delivered at an international symposium on cement chemistry held in Japan. Closely related to this research is that done on sewer corrosion. These investigations have

yielded valuable information on the behaviour of concrete pipes lined with synthetic resin and other types of linings. Work is being continued on the hydration of South African blast-furnace slags which contain a high proportion of magnesium oxide, and some of the hydration products have been identified.

#### Concrete

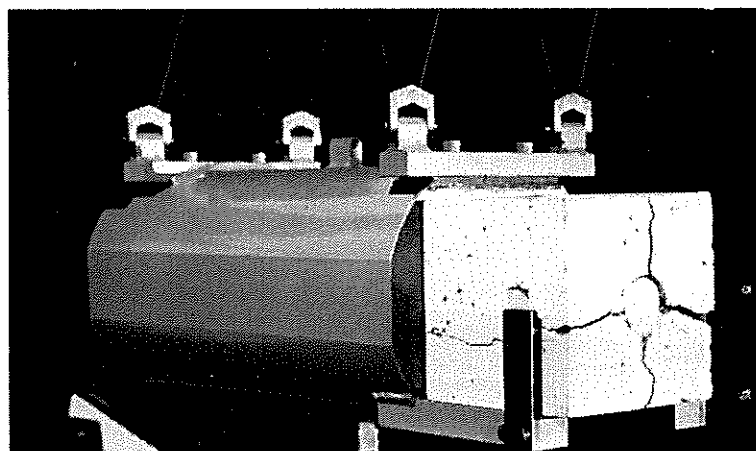
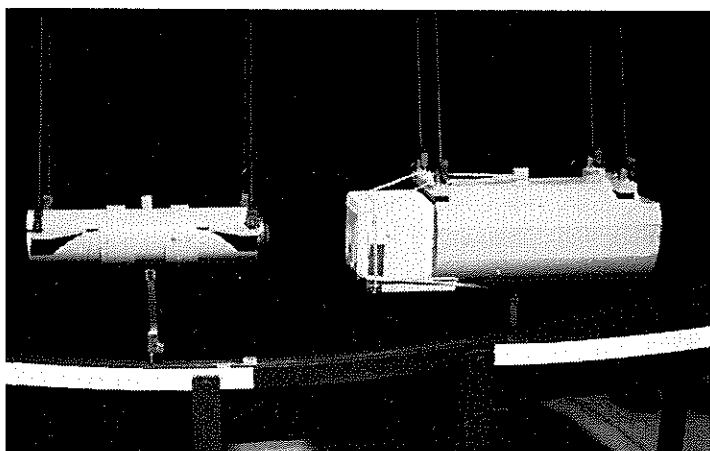
Curing concrete at high temperatures continues to be used increasingly as the tendency towards prefabrication in the construction industry becomes more widespread. This method of curing increases the rate at which the concrete gains strength, so that pre-cast products can be produced at an increased rate.

Although the factors involved in high temperature curing which influence the strength of concrete are now well understood, the influence of the same factors on other properties of concrete, such as permeability and impact resistance, are not yet fully understood. An investigation by the NBRI into the effects of high temperature curing on impact resistance was therefore carried out, and it has been shown that impact resistance is not impaired by suitable forms of high temperature curing.

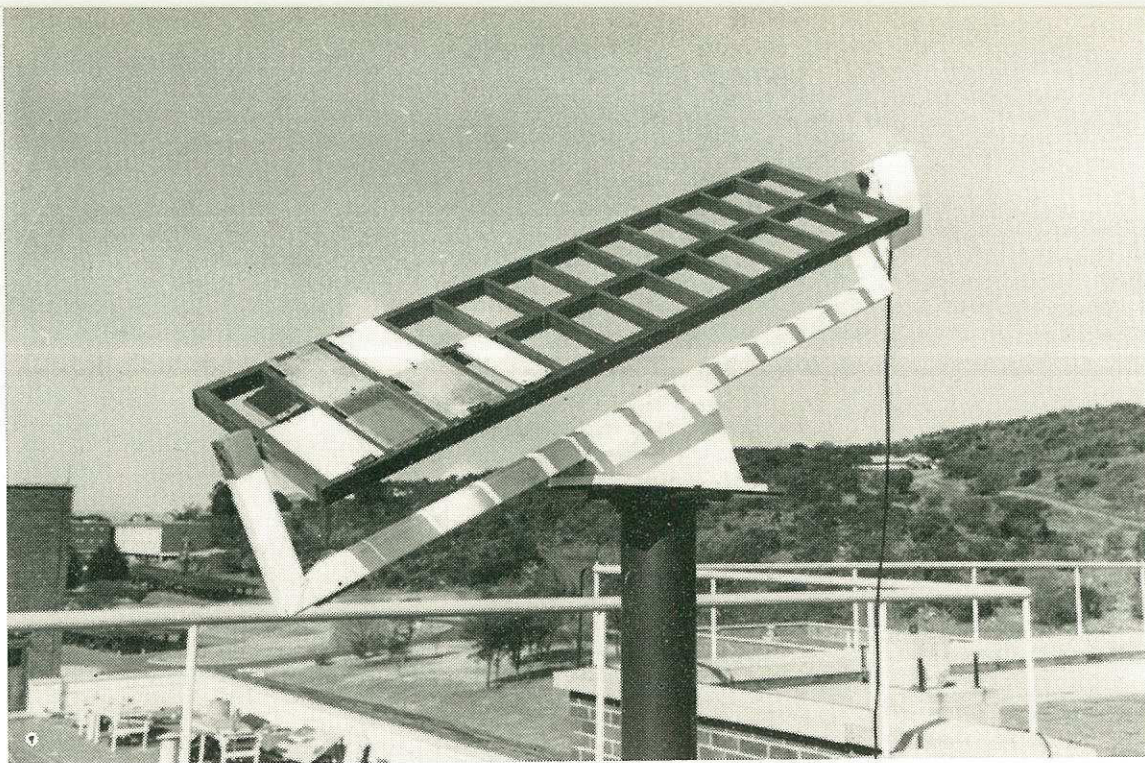
A section dealing with high temperature curing has been contributed by the NBRI to a new edition of *Concrete Technology: A South African Handbook* by Dr F. S. Fulton.

Research has also been initiated to investigate a variety of stones of different origins in order to determine their suitability as concrete aggregate. A considerable amount of information has already been gained in respect of the dimensional stability and durability of concrete made from such aggregate. This work is of particular interest to regions such as Ovamboland, where no recognized type of aggregate is found over an extensive area.

Impact testing of a concrete cube







Rotating exposure rack that presents the full face of samples to the sun throughout the day

#### Plastics and paints

The interrelated fields of plastics, elastomers and paints, and their use in building, are becoming increasingly important since these materials often possess properties that make them particularly suited to modern building techniques. The ease with which plastic components can be manufactured to high standards of finish, their relatively light weight and freedom from corrosion, recommend these materials for use by the building industry. However, their weathering characteristics and physical properties are not always adequate under South African conditions.

Investigations have therefore been conducted with a variety of organic flooring materials to test their durability and resistance to different kinds of traffic. Where failures have been reported, the reasons for such failures have been sought and remedial measures suggested if possible.

Exposure tests on a large variety of plastic and elastomeric roofing materials, waterproofing sheets and plumbing items have been continued at exposure sites in Durban, Cape Town, Windhoek, Walvis Bay, Johannesburg and Pretoria. A sun-following exposure rack has been constructed and is used for special exposure tests, while the relative effects of different directions of exposure are being examined by means of pyramidal racks on which identical samples are exposed to the north, east, south and west.

In the field of paint and coatings, investigations include studies on anti-corrosion coatings for metals, clear and pigmented coatings for timber and also for cementitious substrates. A major investigation that is approaching completion concerns coatings for the protection of cold-rolled steel sheet against corrosion in marine environments. A similar project on hot-rolled structural steel is well under way and should produce valuable information in the near future. It has already been found that, for both these base materials, the application of two or more layers of epoxy tar coating over sand or grit blasted steel provides effective protection against corrosion.

On the basis of work done in the Institute it is now possible to suggest, for most kinds of timber, a painting system that will withstand the ravages of the South African climate for from 5 to 7 years. Investigation of the clear coating of timber has, however, merely confirmed overseas experience that clear varnishes do not last for more than two years in exposed situations. Problems associated with the re-coating of varnished timber make the use of clear or lightly pigmented water repellent stains more acceptable as an alternative to varnishes.

Determination of the degree of degradation of the plastic or paint, identification of the degradation products and elucidation of the mechanism of degradation form an integral part of all these investigations. Considerable attention is therefore being paid to the development

of suitable analytical techniques. At present infra-red spectrophotometry and gas chromatography constitute the major analytical tools, and considerable success has been achieved in the identification of such materials on the basis of their infra-red absorption spectra.

#### International activities

Participation in the activities of a number of working groups of the International Council for Building Research, Studies and Documentation (CIB) and the International Commission on Illumination (CIE) that are concerned with active research in specific fields has continued and considerable benefit is being derived from our participation. During the year the Institute became a member of two more organizations open to international membership — the International Council for Advancement of Audio-Visual Education and the American Society for Testing Materials — while membership of 15 other such organizations has been maintained.

The Director of the Institute attended the 4th Triennial Congress of the CIB held in Ottawa and Washington in October, 1968, and was elected a member of the CIB Executive for the next three-year period. He has also been elected

to the Council of the International Confederation of Thermal Analysis for the period 1968-71.

Three others members of staff attended the following meetings overseas as specially invited guests: the 4th International Hospital Symposium held in West Berlin; the Engineering Research Conference on Expansive Soil held at Beaver Dam, USA; and the symposium on Urban Climates and Building Climatology, organized by the World Meteorological Organization and the World Health Organization and held in Brussels. Members of staff also attended the following conferences at which they presented papers or other contributions: the Building Science Research Symposium on Daylight and Sunlight in Buildings, held in Adelaide, Australia; and the 5th International Symposium on the Chemistry of Cement held in Tokyo.

Two chapters on building materials and one on carbonates were completed for an international book on differential thermal analysis which is to be published in the United Kingdom, and several NBRI reports were translated into foreign languages by overseas organizations so that they could distribute printed copies of the translated versions within their own countries.

## Selected Publications

BLIGHT, G. E. A note on field vane testing of silty soils. *Canadian Geotechnical Journal*, vol. V, no. 3, Aug. 1968, pp. 142-149.

CHINNERY, D. N. W. *Solar water heating in South Africa*. CSIR Research Report 248 (NBRI Bulletin 44), Pretoria, CSIR, 1967, 79p.

COOKE, B. V. and FAIRBAIRN, D. G. *The hospital laundry and linen service* (Hospital Design 8). CSIR Research Report 258 (NBRI Bulletin 49), Pretoria, CSIR, 1968, 16p.

COWAN, D. The development of space and building standards in hospitals. *Dt. Bauz*, vol. 10, October 1968, pp. 1678-1680.

CRABTREE, P. R. *The development of modern joints for sewers*. Paper presented at the 1968 Conference of the Institution of Municipal Engineers of Southern Africa, Cape Town, 1968, 14p.

CROMARTY, R. E. *Plastic floors and some problems involved in their use*. Paper presented at the Symposium on Plastic Floors, Durban, Nov. 1967. Arranged by the NBRI under the auspices of the Durban Master Builders and Allied Trades Association and the Natal Provincial Institute of Architects.

DE VOS, T. J., EVENWEL, J. K. and MINERS, J. K. *Preliminary report on some aspects of mechanization in the building industry in South Africa*. CSIR Research Report 265 (NBRI Bulletin 52), Pretoria, CSIR, 1968, 72p.

DOBSON, D. E. *Building regulations: A review of the position in some western countries*. CSIR Research Report 269 (NBRI Bulletin 54), Pretoria, CSIR, 1968, 163p.

DOBSON, D. E. and DANNENFELDT, H. T. H. Fire research aspects of building regulations. *S. Afr. archit. J.*, vol. 53, no. 11, Nov. 1968, pp. 25-29.

- FAIRBAIRN, D. G. Architectural research on the planning of buildings. *Public Works, Roads and Transport*, May 1968, 3p.
- LUNT, B. G. *Civil defence planning and the structural engineer*. Paper presented at the 1968 Convention of the South African Institution of Civil Engineering, July 1968.
- MINERS, T. W. *The client and management in the building industry*. Paper presented at the 1968 Building Exhibition Conference, Johannesburg, August 1968.
- MORRIS, J. *Outlook on materials*. Paper presented at the 1968 S.A. Building Exhibition Conference, Johannesburg, August 1968.
- NATIONAL BUILDING RESEARCH INSTITUTE. *A guide to special housing for aged people*. CSIR Research Report 245 (NBRI Bulletin 43), Pretoria, CSIR, 1967, 54p.
- NATIONAL BUILDING RESEARCH INSTITUTE. *List of NBRI publications*. CSIR Bibliography A 7, Pretoria, CSIR, 1968, 40p.
- NIX, M. J. *Properties and selection of plastic flooring materials*. Paper presented at the Symposium on Plastic Floors, Durban, Nov. 1967. Arranged by the NBRI under the auspices of the Durban Master Builders and Allied Trades Association and the Natal Provincial Institute of Architects.
- RENNHACKKAMP, W. M. H. The lighting of buildings. (With discussions). *Certifd. Engr.*, vol. 41, no. 6, June 1968, pp. 179-88.
- RICHARDS, S. J. Sunlight and buildings. *S. Afr. archit. J.*, vol. 52, no. 12, Dec. 1967, pp. 19-23.
- RICHARDS, S. J. *Technical information for the building industry*. Symposium on Scientific and Technical Information, Lourenço Marques, June 1968.
- RICHARDS, S. J. Research for the building and construction industry. *Public Works, Roads and Transport*. Oct. 1968, 6p.
- ROUNTREE, H. V., Improving the climate for industry. *Interbuild/Arena*, Nov. 1967, pp. 19-22.
- SCOTT, T. W. and FAIRBAIRN, D. G. *Brick veneer construction*. CSIR Research Report 255 (NBRI Bulletin 48), Pretoria, CSIR, 1968, 12p.
- TAUBER, K. A. G. and SCHMIDT, E. R. *Electrical potential measurements in research on clays*. *Nature, Lond.*, vol. 218, no. 5136, April 6, 1968, p.105.
- VAN DEVENTER, E. N. *Tables and alignment charts for sunlight and shade design of buildings*. CSIR Research Report 262 (NBRI Bulletin 51). Pretoria, CSIR, 1968, p.301.
- VAN STRAATEN, J. F. *Ventilasiëbeginsels by die ontwerp van plaasgeboue*. Paper presented to the S.A. Institute of Agricultural Engineers, Pretoria, August 1968, 16p.
- WEBB, T. L. Building research in South Africa. *The South African Bankers' Journal*, vol. 64, no. 4, November 1967, pp. 408-18.

# THE NATIONAL CHEMICAL RESEARCH LABORATORY



Dr P. C. Carman, Director  
of the National Chemical  
Research Laboratory

**T**HE 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 NCRL is organized into divisions of organic chemistry, biochemistry and physical chemistry, the last-named including physical chemistry proper as well as inorganic and analytical chemistry. The NCRL also supervises a chemical engineering group.

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, the vast majority of research projects is carried out in collaboration with other research organizations which are directly concerned with the practical problems involved.

## Bantu Beer

Production by municipalities has once again shown a remarkable increase of 14 per cent, the latest available figures for 1966/67 being 140 million gallons. Research expenditure is now R114,000 per annum, paid for *in toto* by a levy on Bantu beer sales.

The Bantu Beer Unit has now added a modification test to specifications for malt, and municipalities are beginning to put it into practice. At the same time, it has shown that a souring quality test now widely employed is useless and even deleterious and its abandonment has now been advocated. The souring process, for lactic acid production, is a very important and complicated part of Bantu beer production. In the past year, the Unit has not only carried out a great deal of fundamental work on this, but has also sent a chemical engineering team to a large brewery to assist in developing practical control methods in full-scale manufacture.

## Corrosion

The South African Navy has now appointed its own corrosion engineers who work in close co-operation with the CSIR and use its facilities.

A member of the Corrosion Group delivered a paper at a National Association of Corrosion Engineers Conference at Cleveland, USA. A significant feature of the Conference was the interest taken in the Group's research on the corrosion of reinforcing steel in concrete. Using

work done in South Africa as a basis, it was possible to draw attention to the drawbacks of using galvanized reinforcing in marine environments.

Assistance has also been rendered outside the Republic's borders, for example, in tests performed on a prestressed concrete pipeline carrying water supplies for Lourenço Marques, in investigations into corrosion in turbines in Swaziland and in connection with several enquiries from Rhodesia.

#### **Wool chemistry**

A research group seconded from SAWTRI is carrying out fundamental studies in the NCRL on the chemical structure of the wool fibre. This work is being co-ordinated with a much more extensive investigation along similar lines in Australia, where one member of our group recently spent a year to gain experience; another member is shortly to make a similar visit. The small South African group has just made a remarkable step forward in its development of an advanced technique for separating a pure fraction of wool protein and determining its amino-acid sequence.

#### **Pharmacology**

A major project undertaken by the Organic Chemistry Division comprises the study and synthesis of substances of pharmacological importance. From experience gained with alkaloids of South African plants, a synthesis is being made of modified alkaloids, which should have improved properties. Research on steroidal compounds found in the cucumber family has shown that certain of these can be used as starting materials in the synthesis of hormones. The chemical work in this field is being carried out in conjunction with work on the cultivation of the more promising species of cucumber by the Department of Agricultural Technical Services. Certain of the foregoing compounds, together with other active substances found in South African plants, are being tested for anti-tumour activity, in collaboration with the National Cancer Institute of the National Institutes of Health, USA. Arising from the programme, a new project specifically aimed at synthesizing anti-tumour substances is being started.

#### **Mycotoxins**

Toxic substances produced by fungi commonly found on foodstuffs have been widely recognized as a source of fatal sickness in livestock, and are also potentially dangerous to human beings. The team of microbiologists and chemists working on these mycotoxins in the CSIR has achieved a world-wide reputation for its achievements in isolating a number of new toxins and determining their structure. Recently, not only has the group determined the structure of one of these and synthesized it in the laboratory, but it has also been able to show how it is synthesized by the organism. A paper on this

biosynthesis of cyclopiazonic acid was presented to the IUPAC Symposium on Natural Products in London during July 1968.

#### **Bilharzia**

As a contribution to the campaign against bilharzia, work is being carried out on a new type of molluscicide, particularly to find out how it kills snails. By using radio-active tracers, it has been found that this molluscicide is rapidly accumulated in the gills and kidneys of snails and, at the time of death, can constitute up to 40 times its original concentration in water. This is an active process, since no such accumulation takes place if dead snails are placed in the solution.

#### **Liquid ion exchangers**

The use of these exchangers in solvent extraction processes in the field of extractive metallurgy is becoming of increasing importance; for example, it is now a primary method for uranium extraction and can well replace existing processes in gold and platinum metal extraction. Research into new types of exchanger is being carried on in collaboration with the National Institute of Metallurgy.

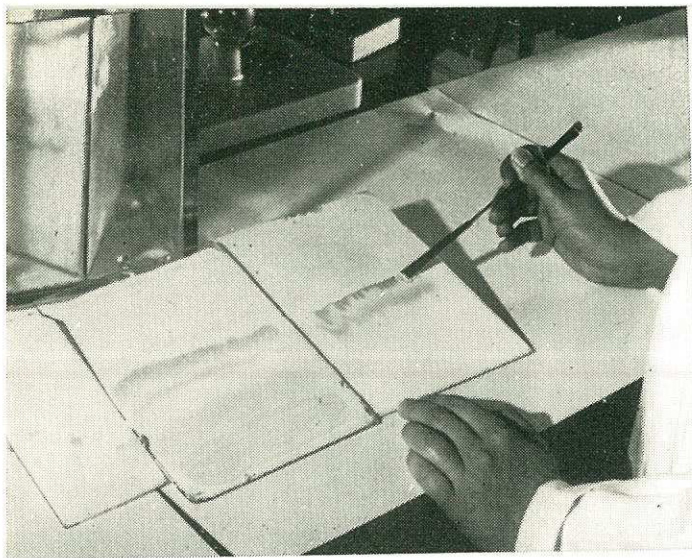
#### **Ruminant digestion**

A collaborative research group set up by the NCRL and the Veterinary Research Institute at Onderstepoort has been in operation for many years and is now recognized as one of the leading groups in this field. A project which has been the subject of a long and careful study is the effect of low quality feeds, such as teff hay, on sheep. It had previously been shown that, apart from protein deficiency, the low protein content of such hay encouraged a poor type of cellulose-digesting bacteria to develop in the rumen, and that the bacterial population changed to a better type if a protein supplement such as egg albumen was added. This is expensive, however, and the usual practice for making up a nitrogen deficiency is to add relatively cheap urea and biuret. It has now been found that this is effective only to a limited degree, but that, if a further supplement of volatile fatty acids is added to a teff hay diet, a good bacterial population is produced and the sheep thrive.

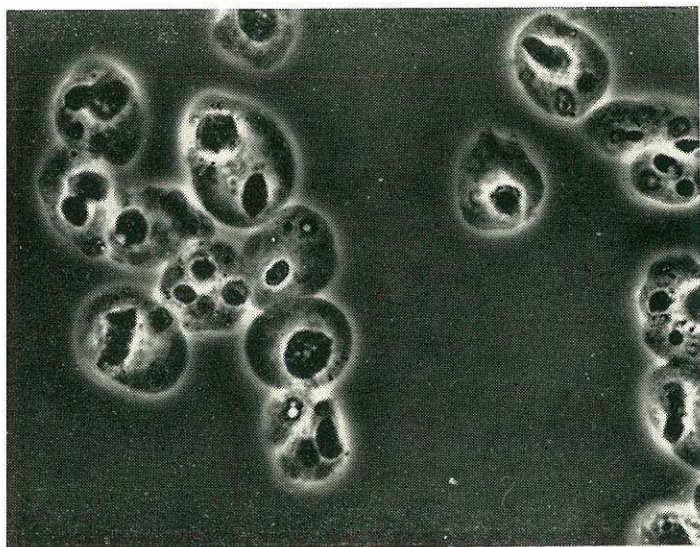
The group has played a leading role in the growing use of biuret in place of the more dangerous urea supplements. Though the findings contradict the view of some American workers, it has been proved decisively that the utilization of biuret takes place only by being broken down to ammonia in the rumen.

#### **Cancer biochemistry**

Studies of the biochemical changes which take place when dyes producing liver cancer are administered to rats have been continued. Certain types of cell nuclei (parenchymal nuclei) show a preferential uptake of the dye, and attempts have been made to locate the point



Pure isolated cell nuclei of carcinomous tumours



Thin layer chromatography of early metabolites of a carcinogenic dye in the liver

of attachment. There is some evidence that it is bound mainly by an active protein fraction. Most of the work has been concerned with changes taking place prior to tumour formation, but, in a recent study of tumours, a new, very large type of cell nucleus was found, which is not present in normal tissue.

#### Proteins and enzymes

Proteins are the vital constituents of living matter. As might be expected, they are extremely complex; the Institute is studying techniques for the examination of their structure and mode of working. The head of the research group is at present overseas to acquire familiarity with new techniques and he is working specifically on a new approach to the conformation of protein molecules. A study of phosphovitin in egg yolk has been started, as it is a protein of most unusual properties. A highly purified form of the important enzyme, hyaluronidase, has been prepared.

Evidence is being collected to support a new theory on the biosynthesis of proteins.

#### Snake venoms

A pure neurotoxin was isolated from the venom of the Egyptian cobra, and was then used for determining its amino acid sequence. This has been completed, thereby providing an addition to the very small international list of biologically active proteins which have been so fully characterized. There are several closely related substances produced by various cobra species, and the foregoing opens up a field of comparative study which should be highly rewarding. As an interesting example, another cobra venom has been partially studied by a Swedish chemist. Knowing that the two neurotoxins were very similar and differed only in a few amino acid residues, it was possible to arrange his fragments in their correct amino acid sequence.

### Pneumoconiosis

Biochemical work carried out on behalf of the Pneumoconiosis Research Unit deals with the biochemical changes associated with silicosis, in particular with the formation of nodular masses of collagen in the lung as a result of exposure to silica dust. The effect of dusty air upon the lungs of monkeys is being followed up. At the same time, the effect of silica implantation upon a number of tissues of various types is being investigated in order to find out what factors stimulate collagen formation. Damage seems to occur initially at the surface membrane of certain types of blood cell (macrophages), and the cause of this is also being traced.

### Analytical chemistry

The use of ion-exchange columns for the analytical determination of small amounts of elements in silicates is being extended by using a wide variety of eluting solutions. A quick and accurate method for determining small amounts of calcium has thus been developed, and it is also possible to make a quantitative determination of rubidium in tap water where its concentration is only two parts per billion.

The separation methods involved can also be applied in other ways. Thus "carrier-free" radio-active cadmium and silver from cyclotron targets have been prepared, even though the quantities involved (but not the activities) were minute.

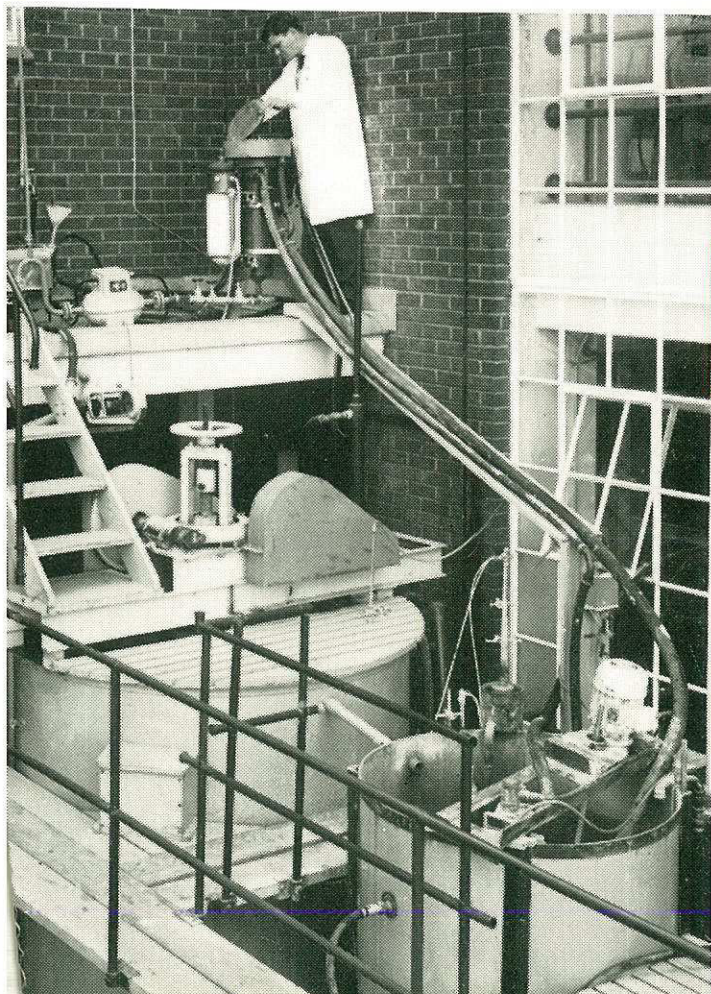
### Gold and platinum metal chemistry

A number of new co-ordinated complexes of gold, platinum and rhodium have been prepared and both their infra-red spectra and their chemistry in aqueous solutions have been studied. Since these metals exist only as complexes in solution, such apparently academic work is essential for both metallurgical separations and for analytical methods; for this reason, it now enjoys a degree of financial support from the Chamber of Mines.

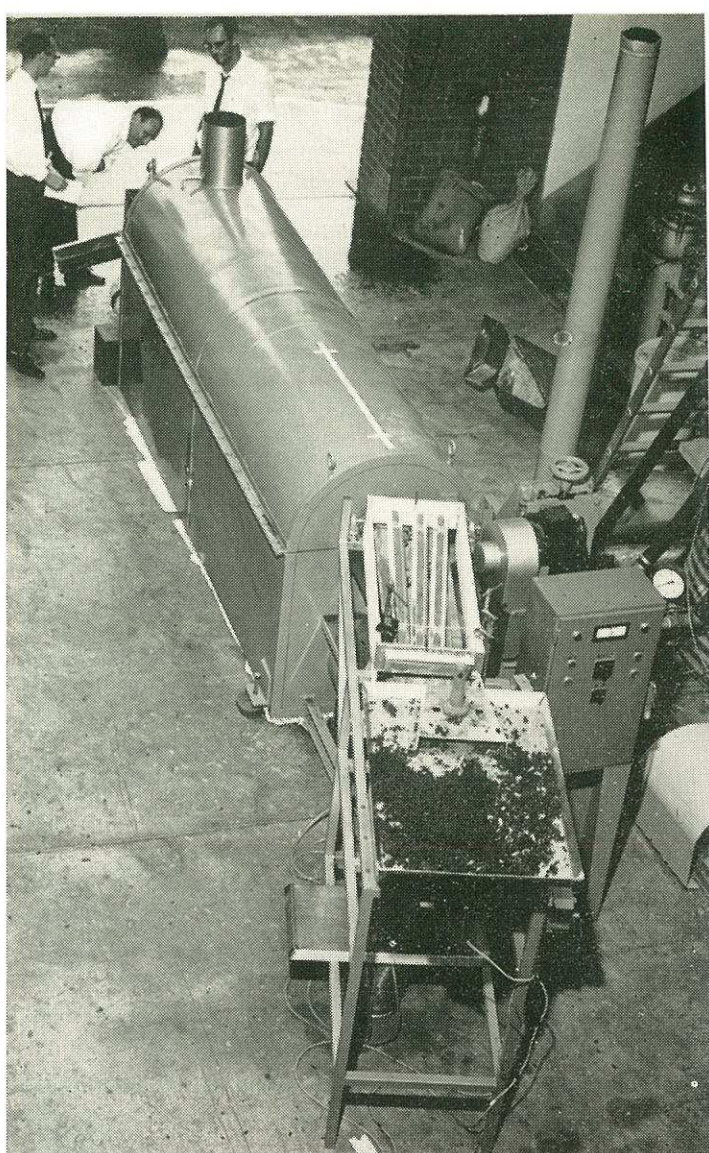
An interesting application resulted from the separation of radio-active silver from a cyclotron target of rhodium. It was known that rhodium could form a complex suitable for separation from silver on an ion-exchange column. The complex is unstable in the presence of chloride, but it reacts at a very slow rate, so that, by using a short column and hence a short time, silver could be removed before the rhodium complex had undergone any change.

### Gold extraction

The behaviour of thickeners for the removal of water from gold-bearing pulps has so far been studied with laboratory thickeners up to six feet in diameter, since it is relatively easy to control all the variables involved. With financial assistance from the Chamber of Mines and in collaboration with the Goldfields Group, a full-scale thickener has been equipped to carry out similar measurements under normal working conditions. The results will be correlated with laboratory measurements, particularly in regard to anomalies which have been found persistently in certain gold pulps.



View of pilot thickener



Rotary kiln with wine lees feed mechanism in the foreground

### Manganese dioxide

In collaboration with the National Institute for Metallurgy, manganese dioxide ores from 29 different deposits in the Republic were evaluated for their suitability for dry cell manufacture. Large variations in quality were found in each individual deposit.

The test methods developed to determine polarization properties have been improved so that the suitability of ore for dry cell purposes can be predicted in a short time with a high degree of accuracy. Fundamental studies are being carried out to improve the test methods even more.

### Maize starch

The industrial utilization of starch from surplus maize is being studied, with financial assistance from the Mealie Industry Control Board. A report on the use of dry-milled cereal flours

in paper making was drawn up, but it was concluded that these would not be successful in South Africa. Chemically modified starches are now being prepared and their properties studied, since these seem likely to prove suitable for utilization.

### Tartaric acid

As part of a programme on the recovery of tartaric acid from winery wastes, the keeping quality of wine lees was investigated. Owing probably to the presence of alcohol in wet lees, it was found that they could be kept in tanks for four to five months without any appreciable loss of tartrate. When filtered, however, the loss of tartrate takes place very quickly unless the filter cake is at once thoroughly dried. With funds provided by the wine industry, two types of drier were purchased and installed at Franschhoek, where it was demonstrated that lees could be efficiently filtered and dried. The dried material can then be transported and processed at a central plant.

### Agar

The process of manufacturing agar from South African seaweeds in all grades up to the very highest quality has been completed and a feasibility study has been started. A memorandum now being drawn up will serve as a basis for discussion with interested bodies with a view to the possible local exploitation of the process.

## Selected Publications

- ALBRECHT, C. F. Fractionation of rat liver nuclei by sucrose gradient centrifugation. *Epl Cell Res.*, vol. 49, 1968, pp. 373-378.
- ANDERSON, L. A. P., DE KOCK, W. T. & PACHLER, K. G. R. The structure of vermeerin. A sesquiterpenoid dilactone from *Geigeria africana* Gries. *Tetrahedron*, vol. 23, 1967, pp. 4153-4160.
- ARNDT, R. R., EGGERS, S. H. & JORDAAN, A. The alkaloids of *Anisotes sessiliflorus* C.B.Cl. (Acanthaceae) — five new 4-quinazolone alkaloids. *Tetrahedron*, vol. 23, 1967, pp. 3521-3532.
- AUCAMP, P. J. & HOLZAPFEL, C. W. The constitution of nidulol (5-hydroxy-7-methoxy-6-methylphthalide), a metabolic product of *Aspergillus nidulans* (Eidam) Wint. *Jl S. Afr. chem. Inst.*, vol. XXI, 1968, pp. 26-32.
- BIRD, C. E. & STRAUSS, F. J. Metallic coating for reinforcing steel. *Materials Protection*, vol. 6, no. 7, 1967, pp. 48-52.



- BIRD, C. E., FULTON, F. S. & ZIETSMAN, C. F. Recommendations for the construction of reinforced concrete structures in marine environments. *Civ. Engr S. Afr.*, Jan. 1968.
- FITSCHEN, W. Studies on monkey lung ribosomes. Cell-free protein synthesis; comparison of free and membrane-bound ribosomes. *S. Afr. J. med. Sci.*, vol. 32, 1967, pp. 119-131.
- GILCHRIST, F. M. C., POTGIETER, E. & VOSS, J. B. N. The biuretolytic activity of the ruminal flora of sheep fed practical rations containing biuret. *J. agric. Sci., Camb.*, vol. 70, 1968, pp. 157-163.
- HOLZAPFEL, C. W. The isolation and structure of cyclopiazonic acid, a toxic metabolite of *Penicillium cyclopium* Westling. *Tetrahedron*, vol. 24, 1968, pp. 2101-2119.
- JORDAAN, A., DU PLESSIS, L. M. & JOYNT, V. P. The structure and synthesis of pavettine, an alkaloid from *Pavetta lanceolata* Eckl. (Rubiaceae). *Jl S. Afr. chem. Inst.*, vol. XXI, 1968, pp. 22-25.
- JOUBERT, F. J. & BURNS, M. A. C. The fractionation of the high-sulphur proteins of reduced merino wool by column chromatography. *Jl S. Afr. chem. Inst.*, vol. XX, 1967, pp. 161-173.
- NOVELLIE, L. Kaffir beer brewing — ancient art and modern industry. *Wallerstein Laboratories Communications*, vol. XXXI, no. 104, 1960, pp. 17-32.
- PRETORIUS, S. T. & MANDERSLOOT, W. G. B. The removal of air pollutants from gases by reaction with particulate solids. *Powder Technology*, vol. 1, 1967, pp. 129-133.
- SCHWARTZ, H. M. The rumen metabolism of non-protein nitrogen. In: *Urea as a protein supplement*, M. H. Briggs, Editor. Oxford, Pergamon Press, 1967, pp. 95-109.
- SCOTT, K. J. Theory of thickening: factors affecting settling rate of solids in flocculated pulps. *Trans. Instn Min. Metall.* (Sect. C), vol. 77, 1968, pp. 85-98.
- STRELOW, F. W. E., COETZEE, J. H. J. & VAN ZYL, C. R. Separation of alkali metals from earths and other elements by cation exchange chromatography in nitric acid. *Analyt. Chem.*, vol. 40, 1968, pp. 196-199.
- STRELOW, F. W. E. & VAN ZYL, C. R. The quantitative separation of calcium from magnesium, aluminium and other elements by cation exchange chromatography in ethanol-hydrochloric acid. *Analytica chim. Acta*, vol. 41, 1968, pp. 529-536.
- VAN WYK, A. J. & ENSLIN, P. R. Bufadienolides of *Moraea polystachya* Ker and *M. graminicola* Oberm. *Jl S. Afr. chem. Inst.*, vol. XXI, 1968, pp. 33-38.

# THE NATIONAL RESEARCH INSTITUTE FOR MATHEMATICAL SCIENCES

Dr A. P. Burger,  
Director of the  
National Research  
Institute for  
Mathematical  
Sciences



**T**HE work of the National Research Institute for Mathematical Sciences is devoted to research in the mathematical and electrical engineering sciences. These two disciplines include especially the theoretical and experimental aspects of research in all scientific fields.

The Mathematical Sciences Research Department consists of divisions for mathematical analysis, statistics and numerical analysis. These deal with the various branches of mathematics and their application to research. Typical activities concern theoretical fluid dynamics, stress-deformation theory, operations research, statistical decision techniques and design of experiments, and numerical and non-numerical computations on digital computers.

The Electrical Engineering Research Department consists of divisions for special problems, automation, applied electronics, solid state electronics, electronic instrumentation and power electrical engineering. Work is done in such diverse fields as the application of digital techniques in data processing, analogue computing, the use of ultrasonics for the analysis and processing of materials, semi-conductor applications, microminiaturization and thin-film technology, and studies of problems peculiar to the Republic in heavy current applications.

**N.R.I.M.S.**

**MATHEMATICAL  
SCIENCES  
RESEARCH  
DEPARTMENT**

**Operations research**

A variety of operations research studies were undertaken, including investigations into a problem of linear programming for the Department of Agricultural Economics and Marketing, the study of extensive transportation problems for the Mealie Industry Control Board and an orientation study in mathematical programming for South African Pulp and Paper Industries Limited.

**Mathematical hydrodynamics**

Basic results were obtained in studying the mathematical equations describing the motion of an incompressible fluid with internal friction under conditions of moving boundaries, i.e. when the walls of the container are not fixed. In this work, the Institute collaborated with scientists at the University of New York.

**Geophysical fluid dynamics**

In attempting to establish a simplified mathematical description of the motion of the earth's atmosphere, various simplifications have to be made to enable the system of equation to be solved. The consistent introduction of various simplifications, aimed at obtaining good forecast results in the South African context, was studied. Owing to the known difficulties arising from South African requirements, this problem is bound to require consistent effort over the next few years.

**General mathematical services**

On the request of a variety of research groups, various mathematical studies were carried out, including area calculations, the analysis of electrical networks and the application of specialized mathematical procedures in solving problems arising in fields such as spectrochemistry and the allocation of manpower.

**Mathematical statistics**

The activity of the Institute in the field of mathematical statistics continually gives rise to new applications. Two examples are given below.

In forecasting the value that a given quantity will have, based on a linear combination of values which a specified set of other variables assume, a known confidence interval can be associated with such a prediction. The converse problem of obtaining a confidence set of values of the other variables associated with a given value of the first-mentioned variable has not, however, been discussed in the literature, and a method was evolved by the Statistics Division to deal with a problem in the field of timber technology encountered by the Timber Research Unit.

To illustrate another statistical method which was developed, it should be assumed that samples of ore-bearing rock from a given area have been analysed chemically and it is now necessary to establish the percentage of ore present in the area from which the samples were collected. A suitable statistical method for estimating such a population mean was established. Extensions include a method for determining the number of samples and the number of replicate determinations per sample which would be necessary to achieve a prescribed accuracy, as well as a method for choosing the combination entailing the minimum expenditure. It is thought that this method will be applicable to data collected in the fields of biology and medicine; in these cases the rock samples used above as an illustration are replaced by experimental animals or patients on which or on whom replicate determinations of a particular quantity are performed.

#### APPLIED STATISTICS

**Traffic speeds** — Continuing an experiment begun in 1966, the NRIMS, in collaboration with the National Institute for Road Research, carried out studies of spot-speeds of light motor vehicles at ten points on rural roads in the Transvaal; speeds at each one of these points were measured eight hours a day for two weeks in order to obtain data on the variation of speed with time of day. Such information is required to facilitate the planning of future studies and the evaluation of earlier ones.

**Timber moisture content** — The Timber Research Unit was interested in determining, within prescribed limits, the moisture content of timber transported by railway trucks. One sample billet of timber was to be taken from a truck, and the problem was to establish the number of trucks from which such samples were to be taken. A mathematical analysis of the data showed that, in the long run, 25 measurements would be needed to make it possible to state with 95 per cent certainty that the moisture content of the timber had been determined with an accuracy involving an error of not more than 2 per cent.

**Human adaptability studies on the Venda tribe** — South Africa is participating in the human adaptability studies which form part of the International Biological Programme. This is a five-year project, involving many scientific disciplines, the purpose of which, in very general terms, is the study of man's adaptation to a wide range of natural and also artificial (or man-made) environments. In this work, the Statistics Division has collaborated with workers from the National Nutrition Research Institute and the National Institute for Personnel Research in planning field work in Venda-land (Sibasa area). The main purpose of the study is the eventual comparison of urban and rural Venda.

**Impaired lung function** — The Pneumoconiosis Research Unit carried out lung function studies on more than 1,300 mine workers. Apart from the lung function variables, a large amount of other information, such as age, height, weight, years of underground service, was recorded. By applying the methods of mathematical statistics to these data it could be shown that an entirely new approach would be needed if lung function variables were to be predicted successfully.

**Cancer incidence** — In collaboration with the Statistical Research Unit of the Medical Research Council in England, the relationship between cancer incidence and age was studied by analysing data for cancers in various sites occurring in males and females from eleven selected countries. A joint publication is in preparation.

**Hygienic quality of milk** — In collaboration with the Animal and Dairy Science Research Institute, Irene, further work was done on the evaluation of various tests to estimate the bacterial count of milk, and hence its hygienic quality. A computation was made of the frequency with which a producer's milk should be sampled and tested if the milk was to be correctly graded with specified probability.

**Children's age and hand skeleton** — A knowledge of the average development of the skeleton of the hand of a large number of children of given ages has been used by workers overseas to construct a standard "atlas", by means of which the "skeletal age" of a child can be determined, using X-rays of the hand. By comparing the "skeletal age" of a child with its actual (chronological) age, various conclusions can be drawn. A medical research worker at the Coronation Hospital in Johannesburg used this "atlas", together with data on hand X-rays obtained by the National Nutrition Research Institute in a Pretoria survey of school children, and the Statistics Division advised him on several problems which arose in the course of this investigation.

**Mosquito-borne epidemics** — Using the electronic computer, a simulation study of epidemics of a vector-borne disease is being undertaken. The vectors in this study are assumed to be mosquitoes which become infectious when they bite a host (monkey). The computer program being written for the study will incorporate a number of quantities relating to infectiousness and mortality in vectors and hosts.

**Bacteria in sheep** — A statistical analysis was undertaken on counts of certain bacteria from the rumen (or first stomach) of sheep, these counts having been obtained by veterinary research workers at Onderstepoort. Five different cultures were used to grow the bacteria, and the analysis was undertaken to identify significant differences between the effects of different cultures.

## COMPUTING CENTRE

To enable a number of typewriter terminals to communicate with the IBM 360/40 digital computer, it became necessary to develop a special support program known as OSTERM II. The system proved to be economical and versatile, and was the most elaborate project of its kind yet undertaken here.

The computer load increased steadily throughout most of the year under review, and it became evident that, by December 1968, the installation would be loaded to capacity. After extensive investigations and discussion locally and overseas, an order was placed for an IBM 360/65 configuration which was to be brought into operation in January 1969; it is expected that, with moderate additions, this will be able to meet the requirements of the CSIR until 1972.

## NUMERICAL CONTROL OF MACHINE TOOLS

A numerically controlled milling machine was installed at the CSIR in January 1968. The Numerical Analysis Division was involved to a high degree in the computing, training and liaison aspects of this development. To control the milling machine, a very powerful computer language, known as APT, is used; this language was commissioned and tested extensively on the computer and introductory courses, provided locally, were followed in April by an intensive APT course conducted by an expert on numerical control from the USA. In March, the Division co-operated in the organization of a Symposium on Numerically Controlled Machine Tools held under the auspices of the South African Council for Automation and Computation (SACAC), this involvement including a

demonstration and a paper on the subject of programming for numerical control.

## COMPUTER PROGRAMMING

**Photographic surveying** — Considerable attention has been devoted to the application of computers in photogrammetry and related problems.

**Eclipses of binary stars** — A great deal of work has been done at the request of the Republic Observatory on a series of computer programs for the analysis of cyclic variations in the intensity of light from binary stars.

**Civil engineering** — An intensive study was made of the very comprehensive Integrated Civil Engineering System (ICES) of the Massachusetts Institute of Technology and the IBM Company. These programs are expected to be of great use in the future in South Africa.

**Agricultural economics** — In collaboration with the Department of Agricultural Economics and Marketing, the development of an elaborate system for the processing of monthly operational and economic data submitted by individual farmers was successfully concluded. Extensions of this project are continuing.

**Data processing and tabulation** — A versatile sorting and tabulating program was applied to massive tasks of data processing arising from research into Bantu housing, the use of scientific literature by South African scientists, and smaller projects. Other major tasks of data processing were commissioned, two connected with traffic surveys and one with folklore. A program for the mechanization of library procedures in dealing with serial literature has been drawn up.

# N.R.I.M.S.

## ELECTRICAL ENGINEERING RESEARCH DEPARTMENT

### Automatic weather station

In previous Annual Reports, mention has been made of a weather station developed by the Automation Division on behalf of the National Building Research Institute and run on a routine basis by the Electronic Instrumentation Division and the NBRI. During the year under review, the information recorded by this station was analysed, using programs written by the NBRI for the IBM 360/40 computer. Of the information finally transcribed on magnetic tape for processing, 95 per cent was found to be within acceptable limits. Some 14 per cent of the original data was not transcribed because the paper tape had deteriorated during storage. Actual downtime of the station contributed less than 5 per cent to the loss of information. A paper dealing with the results of an analysis of the accumulated data is being prepared by the NBRI.

### Process control

The Automation Division has placed an order for an EAI-580 analogue computer (80 amplifiers, 70 servo-controlled potentiometers) which is to be used primarily in a fundamental study of process control; the intention is to simulate an industrial process on the analogue computer and effect control by means of a coupled digital computer

- WEERSTASIEGEGEWENS - EERSTE FASE VAN VERWERKING (SCIENTIA, PRETORIA) -

BREEDTEGRAAD 25 45 S LENGTEGRAAD 28 17 O HOOGTE BO SEESPEEL 4,490 FT.

DATUM	ELEMENT	I	UUR VAN DAG																			
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16	8 00	34 SRUI-CS	1	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	0	0		
		3 SW-IN	1	9	13	28	44	58	68	40	68	53	36	18	9	9	0	0	0	0		
		4 SW-OUT	1	2	3	6	10	13	15	8	15	12	8	4	2	2	0	0	0	0		
		5 SW-RAL	1	3	2	5	7	10	12	7	12	9	6	3	2	2	0	0	0	0		
		8 I-RAD	1	17	44	61	66	70	67	55	73	67	66	51	20	9	0	0	0	0		
		9 FILTER1	1	2	10	14	15	16	16	13	17	15	15	12	5	2	0	0	0	0		
		10 FILTER2	1	8	35	50	53	55	55	49	57	54	54	43	17	13	0	0	0	0		
		11 FILTER3	1	2	11	15	16	17	17	15	17	16	16	13	5	2	0	0	0	0		
		12 FILTER4	1	3	10	14	15	16	16	13	16	15	15	12	5	5	0	0	0	0		
		13 FILTER5	1	3	11	15	15	16	16	15	17	16	16	12	5	2	0	0	0	0		
		14 FILTER6	1	7	34	44	47	49	48	40	50	47	47	38	17	7	0	0	0	0		
		15 FILTER7	1	6	28	37	40	42	39	37	43	40	40	32	15	8	0	0	0	0		
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				4 SW-OUT	1	2	3	6	10	12	13	14	13	11	8	2	5	4	0	0	0	0
5 SW-RAL	1			2	3	4	7	9	11	11	10	8	6	4	4	4	0	0	0	0		
8 I-RAD	1			15	35	47	62	65	71	69	67	58	50	16	13	12	0	0	0	0		
9 FILTER1	1			4	9	11	14	15	16	16	15	13	12	2	4	3	0	0	0	0		
10 FILTER2	1			14	32	40	49	52	57	55	53	47	40	14	12	8	0	0	0	0		
11 FILTER3	1			4	10	12	15	16	17	16	16	14	13	4	3	2	0	0	0	0		
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13 FILTER5	1			2	10	12	15	15	16	16	15	14	12	3	4	3	0	0	0	0		
14 FILTER6	1			7	30	36	44	46	50	48	47	42	36	11	13	7	0	0	0	0		
15 FILTER7	1			9	26	31	39	40	42	42	40	34	32	8	13	6	0	0	0	0		
18	8 06			34 SRUI-CS	1	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	0	0
				3 SW-IN	1	9	13	27	41	55	64	65	60	47	36	18	24	23	0	0	0	0
				4 SW-OUT	1	3	3	6	9	12	14	15	13	11	8	5	5	10	0	0	0	0
		5 SW-RAL	1	2	2	4	7	9	11	11	10	8	6	3	3	5	0	0	0	0		
		8 I-RAD	1	19	36	52	58	66	73	74	69	59	48	36	16	9	0	0	0	0		
		9 FILTER1	1	4	9	13	13	15	16	16	15	14	12	8	3	7	0	0	0	0		
		10 FILTER2	1	11	33	44	48	53	57	57	54	47	40	29	13	22	0	0	0	0		
		11 FILTER3	1	2	10	13	14	16	17	17	16	15	12	9	4	4	0	0	0	0		
		12 FILTER4	1	4	13	13	14	15	16	16	15	13	12	8	4	6	0	0	0	0		
		13 FILTER5	1	3	10	13	14	15	17	16	16	14	12	8	4	8	0	0	0	0		
		14 FILTER6	1	11	30	40	43	47	50	50	48	42	37	27	13	22	0	0	0	0		
		15 FILTER7	1	11	25	34	36	40	42	42	41	35	32	22	12	20	0	0	0	0		

Figure 1  
Example of computer tabulation of data recorded by the Automatic Weather Station

Before embarking on a large-scale investigation of a selected problem, it is intended to hold a seminar on the use of analogue and digital computers in process control. Contact has been made with several industrial firms and visits to other firms are being arranged in order that knowledge of a wide spectrum of control problems can be acquired before a suitable one is selected for intensive study.

#### Thin-film technology

Having successfully produced some circuits during the previous year, the main effort of the thin-film team in the year under review was devoted to improving and perfecting the evaporation technique of nickel-chromium resistors and gold conductors; and to setting up an in-house production facility. To improve the basic accuracy of the resistors, a trimming apparatus was designed and built. By means of a spark erosion process, the value of the resistors could be adjusted until it was accurate to within 0.5 per cent.

For the manufacture of circuits, it was decided to use normal unencapsulated transistor chips, which are cheap and readily available. To bond these chips to the substrate an epoxy bond was developed in co-operation with the Technical Services Department.

A radio-frequency sputtering unit was acquired to make possible the production of condensers. This particular sputtering module permits three different materials to be deposited without breaking the vacuum, and, with its aid, dielectrics and conductors can be deposited.

#### Ultrasonics

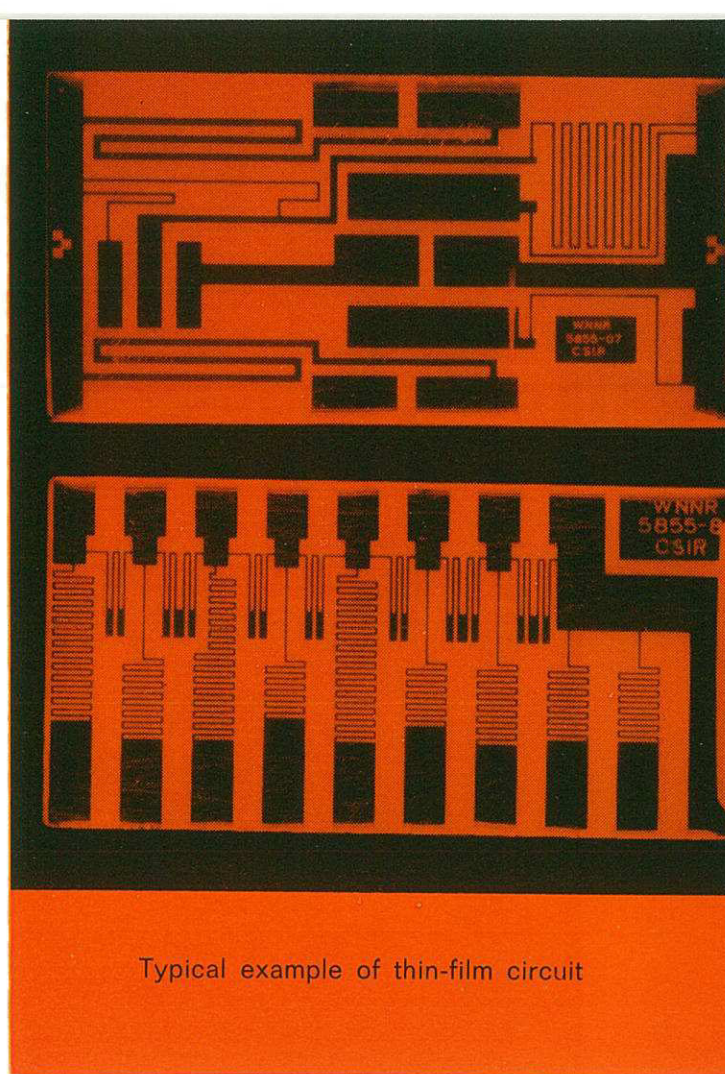
Further improvements were made to the ultrasonic thin-film monitor to measure the growth of thin films: The method is based on the principle that the velocity of a surface elastic wave changes when a material with different elastic constants is deposited on the surface. The improvement uses an interference pattern set up between the surface and bulk waves and produces a digital output rather than the analogue signal previously obtained. A paper on this work was published.

#### Low-level amplifiers

Semi-conductor diodes or transistors have in the past been used as temperature sensors. A new method of using transistors for this purpose was developed in the Solid State Electronics Division, and the result was a much improved performance. One practical advantage of the method is that, if a convenient electrical thermometer circuit were designed to operate on this principle, no complicated initial adjustment or recalibration would be necessary if a sensor had to be replaced.

#### Micro-circuit analysis

A start was made with the investigation of different methods of computer-aided circuit de-



sign, and a limited number of computer runs, using the electric circuit analysis program (ECAP), have been carried out. It has been found that direct communication with the computer by means of a typewriter terminal is essential for this type of work.

#### Voltage-stabilized spark source

Spectrographic spark sources operating on the principle of voltage control have been designed and constructed. Applications for a patent in the USA have now been successful. The South African Inventions Development Corporation has made a grant available for the further development of this invention by the CSIR in South Africa.

#### Electromedical apparatus

The Institute has developed a special electrocoma unit which has proved to be so successful that a second improved unit is now being developed. In the light of experience gained with the first unit, the second will cover a higher frequency range and be of lower power, while it will also be of a rather simpler design.

#### Information service on electronic instrumentation

The Electronic Instrumentation Division is providing an internal information service on

the availability of electronic components and instruments, from local or overseas sources. Some 150 enquiries are dealt with monthly.

#### Sandwich course

The scheme for training technicians by means of a sandwich course in conjunction with the Pretoria College for Advanced Technical Education is producing good results, although the syllabuses need to be revised. The students who obtained their diplomas are proving to be very useful additions to the staff.

#### Evaporation measurements at Gross Barmen

Following original research work carried out by the Automation Division, equipment built by the Electronic Instrumentation Division for the National Institute for Water Research is now being used to measure the evaporation of water in one of the "dry" river beds of South West Africa. The number of channels used during the first stage of the investigations has been extended, although recording is still done by means of a graphic recorder. The next step will be to record on punched paper tape so

that the recorded data can be processed on a computer.

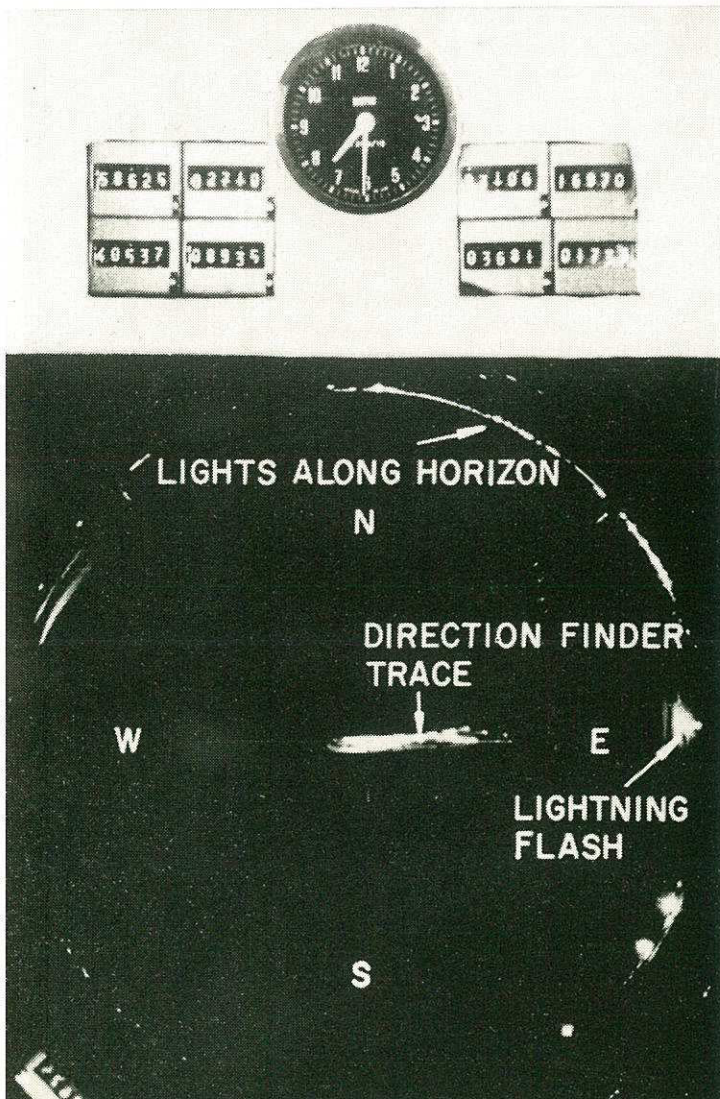
#### Tracking animals in the bush

Biologists wishing to mark animals, with a view to identifying and tracking them in the bush, needed miniature transmitters. With assistance from the National Institute for Telecommunications Research and the Acoustics Division of the National Physical Research Laboratory, a prototype, in the form of a collar, was fitted to a monkey and was of great assistance in identifying and tracking the animal for a period of 28 days (the life of the batteries used). Work is proceeding on 10 more transmitters which will operate for periods of 6 to 12 months. A portable receiver and an aerial with directional sensitivity were also developed. The development of a similar instrument for tracking rhinoceros is being investigated.

#### Wave and tide recorders

On behalf of the Hydromechanics Division of the National Mechanical Engineering Research Institute, a commercial echo sounder was modified for recording wave and tide information at the coast. The modifications included a mechanical re-design of the paper drive mechanism to allow a bigger roll of chart paper to be fitted and to achieve a higher recording speed and a more efficient method of regulating speed, a battery-driven clock and timing mechanism to enable sample readings to be made every hour, and a change in design to achieve a higher sensitivity. A special re-chargeable battery and a watertight container were also required, as the units were to be deposited on the sea-bed and only retrieved once a month for re-charging the batteries and changing the chart paper. Tests were conducted at Durban and Port Elizabeth and additional units are being built for use at other harbours.

Lightning flash taken with 360 degree camera, superimposed on the simultaneous cathode ray oscillograph direction finding record



#### Calibration of electronic instruments

The necessary precision-measuring apparatus having been received, it was possible to make a start with the routine calibration of equipment. To begin with, only new equipment is being evaluated against specifications. The need for such a facility is emphasized by the fact that it was found that some 75 per cent of all new instruments do not conform in all respects to their specifications.

#### Lightning observations

Considerable progress was achieved in the establishment of three lightning direction finding stations at Silverton, Bapsfontein and Diepsloot. The Institute has been working in close collaboration with the National Physical Research Laboratory on this project. Each station is provided with a direction finder with cathode-ray tube-display, electrically controlled cameras and a 360 degree all-sky camera, in addition to other equipment. All cameras are operated with their shutters open, awaiting the event of a lightning flash



which then triggers off operation; when this takes place the shutters are closed and the film advances by one frame before the shutters are re-opened.

Some of the data obtained during the 1967/68 lightning season have been transferred to punched paper tape and will be processed on the digital computer.

#### Survey of impulse voltages

The Institute is studying impulse voltages which occur on high voltage transmission lines and which are due to switching and lightning surges. As part of the study, the Automation Division and the Power Electrical Engineering Division jointly completed a design for voltage and current recording equipment not physically connected to transmission lines. Prototypes of this equipment were used during a series of switching tests carried out jointly, on the newly commissioned 400kV lines, by ESCOM, the CSIR, the SABS and the Universities of Pretoria and the Witwatersrand. It is anticipated that it will be possible during the forthcoming year to complete the equipment of a mobile recording laboratory for long-term studies.

Work is also in progress on a universal statistical counter, which will make measurements providing the basic data needed to fix insulation levels and design the protection of connected equipment against over-voltage.

#### Protection of pipeline against lightning

In the previous Annual Report, reference was made to research which had led to the provision of suitable protection against lightning for a main water pipeline of prestressed concrete between Riversdale and Johannesburg. There were no failures of the pipeline due to lightning during the 1967/68 season.

Equipment for measuring the lightning currents carried by the water main and its protective system of conductors is being constructed with a view to obtaining information regarding the distribution of the currents which are carried by the protection system and the pipeline respectively, in order to confirm design data.

#### Insulation research

At the request of the Advisory Committee for Electrical Engineering, the Institute will carry out research into the electric properties of insulation materials. Some basic equipment has been acquired for this purpose.

#### General

An optical-electrical system has been worked out to measure the wear of the overhead contact wire used in detraction systems; its success will depend upon the accuracy with which the optical components can be manufactured. This investigation has important economic impli-

cations and is being continued in close collaboration with the Electrical Engineering Department of the South African Railways and Harbours.

At the request of the Department of Commerce and Industries, as it was at that time, the whole question of research into battery-operated electrical vehicles was critically examined. Three recent conferences in the United States and the United Kingdom were attended by representatives of the CSIR, and a literature survey was carried out. A report was made to the Department.

### Selected Publications

- ANDERSON, R. B. *Comments on the agenda for the 1968 meeting of the CIGRE Working Group on lightning flash counters*. CSIR Technical Report E/65/2, no. 12/1968, Pretoria, CSIR, 1968, 7p.
- ANDERSON, R. B. *The measurement of lightning ground flash density*. CSIR Special Report WISK 39, Pretoria, CSIR — SAIEE, Oct. 1967, 20p.
- BOUWER, I. Z. Standard representations of simple Lie algebras. *Can. J. Math.*, vol. 20, no. 2, 1968, pp. 344-361.
- BOZZOLI, G. R., TROOST, N., HEYMANN, F. G., MIDDLECOTE, A. A. & ANDERSON, R. B. A review of high-voltage research and testing techniques in South Africa. *Trans. S. Afr. Inst. elect. Engrs*, vol. 59, part 12, Dec. 1968.
- ENGELTER, A. *Thin-film integrated circuit technology in Europe*. CSIR Special Report WISK 34, Pretoria, CSIR, 1967, 14p.
- ENGELTER, A. & KAPPETIJN, H. Rapid determination of the temperature coefficient of thin-film resistors. *Micro-electronics and reliability*, vol. 7, no. 3, Aug. 1968, pp. 181-184.
- GREGGOR, K. N. The symbolic control of machine tools. In: *Proceedings of the Second National Conference of the South African Council for Automation and Computation (SACAC)*, Cape Town, Sept. 1967.
- INGELS, H. G. & KÜHN, G. J. Integration of instruments in a data acquisition system. In: *Proceedings of the Second National Conference of the South African Council for Automation and Computation (SACAC)*, Cape Town, Sept. 1967.
- JOUBERT, G. R. 'n Nuwe metode vir die benaderde oplossing van paraboliese differensiaalvergelings. In: *Annual Report, The South African Mathematical Society*, published 1967.
- JOUBERT, G. R. Ontwikkelings in die rekenaarwese in Wes-Europa en gevolgtrekkings daaruit. *ADP, The South African Computer Bulletin*, vol. 9, no. 4, March-April 1968.
- LAUSCHER, N. F. & POTGIETER, J. F. *South Africa and the International Biological Programme: Report on demographic surveys undertaken in Sekukhuniiland and Vendliland*. CSIR Research Report, Pretoria, CSIR, Nov. 1967, 23p. plus 2 appendices.

- LAUBSCHER, N. F. & RUDOLPH, G. J. *A distribution arising from random points on the circumference of a circle*. CSIR Research Report no. 268, Pretoria, CSIR, 1968, 13p.
- LÜCK, H. & FELLINGHAM, S. A. Relationship between oxygen content of milk and its reductase activity. *Milchwissenschaft*, vol. 22, no. 3, March 1967, pp. 168-173.
- POTGIETER, J. F. & FELLINGHAM, S. A. Assessment of methods for dietary surveys. *S. Afr. med. J.*, vol. 41, no. 35, 16 Sept. 1967, pp. 886-890.
- SAUER, N. Properties of bilinear forms on Hilbert spaces related to stability properties of certain partial differential operators. *J. math. Analysis Applic.*, vol. 20, no. 1, Oct. 1967, pp. 124-144.
- SMIT, P. J., POTGIETER, J. F. & FELLINGHAM, S. A. Body measurements of school children of four racial groups in Pretoria. *S. Afr. med. J.*, vol. 41, no. 35, 16 Sept. 1967, pp. 868-886.
- SMIT, P. J., POTGIETER, J. F., NESER, M. L. & FELLINGHAM, S. A. Sex, age and race variations in the body measurements of White, Coloured and Indian children aged 7-15 years. *S. Afr. med. J.*, vol. 41, 22 April 1967, pp. 422-426.
- STEFFENS, F. E. On comparing two simple linear regression lines. *South African Statistical Journal*, vol. 2, no. 1, 1968, pp. 33-53.
- STEWART, P. G. *CIGRE lightning flash counter: digital computation of its response under various conditions*. CSIR Technical Report E/65/2, no. 7. Pretoria, CSIR, 1968, 4 p., plus annexures 9p.
- VAN NIEKERK, H. R. *Improvements relating to suitable ratiometer for lightning investigations*. CSIR Technical Report E/65/2, no. 10, Pretoria, CSIR, 1968, 5p., plus annexures 4p.
- VAN TWISK, P. & FELLINGHAM, S. A. Inleidende ondersoek na die  $\alpha$ -amilaseverteerbaarheid van die stysel van verskillende mielievariëteite afkomstig van verskillende produksiestreke. *Suid-Afrikaanse Tydskrif vir Natuurwetenskap*, vol. 8, no. 1, 1968, pp. 27-31.
- VAN WYK, J. D. N. Contribution to a paper 'Certain aspects of automation applied to power station operations' by Philip Freymeyer. In: *Trans. S. Afr. Inst. elec. Engrs*, vol. 59, part 5, May 1968.
- VAN WYK, J. D. N. Technical education in the Republic of South Africa. *S. Afr. elect. Rev.*, Jan. 1968, pp. 41-45.
- VERSTER, T. C. Anomalies in transistor low-frequency noise. In: *Proceedings of the Institute of Electrical and Electronics Engineers*, vol. 55, no. 7, July 1967, pp. 1204-1205.
- VERSTER, T. C. p-n Junction as an ultralinear calculable thermometer. *Electronics Letters*, vol. 4, no. 9, 3 May 1968, pp. 175-176.
- WITTMANN, W., MOODIE, A. D., FELLINGHAM, S. A. & HANSEN, J. D. L. An evaluation of the relationship between nutritional status and infection by means of a field study. *S. Afr. med. J.*, vol. 41, 22 July 1967, pp. 664-682.

# THE NATIONAL MECHANICAL ENGINEERING RESEARCH INSTITUTE

Dr H. G. Denkhaus,  
Director of the  
National Mechanical  
Engineering  
Research Institute



**T**HE activities of the National Mechanical Engineering Research Institute (NMERI) are devoted to the development of new ideas and techniques in mechanical engineering, and to the improvement of machines and materials used in industry. The Institute is also active in fields such as rock mechanics to improve efficiency and safety in mines. The Institute has qualified personnel, testing equipment, machines and instruments for research in the fields of metallurgy, strength of structures, process development, rock mechanics, aeromechanics (including aeronautics), hydromechanics (including harbour and river engineering) and heat mechanics (including air-conditioning and refrigeration). The NMERI also has at its disposal wind tunnels for the range up to Mach. 4.3.

The Mine Equipment Research Unit at Cottesloe, Johannesburg, is part of the NMERI and deals with investigations related to mine ropes and winding equipment.

The Hydromechanics Department is being transferred to Stellenbosch where it will operate as the Hydraulics Research Unit but still remain part of the NMERI. The Aeromechanics Department has become the Aeronautics Research Unit and will continue to operate at Scientia as part of the NMERI.

## METAL MECHANICS

### Failures in service

The Metal Mechanics Division continued to offer industry the service of investigating failures of machine or structural metal components. This service includes general metallurgical tests to identify specific materials, heat treatment studies, the investigation of corrosion problems and any metallurgical tests necessary to determine the reason for the failure of metal components. A number of such investigations were carried out for industrial firms as well as for Government departments.

### Stress corrosion

An investigation to determine the influence of steel composition and structure on the susceptibility of mild steel to intercrystalline stress corrosion in both nitrate and caustic soda solutions was carried out in collaboration with the University of Cape Town. It was found that the susceptibility to corrosion of spheroidized steel was considerably less than that of the normal annealed structure. It was also found that steel with a high carbon content is more susceptible to stress corrosion and that cold deformation increased the susceptibility of steel to this type of corrosion.

### Plastic deformation

The influence of shock loading on the yield point of mild steel was investigated. Specimens

were strained in an impact machine to elongations between 0.8 and 8.5 per cent and the yield point was determined on the prestrained specimens. An inhomogeneous deformation was found during yielding, in particular near the so-called Lüders bands. A new theory in regard to the movement of dislocations was supported by the results obtained.

#### **Wear of mill lining materials**

A final report on a comprehensive investigation into rotary mill liner practice in the South African Gold Mining Industry was submitted to the Chamber of Mines of South Africa who had sponsored the research. The report contains a description of tests undertaken to determine the most suitable alloys for use under various conditions of milling. Considerations relating to liner and mill design which had arisen from the tests were discussed and future trends were indicated. An abbreviated version of the report was prepared for publication in a South African technical journal.

#### **Foundry research**

Investigations on behalf of several foundries, as well as of foundry-supply firms, were conducted. The properties of different binders and foundry sands were investigated and material tests were carried out on samples of cast iron to determine their mechanical properties, microstructures and chemical composition. The object of the tests was to evaluate the quality of sands, binders and castings. Several investigations into the causes of service failures of cast machine and vehicle components were also carried out.

A CSIR one-day symposium on air pollution and the foundry industry was held during August in co-operation with the South African Institute of Foundrymen. Papers were presented by speakers from the foundry industry, a municipality and from research organizations, including the CSIR.

A report on research carried out into the properties of resin bond mould materials was submitted to the South African Foundry Research Foundation. The data sheets included in the report give the properties of resin bonding materials available in South Africa. Tests were carried out on mixtures containing cold-setting and thermosetting resins, on resin-coated sand and on a clay-bonded mixture containing additional resin. The tests included the casting of a special test piece to determine the porosity index — a measure of the tendency of the different resins to create pinholes.

### **STRENGTH MECHANICS**

#### **Stress analysis and material testing**

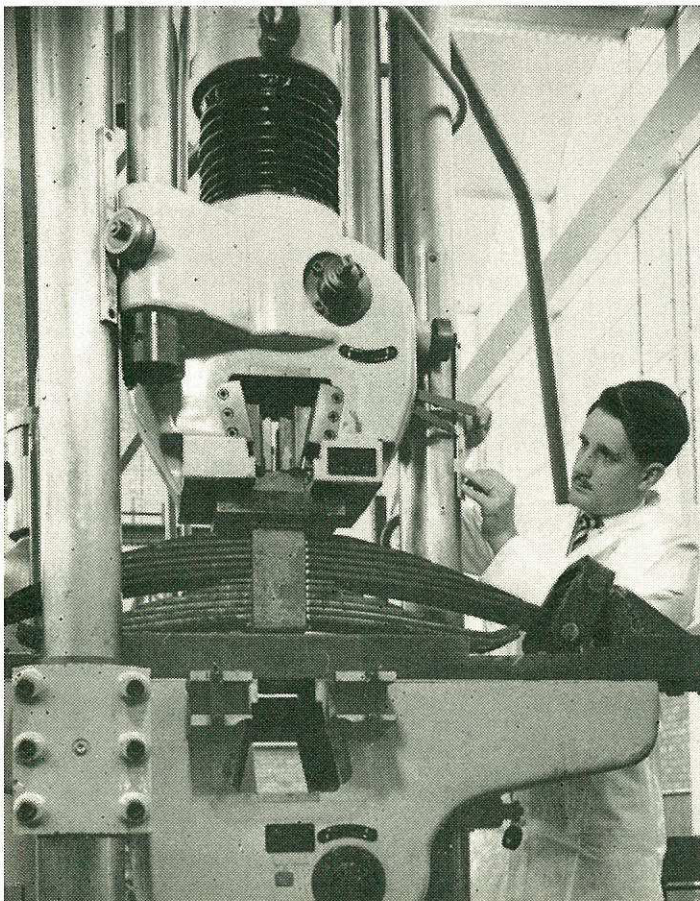
Several important stress analyses and strength investigations were carried out on behalf of industrial organizations. In addition, a wide range of fatigue tests were undertaken, several of which are still in progress, principally on railway rolling stock components and permanent way equipment.

Preparations are being made to carry out a complete stress analysis of a railway carriage for its manufacturers.

A structural test was carried out in Holland on the heavy lifting gear of a large cargo vessel which had been damaged by a fire in the hold.

#### **Impact properties of metals**

A study is being made of the effect of impact on small metal specimens and the effect of the rate of loading on the yield point of steel. Preliminary work was carried out in order to gain experience of the experimental techniques involved in using electrical resistance strain gauges and reflection photoelasticity in studying strain phenomena of the wave type. Specimens of mild steel in the normalized heat-treated condition were tested in tension using the above-mentioned techniques at slow loading



Fatigue test on a railway spring in the Strength Mechanics Division

rates. In this heat-treated condition mild steel exhibits a very pronounced yield-point effect which is accompanied by the propagation of one or two Lüders bands from the grips of a tensile specimen. The Lüders band can be considered a plastic wave travelling through the specimen with a velocity which depends upon the loading rate. It has thus been possible to investigate a quasi-static situation which resembles impact conditions.

## PROCESS MECHANICS

### Conveyance of granular material

At the request of a cement manufacturer an investigation was undertaken to determine the pressure loss, in terms of pounds per square inch per mile, which would occur in transporting limestone in the form of a slurry in a pipeline over a considerable distance from a quarry to a cement factory. This information was needed to establish the capacity of the pumping plant required for the system.

Tests on numerous slurries, each of which had a different water concentration and particle size distribution, were carried out in pipes of small diameter, and an estimate of the pressure required to pump such slurries in, for example, an 8-inch pipeline over 100 miles was deduced from the results.

It is planned to conduct further tests in a test circuit of approximately one mile in length in which the pipes used will have the same diameter as that proposed for the actual system.

### Heavy machinery testing

A report on an extended study of the need for establishing a central pumping station in the Republic, which will be capable of testing single pump units up to 12,000 hp, was submitted to the Councils of the SABS and CSIR by the Committee on Facilities to Further the Development of Heavy Industries in South Africa.

### Potato sizing machine

The Potato Board requested the Institute to develop a potato grading machine, in which the Board had patent interests, to the production stage. After acceptance tests had been completed and small modifications made, it was delivered early this year to the Potato Board, who are subjecting it to practical tests.

A typical photoelastic fringe pattern obtained in the Rock Mechanics Division in the course of analysing the stresses around an underground mining excavation

## ROCK MECHANICS

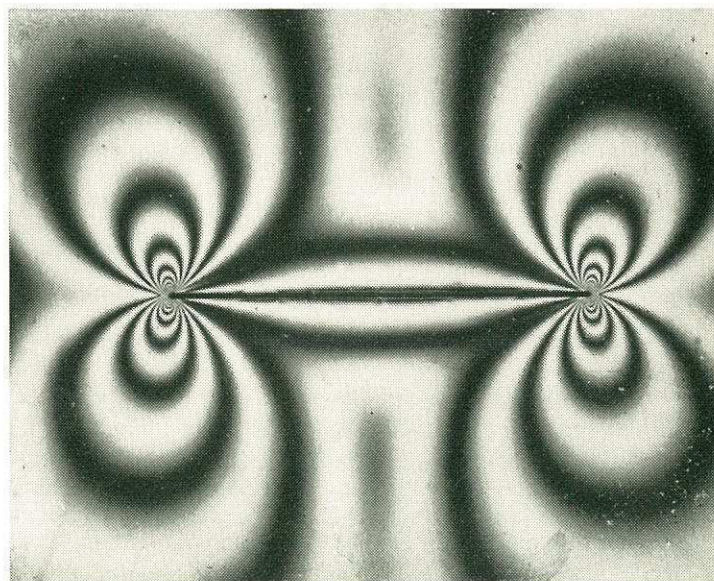
Research into problems in the field of rock mechanics was continued on behalf of the Chamber of Mines of South Africa and the Coal Mining Research Controlling Council. In addition, various investigations were conducted for sponsors in South Africa and abroad.

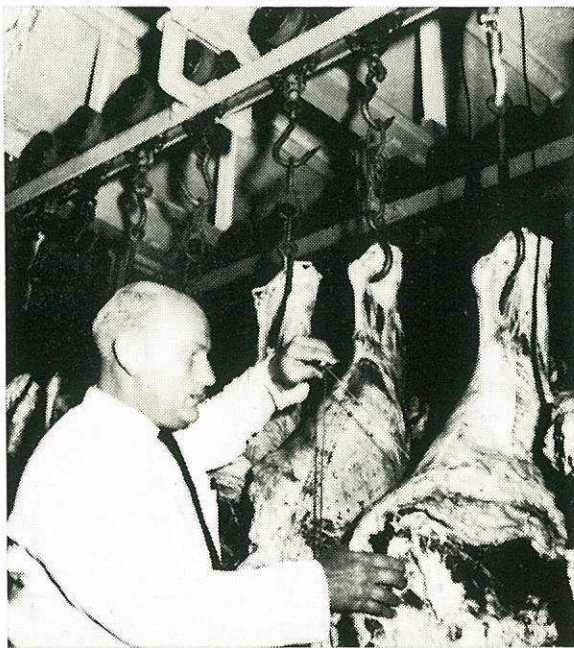
### Properties of rock

Progress was made with a catalogue of the strength and deformation characteristics of South African rocks for use in the study of rock mechanics. It is hoped to issue the first edition by the end of 1969.

### Measurement of stress in elastic rock

Methods and instruments for the measurement of rock stress are being developed. The CSIR's so-called "doorstopper" equipment and the CSIR "triaxial" cell equipment were both perfected. The former is being produced commercially for South African and foreign markets and arrangements for the manufacture of the latter have been concluded. Both types of equipment have been used in underground investigations in gold, asbestos and coal mines. A novel investigation was carried out in a colliery, where stress measurements were carried out on large coal specimens subjected to known *in situ* load. In this way, data were acquired on the accuracy of the equipment. The accuracy was found to be well within the limits imposed by practical requirements.





Research into the quick chilling of meat in abattoirs

#### Large-scale testing of coal *in situ*

The object of such testing is to determine the strength and deformation characteristics of the coal pillars left in the course of colliery mining. Coal specimens, with side dimensions up to 6.6 ft (2 metres) and of various heights, were tested *in situ* and results previously obtained were confirmed.

This work was conducted on behalf of the Coal Mining Research Controlling Council.

#### Fracture mechanism of rock

Research on certain aspects of the propagation of fracture in rock continued, with an emphasis on the processes of fracture under dynamic stress conditions. This led to the initiation of a project in which the phenomenon of pre-split blasting was investigated by means of a high-speed camera at speeds exceeding 1½ million frames per second.

This research should throw light on problems connected with the drilling and blasting of rock and also with rock bursts in the gold mines.

### FLUID MECHANICS

#### Natural aerodynamics

An investigation was undertaken into problems connected with the wind-excited roof oscillation of large petroleum products storage tanks. The tank roofs are of the floating type, and during moderate and high winds these roofs oscillate with a type of wave motion that has an ampli-

tude of several inches. Some cracks have been observed along the welded joints of the steel roofs and it is feared that continued oscillations may cause further cracking. A model of one tank was built and was used in a wind tunnel to study remedial methods.

### HEAT MECHANICS

#### Air conditioning and refrigeration

On numerous occasions the Institute acted as technical adviser to consultants and interested bodies concerned with the planning of air-conditioning and refrigeration facilities.

Basic investigations into the economic planning of abattoir refrigeration equipment were continued. In particular, the effect of environmental conditions such as air temperature, humidity and air velocity on carcass weight losses was investigated.

Detailed specifications for two experimental cold rooms were completed. The cold rooms will be used to determine the effects of environmental conditions on the keeping qualities of certain perishable products, chilling and freezing rates and product weight losses during chilling, freezing and storage.

Numerous enquiries relating to the design of process and comfort air-conditioning systems were dealt with. Performance tests on such air-conditioning systems were carried out. These included tests on the temperature- and humidity-control equipment for textile mills, surface acclimatization chambers for the mining industry and plant-growth rooms for horticultural research.

Basic investigations into various air distribution systems for glass houses were carried out.

#### Climatological data

Charts were published on which various climatic parameters for summer conditions were shown in the form of isothermal lines on maps of the Republic. This information is of considerable interest to architects, consulting engineers and similar specialists. Numerous requests for relevant information have been received.

The analysis of dry- and wet-bulb temperatures was extended to include dew-point temperature values for the Republic — a pre-requisite for the design of humidification equipment in comfort air-conditioning systems.

#### Heat loss from the human body

Instrumentation, based on the model studies which were successfully carried out in a temperature- and humidity-controlled wind tunnel, was constructed and installed in the Climatic

Chamber of the Chamber of Mines' Human Sciences Laboratory, in order to measure the evaporative heat loss component from the human body.

The instrument for measuring the evaporative heat loss, together with the instruments previously developed for measuring the convective and radiative heat loss components, was used for animate studies in the Climatic Chamber.

Satisfactory results have been obtained from the operation of all the equipment.

#### Coal-burning gas turbine

The feasibility of a coal-burning gas turbine of the comparatively simple open-cycle type for power generation in South Africa, is being investigated.

Experimental work to determine the feasibility of coal-burning combustion chambers for open-cycle gas turbines was continued.

The tests showed that, in spite of fairly low combustion efficiencies, the exhaust gases from the combustion and ash separation system contained small enough quantities of ash particles to be nearly acceptable from the viewpoint of turbine blade erosion.

Further investigations into methods of improving efficiency in both combustion and ash separation made considerable progress. A new type of combustion chamber, which shows promise of increased efficiency, is undergoing tests, and a number of alterations to the ash separation equipment are being effected.

### MINE EQUIPMENT RESEARCH UNIT

#### Statutory wire rope testing

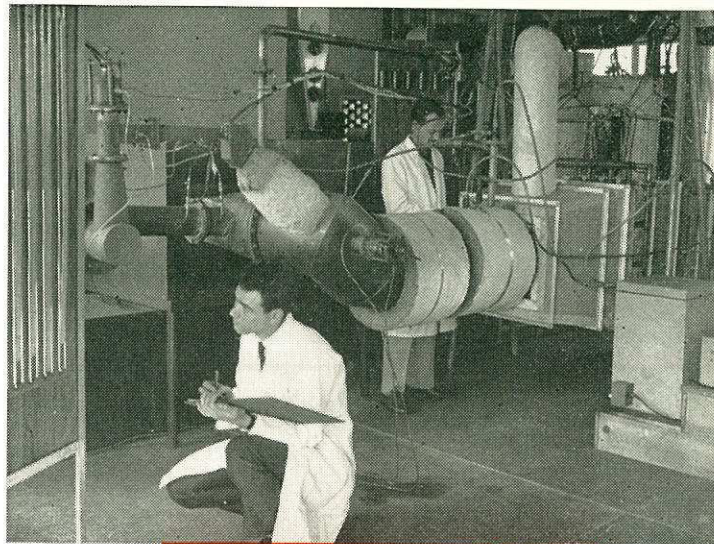
Apart from ropes for the mining industry in South Africa, ropes from South West Africa, Rhodesia and Zambia were tested. From October 1st, 1967, to September 30th, 1968, 4,660 tests were done on ropes of over 1½ inch nominal diameter, and tests on 2,490 smaller ropes were also carried out.

#### Non-statutory testing of components

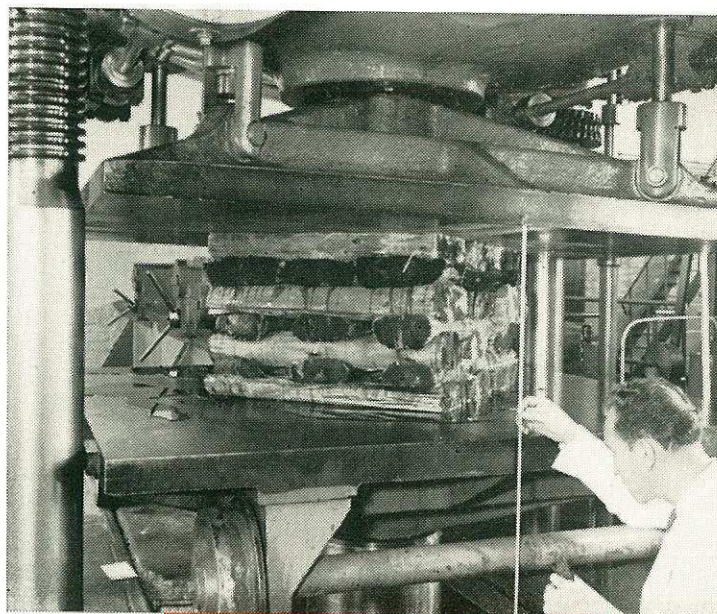
The facilities for testing at high loads, which are available at Cottesloe, were widely used by the Chamber of Mines, the South African Railways, Iscor, private industry, and the CSIR.

#### Service behaviour of winding ropes

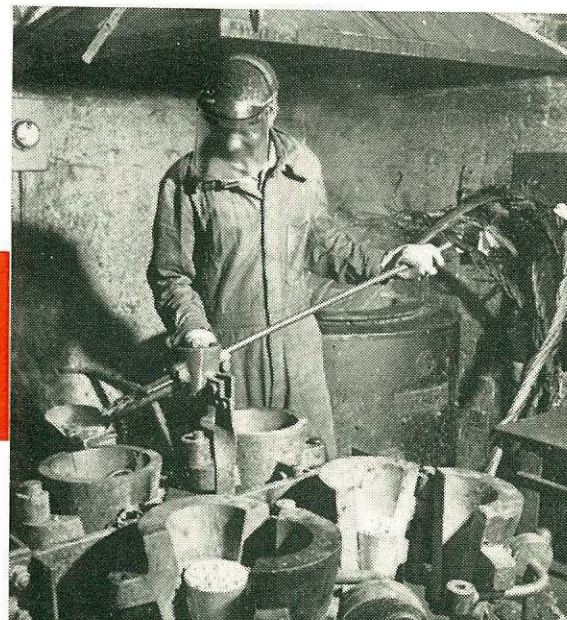
Thirty rock hoists were selected and an analysis was begun of the behaviour of the winding ropes installed in them. Information



Coal-burning gas turbine testing equipment



Testing timber mine-packs at the Mine Equipment Research Unit



Casting white metal end caps on mine winding ropes for testing at the Mine Equipment Research Unit

about all the features that could conceivably affect the performance of the ropes installed in these hoists was collected and tabulated. Equipment to measure and record loads and elongations accurately during statutory tests to destruction has been designed and built.

A device to measure wear in experimental sheave liners was designed and built.

#### **Fatigue of winding ropes**

The unique Universal Wire Rope Fatigue Testing Machine, designed in the Institute, was brought into successful operation. It is possible with this machine to simulate all the fatigue loading conditions to which a mine winding rope is subjected. It will, therefore, be possible to obtain more accurate information on the fatigue behaviour of winding ropes than was possible with any previous testing machine.

#### **Hydraulic hoisting**

As a result of a survey into literature on the subject of hoisting ore out of a mine, it was decided that the principle of the so-called hydrolift system held the greatest promise for further investigations.

To find the design parameters for a prototype plant in a mine, a research plant was built with the same dimensions as the plant to be built underground, only with lower hoisting height. It has been estimated that, if the system works, capital and operating costs should be less than one-half those of conventional hoisting.

### **HYDRAULICS RESEARCH UNIT**

#### **Sediment movement in the sea**

The Unit is currently attempting to trace, in deeper water, silt discharged into the sea. It was established from various surveys carried out during floods in some of the Natal rivers that the silt-laden river water spread out over the heavier sea water. Further studies, which are being sponsored by the South African National Committee for Oceanographic Research (SANCOR), will be concentrated on sediment movements close to the shore along the Natal coast.

#### **Ocean wave research**

The purpose of ocean wave research is to collect and analyse statistically wave data representative of conditions along the entire coasts of South Africa and South West Africa. Wave clinometers are now in operation at St. Lucia, Richards Bay, Durban, Port St. Johns, East London, Cape St. Francis, Mossel Bay and Cape Town. In addition, ship-borne wave recorder records are obtained from the research vessels *Africana II*, *Thomas B. Davie* and the *Meiring Naudé* and from the *S.A.S. Natal*.

The first report was completed in April, 1968.

#### **Coastal design**

A large number of enquiries were received regarding problems of coastal design including one in connection with the stability of the mouth of the Cunene river, one from Queensland, Australia, about coastal protection with dolosse, and one about sediment movements in Chameis Bay.

A further study was made of possible harbour sites on the northern coast of South West Africa. Advice was also given to the consulting engineer appointed to design the harbour regarding the collection of data required and hydraulic model studies. The Unit was also requested by the Administration of South West Africa to carry out model studies for the proposed extensions to the fishing harbour at Walvis Bay.

Further tests were carried out to determine the best layout for the new harbour at Gansbaai. The effect of rubble and dolosse as protection for the vertical wall breakwater was also determined. It was found that such protection was not very effective.





### Durban harbour siltation and beach erosion

Further research was carried out on the Durban underwater mound, a sand ridge about 200ft wide at the crest and rising to about 24ft below low water level. The mound, constructed parallel to and 4,000ft from the shoreline of the Durban beaches, causes large waves to break at that point and thus effectively protects the Durban beaches against storm damage.

The model work — for example, large-scale tests on the stability of the mound and the long-term effect on the beaches — carried out in the 400ft long wind-wave flume, was completed during the year. The results showed that the mound would remain stable and that considerable improvement of the beaches could be expected over the years.

A start was made with the actual construction of the mound in June, 1966, and approximately 3 million cubic yards of sand have been dumped up to now. The mound is now about 8,000ft long (a third of its total length). A close record is kept of the behaviour of both the mound and the portion of the beaches which are already partly protected by the completed section of the mound. Results are very encouraging — model predictions of the mound's stability have been confirmed and the beaches are showing a gradual improvement.

### Richards Bay harbour development

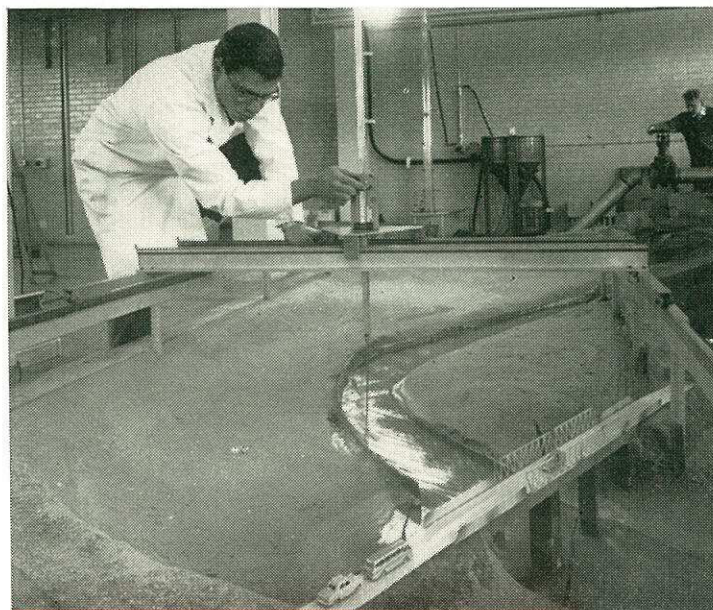
A start was made with a very important project in December, 1967, namely, the development of the harbour at Richards Bay. The South African Railways commissioned the Unit to collect representative oceanographic, hydrographic and geomorphological data at Richards Bay over a period of at least two years and to carry out the necessary model studies for the optimum design of the outer harbour works.

Regular records were made throughout the year of beach changes, variations in the offshore sea bottom, bottom changes in the surf zone, sedimentological changes, wave conditions, currents, winds and changes in the estuary mouth. Tide recording in the sea and in the Bay, sand tracer tests in the breaker zone, recording of flood and suspended solids in the Umhlatuzi river and salinity records in the Bay were also started during the latter part of the year.

All these data are being analysed and interpreted with the object of using the results later in the model studies. A start will be made with the design of the models as soon as the new offshore bathometric survey, to be made by the South African Navy, is completed.

### Rietvlei harbour siltation and wave studies

Investigations were carried out to determine the best harbour entrance layout for a new fishing-cum-shipbuilding harbour at Rietvlei and



Investigation, with the aid of a model, into the best location for a bridge over a river

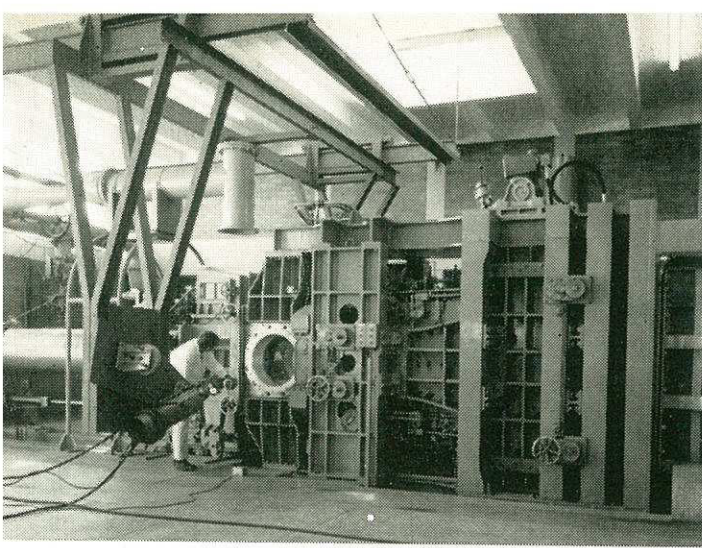
to study the effects on the coastline of this harbour and the proposed new extensions to the main harbour at Woodstock. Both the field-work and the model studies were completed.

It was found that very satisfactory entrance conditions for a harbour at Rietvlei would be obtained, if a breakwater, slightly longer than a mile in length, were erected on the northern side of the entrance.

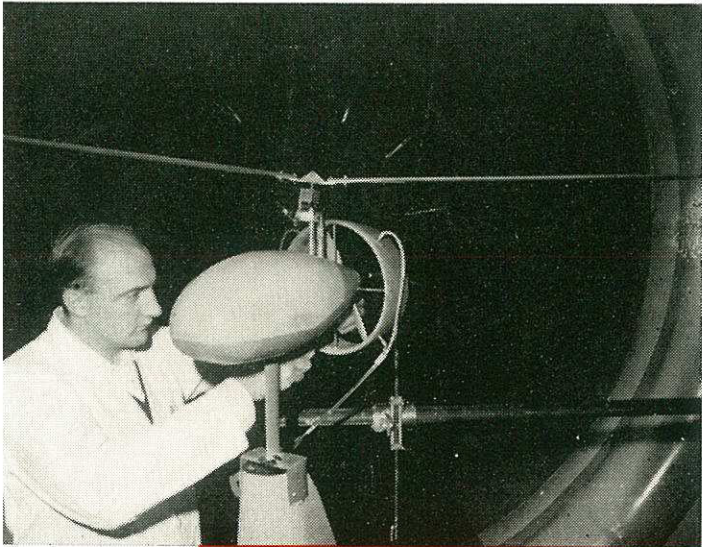
To check what influence such a breakwater would have on the stability of the coastline, the wave and wind conditions encountered over a period of two years, as recorded at Cape Town, were reproduced to scale in the movable bed model. Crushed anthracite was used as model sand and model beach changes were correlated with beach changes measured over two years in Table Bay to prove that the model was behaving correctly. The breakwater of the Rietvlei harbour, as constructed in the model, was found to have no bad effects, and the local erosion, which was found to be caused by the Woodstock harbour extensions could be completely eliminated with a minor relocation of the shore protection works, as proposed by the South African Railways.

### Port Elizabeth shore erosion study

The Department of Transport commissioned the Unit to investigate the causes of serious shore erosion adjacent to the new national road at Deal Party in Port Elizabeth. Methods of re-establishing eroded beaches were also to be studied.



The 0.6 to 4.3 Mach supersonic wind tunnel in the Aeronautics Research Unit



Wind tunnel tests on a model of the two seater autogyro being developed in the Aeronautics Research Unit

A temporary research team was established at Port Elizabeth to carry out an extensive survey of hydrographic and geomorphological conditions. An analysis was made of all available historical data on the behaviour of the Algoa Bay coastline. New depth soundings were made to determine near-shore sediment movements and beach profiles were measured at regular intervals over a shore length of some 12 miles. Wave, wind and current conditions were measured. Wave refraction diagrams, which are of great importance for the determination of the wave energy distribution along the shore, were constructed by computer for 34 typical wave conditions. Littoral drift potentials were calculated and the results were confirmed by sand tracer tests. On the basis of all this work it was possible to define the causes of the erosion and to suggest certain remedial measures, thus completing the first stage of this project.

### Stability of estuary mouths

A start was made during the year with the implementation of the recommended berm scheme to stabilize the St. Lucia estuary mouth. The Natal Provincial Administration requested further advice on construction methods and a visit was paid to the site in this connection.

Further enquiries were received about problems with the siltation of river mouths — for example, the Kowie and Zinkwazi river mouths.

### Sand dams

Intensive surveys of existing sand dams were made in South West Africa. Three dams — the Ondekaremba, Neudamm and Otjozondu dams — are being raised for the specific purpose of carrying out full-scale tests. One of the biggest drawbacks of the system is that it is difficult to prevent the siltation of fine sediments and clay in the dams, with the result that the nett yield and the permeability of the material deposited becomes unacceptable. It is hoped a find a solution in the provision of specially designed openings left in the dam walls which will cause sufficiently high water velocities in the dam to transport the silt through the wall, but which are at the same time sufficiently low to allow the coarser sediments to be deposited behind the dam wall.

## AERONAUTICS RESEARCH UNIT

### Low-speed wind tunnel

The 7ft x 5ft wind tunnel, which had been under construction for some time, was brought into commission. Trial runs indicated that except for a few minor defects, all mechanical and electrical installations were operating satisfactorily. Preliminary measurements in the tunnel indicated that good flow distribution and reasonably low turbulence could be expected in the tunnel working section. The development of special instruments and calibration gear was completed and the systematic calibration of the tunnel was begun. The development of suitable data collecting systems was also started.

### High-speed wind tunnel

A six-component internal strain gauge balance, required for measuring forces on models in the test section of the trisonic wind tunnel, was completed and calibrated.

A 24in Schlieren system for the optical study of supersonic flow about bodies is being installed, primarily for the purpose of carrying out stability tests on free-flying models.

In order to improve the performance of the computer-controlled data acquisition system, an arithmetic unit is being developed by a local computer manufacturer. This arithmetic unit will facilitate the real-time control of processes such as pressure variation in the settling chamber of the trisonic wind tunnel.

#### Stability and control of missiles and high-speed aircraft

A free-flight testing technique is being developed. The technique provides an unusual method of testing projectiles in a conventional wind tunnel with the object of obtaining aerodynamic characteristics which are free from the usual support interference. A pneumatic model launcher of sophisticated design was completed and found to operate most satisfactorily. Specialized instruments were built for the precision measurement of the dynamic properties of a free-flight model. An analysis of the design criteria for free-flight cone models was made so that such models might be manufactured in the near future.

#### Aircraft design and construction

The structural and mechanical design of the experimental two-seater autogyro which is being developed by the Unit was finalized and the construction of the first prototype aircraft was virtually completed. Ground trials of the various mechanisms of the aircraft, and static and mobile ground tests on the aircraft as a whole are under way. Design work on various modifications, the need for which is becoming apparent as the trials proceed, is in progress.

#### Aircraft noise

Further progress was made with the development of a method for assessing aircraft noise disturbance in areas surrounding airports. The aim of the work is to eliminate the problems of aircraft noise by the suitable zoning of residential areas or by revising operational procedure at particular airports. The South African Bureau of Standards co-operated by undertaking a number of surveys of aircraft noise, while the National Institute for Personnel Research undertook a sociological survey with a view to confirming the validity of the method.

The method was discussed at a committee meeting of the International Organization for Standardization held in Denmark, where it was agreed that a further revision of the proposed international method be considered, taking into account the proposals and suggestions arising from the work in South Africa.

### Selected Publications

- BIENIAWSKI, Z. T. Mechanism of brittle fracture of rock. Part III: Fracture in tension and under long term loading. *International Journal of Rock Mechanics and Mining Sciences*, vol. 4, no. 4, Oct. 1967, pp. 425-430.
- BIENIAWSKI, Z. T. Eine in situ Studie des Bruchmechanismus von Kohle. *9 Ländertreffen des Internationalen Büros für Gebirgsmechanik, Leipzig*, November 1967, Akademie Verlag, Berlin, 1968.
- BIENIAWSKI, Z. T. Stability concept of brittle fracture propagation in rock. *Engineering Geology*, vol. 2, no. 3, Dec. 1967, pp. 149-162.
- BIENIAWSKI, Z. T. Note on in situ testing of the strength of coal pillars. *Jl. S. Afr. Inst. Min. Metall.*, vol. 68, no. 10, May 1968, pp. 455-465.
- BIENIAWSKI, Z. T. Mechanism of brittle fracture of rock. Part II: Experimental studies. *International Journal of Rock Mechanics and Mining Sciences*, vol. 4, no. 4, Oct. 1967, pp. 407-423.
- BIENIAWSKI, Z. T. Mechanism of brittle fracture of rock. Part I: Theory of the fracture process. *International Journal of Rock Mechanics and Mining Sciences*, vol. 4, no. 4, Oct. 1967, pp. 395-406.
- BIENIAWSKI, Z. T. and DENKHAUS, H. G. The triaxial state of stress in rock. In: *Proceedings of the 8th International Conference of International Bureau of Rock Mechanics, Leipzig*, November 1966, Akademie Verlag, Berlin, 1967, pp. 17-40.
- DENKHAUS, H. G. Residual stresses in rock masses — General report of theme 4. In: *Proceedings of the First International Congress on Rock Mechanics, Lisbon 1966*, vol. 3, Sept. 1967, pp. 312-313, 366-368.
- DENKHAUS, H. G. Thoughts on the scope of the International Bureau for Rock Mechanics, *10th Anniversary of the International Bureau for Rock Mechanics, Leipzig*, 15 Oct. 1967.
- HEYNS, A. and HODGSON, T. Physiological reactions of desert bushmen in hot, dry and hot, humid conditions. *Int. Z. Angew. Physiol.*, vol. 24, 1967, pp. 315-319.
- LEEMAN, E. R. The determination of the complete state of stress in rock in a single borehole — laboratory and underground measurements. *International Journal of Rock Mechanics and Mining Sciences*, vol. 5, no. 1, Jan. 1968, pp. 31-56.
- MITCHELL, D., WYNDHAM, G. H., HODGSON, T. and NABARRO, F. R. N. Emissivity and transmittance of excised human skin in its thermal emission waveband. *J. appl. Physiol.*, vol. 23, no. 3, Sept. 1967, pp. 390-394.
- MITCHELL, D., WYNDHAM, G. H. and HODGSON, T. The selection of a biothermal radiometer. *J. scient. Instrum.*, vol. 44, 1967, pp. 847-851.
- VAN HEERDEN, W. L. and GRANT, F. A comparison of two methods for measuring stress in rock. *International Journal of Rock Mechanics and Mining Sciences*, vol. 4, no. 4, Oct. 1967, pp. 367-382.
- ZWAMBORN, J. A. The CSIR's new wind-wave flume is amongst world's longest. *South African Engineer*, vol. 85, no. 595, Dec. 1967, pp. 25-29.

# THE NATIONAL NUTRITION RESEARCH INSTITUTE

**T**HE National Nutrition Research Institute (NNRI) is concerned mainly with applied research aimed at raising the nutritional status of all sections of the South African population to a satisfactory level. For this reason the Institute maintains close contact with the Department of Health and other organizations concerned with combating malnutrition.

The activities of the Institute include investigations into the nutritional status of all groups of the South African population; the study of methods of combating malnutrition and preventing deficiency diseases; research on the nutritional value and improved utilization of foods produced in South Africa; research on the harmful substances found in some foods; research on food processing, including investigations on behalf of private industries.



Dr J. J. Theron,  
Director of the  
National Nutrition  
Research Institute

## Nutrition research department

### Supplementary food formulations

Investigations into the problem of finding a low-cost high-protein food mixture for supplementing the proteins, vitamins and minerals in predominantly cereal diets have been completed after several years of intensive research. This work has led to the development of a food mixture which consists of specially prepared whole soybean meal, whole egg powder, milk powder, deodorized fish flour, synthetic vitamins, minerals and flavouring substances. Extensive

A young patient being weighed in the NNRI Nutrition Clinic for Children at the H. F. Verwoerd hospital



laboratory tests, as well as clinical and field trials, have shown the mixture to be not only safe and effective, but also acceptable to the consumer and of good keeping quality. The Institute has thus succeeded not only in developing a most useful tool for combating all common forms of dietary inadequacy amongst the less privileged members of the community, but also in laying a sound scientific foundation for dietary supplementation practice and creating a potentially useful outlet for certain foodstuffs which at present are considered to be over-produced.

#### Biological evaluation of proteins

As part of its attempt to improve available techniques for the laboratory measurement of the nutritive values of foodstuffs, the Institute carried out an extensive investigation into the problem of assessing dietary protein digestibility. Figures pertaining to the digestibility of the proteins present in a large number of common South African foodstuffs have been published.

#### Vitamin deficiencies in the diet

From data obtained during nutrition status surveys carried out in the Pretoria area in recent years, it was concluded that, with the exception of two vitamins of the B-group (riboflavin and nicotinic acid), there were generally no pronounced nutritional deficiencies among children aged 7-15 years in the four main racial groups. Definite signs of a sub-clinical deficiency of riboflavin and nicotinic acid were found in children of all four racial groups, the non-White groups in particular.

Since sub-optimal nutritional levels in these two vitamins are a logical consequence of the traditional non-White diet, it could be expected that this sub-clinical deficiency would not be limited to the Pretoria area. With the co-operation of the Health Advisory Board and the Department of Health, field trials were therefore planned with a view to determining the minimum quantity of these two vitamins re-

quired to supplement adequately the normal intake and to test the suitability of mealie (maize) meal as a possible carrier of the vitamin supplement. Two field trials were planned to investigate these aspects. The first of these is currently in progress near Hammanskraal and the second will be carried out at Pietersburg. It is hoped that these experiments will be concluded during 1969 and that the results will enable the Department of Health to decide whether the supplementation on a national scale of mealie meal with these two vitamins is desirable and justifiable.

#### International Biological Programme

The Division of Field Studies of the National Nutrition Research Institute has been fully occupied in a study which forms part of the International Biological Programme, Human Adaptability Section. In this respect, the National Nutrition Research Institute, the National Institute for Personnel Research, the Human Sciences Laboratory of the Chamber of Mines, the S.A. Institute for Medical Research, the Department of Anatomy of the University of the Witwatersrand and the Non-European Hospital, Johannesburg are engaged in a multi-disciplinary study, the main object of which is to study human adaptation to changing environments. This is the first time that such a large-scale study of this subject has been undertaken.

During the year a study was carried out on rural Venda males in the Sibasa district and another on urbanized Venda males living in Johannesburg. The contribution of the Institute to the study included clinical, biochemical, somatometric, haematological, dietary and socio-economic investigations of each experimental subject.

A comparative analysis of the data obtained in the rural and urban surveys is in progress, the object being to observe in what ways and to what extent the two groups differ from one another.

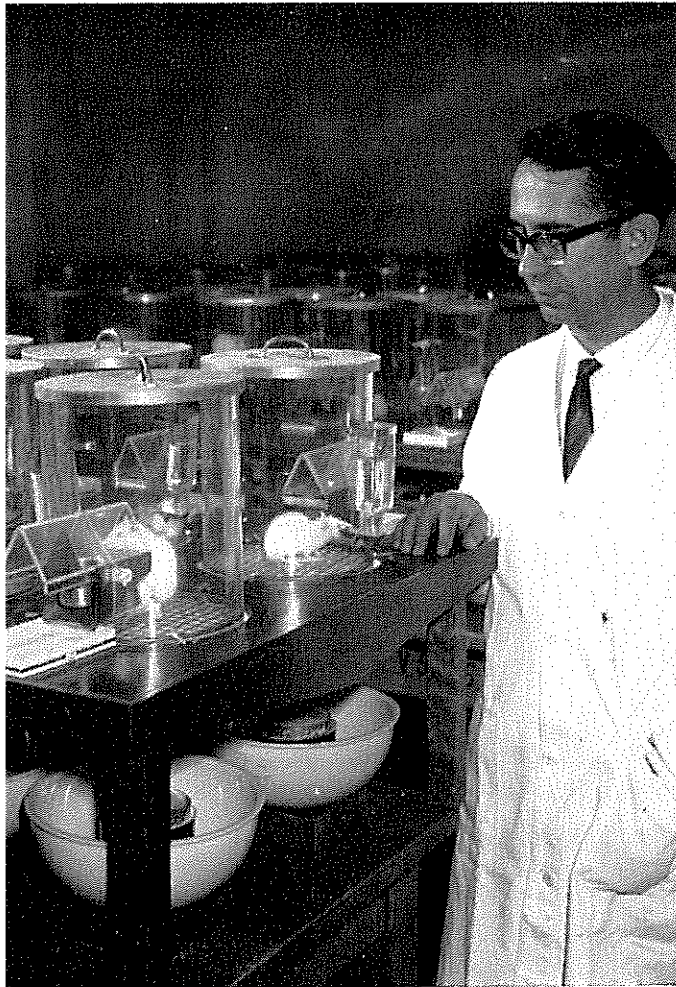
At the same time a study was made of the dietary habits of both rural and urban Venda and of the edible veld foods used in the Sibasa area.

#### Cancer of the liver and oesophagus

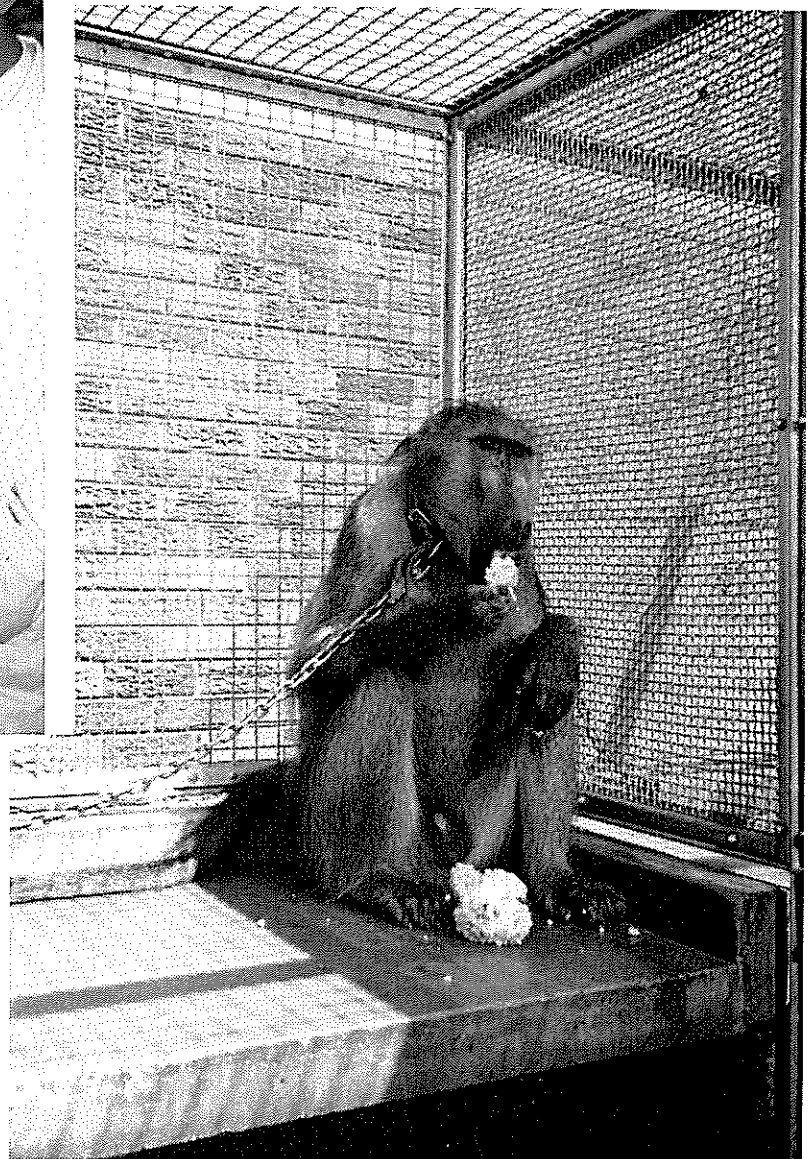
Liver cancer is the most common form of cancer in the Bantu (up to 80 cases per 100,000 population per year). Because liver cancer occurs mainly in hot humid areas, and because the food storage practices of the Bantu people

are unsatisfactory, it has been suggested that contamination of foodstuffs by fungi may be responsible for the high incidence of the disease. It is this relationship which is being studied at the NNRI.

Toxins produced by fungi (mycotoxins) are purified on a large scale so that they may be used in the laboratory to develop methods of analysing foods for toxins, to discover whether these toxins produce tumours and to determine how the toxins produce their effects. New



A special cage used to determine accurately the nutritive value of proteins



In the new primate centre, which was completed during 1968, the baboon is used as an experimental animal in the study of the part played by diet in the incidence of heart disease

methods have been developed for detecting two of the carcinogenic mycotoxins (aflatoxin M and sterigmatocystin) in foods such as milk and certain cereals and legumes. For the first time sterigmatocystin, a mycotoxin produced by at least five different species of fungi, has been shown to produce liver cancer in experimental animals. The most interesting aspect of this finding is that the tumours appear, under the microscope, to be identical to those found commonly in the Bantu.

Another finding, which is of the utmost importance to laboratory workers handling these toxic materials, is that aflatoxin produces cancer of the liver in rats when applied to the skin. The danger to the health of laboratory workers is obvious.

Biochemical studies are being undertaken to find how these toxins alter the genetic material of normal liver cells to produce the changes which initiate the rapid cell growth resulting in cancer.

The facilities for research on the relationship between mycotoxins and the above-mentioned form of cancer have improved considerably during the past year, owing to the availability of primate quarters for housing vervet monkeys and marmosets.

Field studies have also been started. Foods are being collected from the families of cancer sufferers and tested by chemical analysis for the presence of these toxins. Tests involving the feeding of rats with foods collected from the families of oesophageal cancer sufferers in the Cape Province are underway and similar studies are planned in the near future for liver cancer sufferers in Mozambique.

#### **Treatment of kwashiorkor**

Tests were carried out on 120 patients to assess the effect of different sugars on the diarrhoea of kwashiorkor and the disaccharide splitting enzymes of the small bowel were determined in some of these patients. The conclusions can be summarized as follows:

- Lactase deficiency is common and often severe — other enzymes are less affected
- Only lactose could be established as a significant cause of fermentative diarrhoea, and the severity of diarrhoea to a certain extent influenced by the concentration of lactose in the diet
- In general, milk (and thus lactose) does not have an adverse effect on curing kwashiorkor, although there are exceptional cases
- Should it be necessary to remove lactose from the diet in order to control diarrhoea,

sucrose is recommended as a substitute because it is well tolerated, easily available and cheap.

#### **Gastroscopy**

The development of optical glass fibres and the use of these in the gastroscope has enabled rapid progress to be made in the gastroscopic examination of the stomach wall. It is now possible to diagnose stomach cancers and other diseases with certainty. The gastroscope also plays an important role in the investigation of abnormal conditions of the wall of the stomach and small intestine which have been caused by deficiency diseases.

Co-operation between the NNRI Nutritional Clinic for Adults and the Technical Services Department of the CSIR has resulted in the development of an apparatus for cutting 4 mm sections, suitable for use in the gastroscope camera, from normal colour film. This enables 32 colour photographs of the stomach wall to be taken during one investigation. These photographs can be intensively studied later.

## **Food science and technology research department**

#### **Composition of South African foods**

Wild fruits, and also the edible leaves, seeds and tubers of many wild plants, play an important role in the diet of the rural non-Whites. The Division of Food Chemistry of the Institute continued its investigation into these veld foods.

The Division co-operated with a research group of Harvard University, USA., which is at present engaged on a study of the !Kung Bushmen in the Dobe area of Botswana, in analysing about 60 samples of veld foods eaten by the Bushmen. With the co-operation of the State Museum in Windhoek, the Division analysed samples of 18 varieties of edible wild fruits and tubers obtained in the Kaokoveld.

For the purpose of the dietary study, which forms an important sub-division of the nutritional status survey carried out in Vendaland, about 270 food samples were collected and analysed. Data on the nutrient content of these foods are necessary for the quantitative evaluation of the nutrient intake of the group which was studied. The Vendas make extensive use of earthenware pots for the preparation of their food and a comparative study of the iron content of the same type of foods prepared in earthenware and iron pots was made. The

results indicate that the iron content of food prepared in earthenware pots is often appreciably higher than that of food prepared in iron pots. The iron content of the beer in particular was rather high.

### Mealies

Various aspects of the utilization of mealies were investigated in work sponsored by the Mealie Industry Control Board. Assistance was rendered to the Agricultural Faculty of the University of Stellenbosch in connection with the breeding of an "opaque" type of mealie which contains protein of higher quality than do normal types of mealie. Chemical and physical changes which occur in mealies and mealie-meal during storage under different climatic conditions were investigated. A fundamental investigation into processes for preparing pre-cooked mealie-meal was begun. This project forms part of a more general research programme for investigating the industrial processing of mealies for human consumption.

### Unmalted kaffir corn for brewing of Bantu beer

At the request of the Mealie Industry Control Board, research was carried out on the processing of kaffir corn with a view to obtaining products more suitable for use in the brewing of Bantu beer. For this purpose it was necessary to prepare kaffir corn grits which complied with certain requirements. Various processing procedures were investigated, and test brews carried out using some of the grits produced resulted in the brewing of Bantu beer with an exceptionally good flavour.

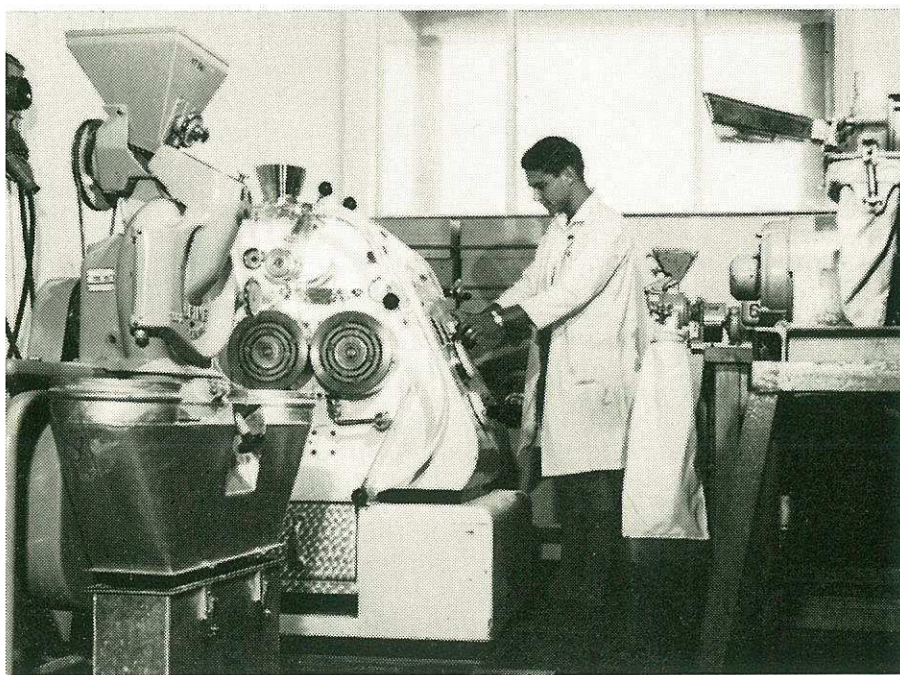
### The milling of mohango

Mohango or pearl millet (*Pennisetum typhoides*), which is the staple food of the Ovambos of South West Africa, is one of the oldest known types of grain. The Ovambos still use the traditional method of reducing it to a fine meal by "stamping", followed by passing through plaited grass sieves. This meal is used for making porridge and various beverages. It was necessary to develop a simple mechanized milling process in order to produce meal for use in institutions such as hospitals and schools in northern South West Africa. When the whole grain is ground in a simple mill, such as a hammer mill, the resulting product is bitter. The Institute found that a very satisfactory meal could be obtained by partially de-germing and decorticating the grain and then passing it through a simple mill. The extraction rate which would ensure the production of an acceptable product without undue loss of vitamins was also established. The procedure is simple and can be applied economically in those situations for which it was designed.

### Protein research

Supplying sufficient proteins of satisfactory quality to the steadily growing world population has become a very serious problem. It was thus deemed advisable to establish a research group which would devote its attention to the utilization of South African protein resources for human nutrition.

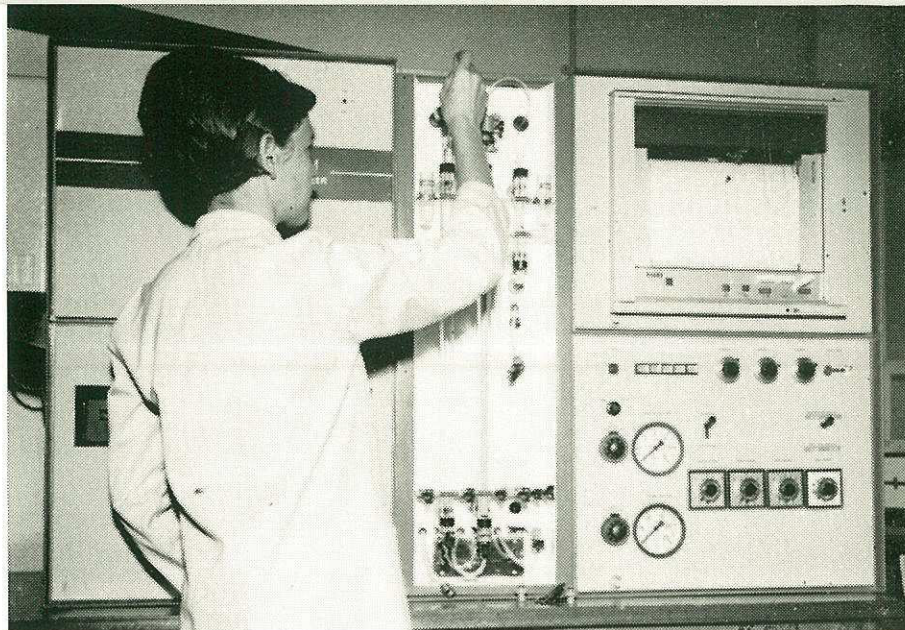
The first step in this direction was the establishment, this year, of facilities for amino acid analysis. The lysine content of a large number



General view of the milling room



Apparatus used for amino-acid analysis



of maize samples was determined in connection with the development of maize varieties with proteins of high nutritional value. It is intended to expand the research group so that both chemical and technological aspects of protein utilization can be investigated on a broader basis than is possible at present.

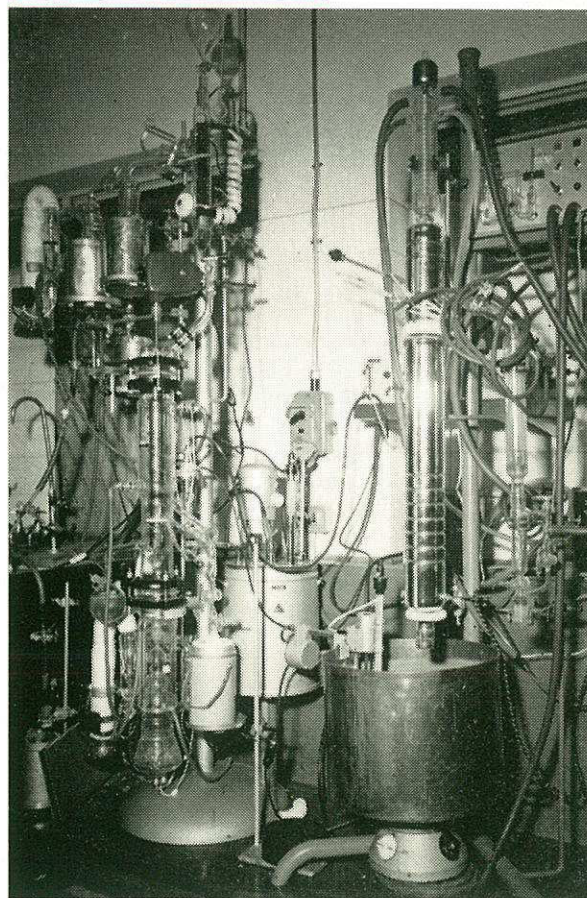
#### Soya beans

Research on the processing of South African soya beans was continued. The object was to determine the most effective and economical methods of treatment to ensure the removal or destruction of the undesirable antitryptic factor and bitter substances present, in the manufacture of a meal with a high food value. Soya meal is a major component of the food supplement which has been developed in the Institute and it can play an important role in the campaign against malnutrition in South Africa. The determination of protein values by means of test animals is time-consuming and expensive. Protein evaluation by means of micro-organisms was therefore investigated, with a view to using this method for determining the protein quality obtained by applying various processing procedures. The results obtained, using the organisms *Tetrahymena pyriformis* W., were very promising and are being compared with those obtained by the conventional method using test animals.

#### Flavour research

The rapid development of gaschromatographic techniques has greatly facilitated and stimulated research into the flavouring substances in foods. During the past few years a flavour research section of the Division of Food Technology has been built up. Most of its efforts have been focused on the flavour of ground-nuts. Knowledge of the nature of the substances which combine to produce the flavour of ground-nuts will provide an objective standard for assessing the value of new varieties of nut and for determining the effects of processing procedures. An investigation of the most satisfactory temperatures for drying ground-nuts artificially after they have been removed from the ground has shown that these should not exceed 40°C.

High-vacuum still used for flavour separation



# Microbiological Research Group

## Bantu Beer sourings

In the manufacture of Bantu Beer spontaneous souring is often effected by maintaining a suspension of kaffir corn malt in water at 48°-50°C for some hours.

Industrial malts can be divided into two groups on the basis of their ability to produce acid spontaneously at 50°C: slow-souring malts which produce small amounts of acid, and quick-souring malts which produce 2-3 times as much acid under the same conditions.

Microbiological studies showed that spontaneous souring with slow-souring malts was brought about by *Pediococcus* sp. and *Bacillus coagulans*. In sourings with the quick-souring malts, Thermobacteria (*Lactobacillus delbrueckii* or *Lactobacillus leichmannii*) developed in addition to the above-mentioned organisms.

Thermobacteria proved to be the most desirable souring organisms. However, apart from the absence of Thermobacteria from the slow-souring malts, even quick-souring malts did not contain sufficiently large numbers of Thermobacteria to bring about good souring. They were also not evenly distributed in the quick-souring malts.

Spontaneous souring has, therefore, proved to be not only inefficient but also a highly erratic and industrially undesirable means of acid production. At present attempts are being made to control the souring process through the use of specially selected cultures as inocula.

## Ochratoxin

Investigations into the production of ochratoxin have been continued. It has been established that *Aspergillus ochraceus* has a highly specific need for glutamic acid in the synthesis of this compound. The influence of this amino acid on the biosynthetic processes is, however, indirect.

The activity of the tricarboxylic acid cycle has also been measured under different nutritional conditions.

The preparation of radio-actively labelled ochratoxin has also progressed. Carbon-14 has been incorporated from the following substrates: phenylalanine, acetate-1-C-14 and formiate-C-14.

## Cyclopiazonic acid

A synthetic medium was developed in which a strain of *Penicillium cyclopium* produced cyclopiazonic acid, with yields in the region of 800mg per litre. Radio-active tracer studies showed this compound to be biosynthetically derived from tryptophan, acetic acid and mevalonic acid. Ionic zinc and iron are required for its synthesis. In the absence of either of the two metals, a new metabolite, which is structurally related to cyclopiazonic acid, and which has been designated  $\beta$ -cyclopiazonic acid, was found to form. Sixty per cent of the radio-activity from a sample of C-14-labelled  $\beta$ -cyclopiazonic acid, added to cultures of *Penicillium cyclopium* grown in a complete medium, was incorporated into cyclopiazonic acid *per se*, thereby establishing the role of the  $\beta$ -compound as a precursor of cyclopiazonic acid.

## Selected Publications

- BALLSCHMIETER, H. M. B. Die Sorptionsisothermen von Mehlen, Mehlprodukten und anderen Lebensmitteln bei 30°C. *Getreide und Mehl*, vol. 17, no. 10, 1967, pp. 118-120.
- BALLSCHMIETER, H. M. B. Die südafrikanische Obst- und Gemüseverwertungsindustrie im Jahre 1965/66: *Die industrielle Obst- und Gemüseverwertung*, vol. 52, no. 19, 1967, pp. 623-624.
- BALLSCHMIETER, H. M. B. Die ondersoek van die geur van voedsel. *Fd Inds S. Afr.*, vol. 20, no. 10, 1968, pp. 32-35.
- BALLSCHMIETER, H. M. B. Ein Molkenpräparat als Fliessmittel. *Milchwissenschaft*, vol. 22, no. 9, 1967, pp. 540-541.
- BALLSCHMIETER, H. M. B. Ein Weizenhefebrot mit 50 Prozent Mais im Mehlanteil. *Brot und Gebäck*, vol. 22, no. 4, 1968, pp. 66-71.
- BALLSCHMIETER, H. M. B. & VLIETSTRA, H. Studien über das Verkürzen des Backverfahrens. *Brot und Gebäck*, vol. 21, no. 12, 1967, pp. 229-234.
- DE WIT, J. P. Methods of combating malnutrition. *S. Afr. med. J.*, vol. 42, no. 24, 1968, pp. 597-598.
- DREYER, J. J. Supplementary effect of the National Nutrition Research Institute food mixture on cereal proteins. *S. Afr. med. J.*, vol. 42, 1968, pp. 604-610.
- DREYER, J. J. The biological assessment of protein quality: A formula for rapid estimation of metabolic faecal nitrogen excretion in albino rats. *S. Afr. med. J.*, vol. 42, 1968, pp. 356-376.
- DREYER, J. J. The biological assessment of protein quality: Digestibility of the proteins in certain foodstuffs. *S. Afr. med. J.*, vol. 42, 1968, pp. 1304-1313.
- DREYER, J. J. & DU BRUYN, D. B. Composition of a food mixture developed at the National Nutrition Research Institute for supplementation of predominantly cereal diets. *S. Afr. med. J.*, vol. 42, 1968, pp. 600-604.

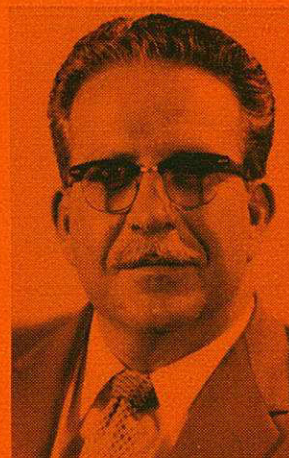
- DU BRUYN, D. B. Mineral and vitamin efficiency of the National Nutrition Research Institute food mixture. *S. Afr. med. J.*, vol. 42, 1968, pp. 611-615.
- DU PLESSIS, J. P., DE LANGE, D. J. & VIVIER, F. S. The biochemical evaluation of the nutrition status of urban school children: Nicotinic acid status. *S. Afr. med. J.*, vol. 42, 1967, p. 1212.
- DU PLESSIS, J. P., VIVIER, F. S. & DE LANGE, D. J. The biochemical evaluation of the nutrition status of urban school children aged 7-15 years: Serum cholesterol and phospholipid levels and serum and urinary amylase activities. *S. Afr. med. J.*, vol. 41, 1967, p. 1216.
- DU PLESSIS, J. P. *An evaluation of biochemical criteria for use in nutrition status surveys.* CSIR Research Report no. 261, Pretoria, CSIR, 1967, 126p.
- FERREIRA, N. P. Recent advances in research on ochratoxin, Part 2. In: *Biochemistry of Some Foodborne Microbial Toxins*, R. I. Mateles & G. N. Wogan, Editors. M.I.T. Press (Mass.), 1967, pp. 157-168.
- LUBBE, A. M. A survey of the nutritional status of White school children in Pretoria: Description and comparative study of two dietary survey techniques. *S. Afr. med. J.*, vol. 42, no. 24, 1968, pp. 616-622.
- MEKEL, R. C. P. M., THERON, J. J. & SIMSON, I. W. Malignant hepatoma in the Bantu. *Recent advances in gastro-enterology*, vol. III, 1967, pp. 87-89.
- MEKEL, R. C. P. M., SIMSON, I. W. & THERON, J. J. A clinico-pathological study of massive hepatic necrosis. *Recent advances in gastro-enterology*, vol. III, 1967, pp. 246-248.
- MEKEL, R. C. P. M., THERON, J. J. & SIMSON, I. W. Pneumonia with jaundice in the Bantu. *Recent advances in gastro-enterology*, vol. III, 1967, pp. 283-285.
- NESER, M. L. The red cell picture in White, Bantu, Coloured and Indian school children of 6-15 years as observed during the Pretoria Nutrition Status Survey of 1962-1965. *S. Afr. J. Lab. clin. Med.*, vol. 14, no. 3, 1968, pp. 768-776.
- NESER, M. L. The leucocyte picture in White, Bantu, Coloured and Indian school children of 6-15 years as observed during the Pretoria Nutrition Status Survey of 1962-1965. *S. Afr. med. J.*, vol. 42, 1968, pp. 444-450.
- NESER, M. L. The sedimentation rate in White, Bantu, Coloured and Indian school children of 6-15 years, as observed during the Pretoria Nutrition Status Survey of 1962-1965. *S. Afr. med. J.*, vol. 42, 1968, pp. 1128-1137.
- PITOUT, M. J. The effect of ochratoxin A on glycogen storage in the rat liver. *Toxic. appl. Pharmac.*, vol. 13, 1968.
- PRETORIUS, P. J., SIMSON, I. W., JANSEN, C. R., PRINSLOO, J. G., DE VILLIERS, L. S. & VAN HEERDEN, C. Prolonged obstructive jaundice in Bantu infants. *S. Afr. med. J.*, vol. 42, no. 21, 1968, pp. 518-527.
- PRINSLOO, J. G., DU PLESSIS, J. P., KRUGER, H., DE LANGE, D. J. & DE VILLIERS, L. S. Protein nutrition in childhood pellagra. Evaluation of nicotinic acid status and creatinine excretion. *Am. J. clin. Nutr.*, vol. 21, 1968, p. 98.
- PURCHASE, I. F. H. Mycotoxins in cancer. In: *Proceedings of the symposium Cancer in Africa*, held in Nairobi in January, 1967, pp. 327-331. Published in November 1967 by East African Medical Journal. Distributed by East African Publishing House, Nairobi, Kenya.
- PURCHASE, I. F. H. & VORSTER, L. J. Aflatoxin in commercial milk samples. *S. Afr. med. J.*, vol. 42, 1968, p. 219.
- SCHWEIGART, F. & ROOS, J. M. E. Bereiding en opberging van 'n volmelkpoeier-ekwivalent uit afgeroomde melk en 'n plant-olie. *The Dairy Industry Journal of Southern Africa*, vol. 7, no. 3, 1967, pp. 123-129.
- SCOTT, DE B. *The genus Eupenicillium Ludwig.* CSIR Research Report no. 272, Pretoria, CSIR, 1968, 150p.
- SCOTT, DE B. & STOLK, A. C. Studies on the genus *Eupenicillium* Ludwig. II. Perfect stages of some Penicillia. *Antonie van Leeuwenhoek*, vol. 33, 1967, pp. 297-313.
- STOLK, A. C. & SCOTT, DE B. Studies on the genus *Eupenicillium* Ludwig. I. Taxonomy and nomenclature of Penicillia in relation to their sclerotoid ascospore states. *Persoonia*, vol. 4, 1967, pp. 391-405.
- THERON, J. J., MEKEL, R. C. P. M. & JANSEN, C. R. Electron-microscopical studies of the small intestine of Bantu patients with iron overload. *Recent advances in gastro-enterology*, vol. II, 1967, pp. 483-486.
- THERON, J. J., PURCHASE, I. F. H. & NEL, W. Occurrence and pathologic effects of toxigenic fungi in a predominantly cereal diet. In: *Proc. of 7th Int. Congr. Nutr.*, vol. 4, Hamburg.
- VAN DER WALT, J. P. *Wingea*, a new genus of the Saccharomycetaceae. *Antonie van Leeuwenhoek*, vol. 33, 1967, pp. 97-99.
- VAN DER WALT, J. P. *Kluyveromyces wikenii* and *Kluyveromyces eicensporus* spp. n. *Antonie van Leeuwenhoek*, vol. 32, 1966, pp. 393-398.
- VAN DER WALT, J. P. Sexually active strains of *Candida albicans* and *Cryptococcus albidus*. *Antonie van Leeuwenhoek*, vol. 33, 1967, pp. 246-256.
- VAN DER WALT, J. P. & NEL, E. E. *Candida edax* sp. n. *Antonie van Leeuwenhoek*, vol. 34, 1968, pp. 106-108.
- VAN KERKEN, A. E. & KANDLER, O. Die Laktobazillenflora des Tilsiterkäses. *Milchwissenschaft*, vol. 21, 1966, pp. 436-440.
- VAN TWISK, P. Dry-milling and dry-degerming of maize. *Die Stärke*, vol. 20, no. 4, 1968, pp. 127-130.
- VAN TWISK, P. & FELLINGHAM, S. A. Inleidende ondersoek na die  $\alpha$ -amilase-verteerbaarheid van die stysel van verskillende mielievariëteite afkomstig van verskillende produksiestreke. *Tydskrif vir Natuurwetenskappe*, vol. 8, no. 1, 1968, pp. 27-31.
- VLIETSTRA, H. Der Einsatz des Varia-Stuhles zur Vermahlung von Babala (*Pennisetum typhoides* (glaucom)) *Die Mühle*, vol. 104, no. 37, 1967, pp. 559-560.

# THE NATIONAL INSTITUTE FOR PERSONNEL RESEARCH

**T**HE optimum utilization of labour resources is of the utmost importance in South Africa with its acute manpower shortage, especially in respect of skilled labour. For this reason, the National Institute for Personnel Research (NIPR) 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 these factors, which include the following —

- definition of the characteristics of work, i.e. the physical and psychological demands on the worker, a description of the job, the value of a specific task in relation to others and the performance of duties
- selection and placing of the right man in the right job (by means of aptitude tests, interest tests, and others) and giving him the necessary training
- improvement of working conditions and equipment in order to suit the task to the worker and to eliminate unnecessary strain, fatigue and risk
- studies of the socio-psychological aspects of work, e.g. manpower shortages, human relations in the work situation, work motivation and the worker's attitude towards his job, his fellow-workers and his superiors
- investigating problems arising from mal-adjustment to work, e.g. absenteeism, accidents, occupational disorders and group conflicts.



Mr D. J. M. Vorster  
Director of the  
National Institute  
for Personnel  
Research

## Significant organizational developments

Traditionally the mathematical and statistical activities of the NIPR have been combined in one Institute division, latterly known as that of Mathematical Psychology. When the link-up of the NIPR and the computer system of the University of the Witwatersrand took place, it became clear that this division should devote all its time to computer work, in order to improve the computer services to research divisions and to develop new computer applications suitable for NIPR research.

At the same time, it became clear that the more basic mathematical problems dealt with by the Institute were beginning to show a distinct bias towards psychometrics — a deve-

lopment which is not surprising, since this is one of the areas in which industry, universities and private practitioners look to the NIPR for instruments and for guidance in their use.

Consequently, the division of Mathematical Psychology has been reconstituted as a computer division, and its activities in the fields of consultation and research have been transferred to an enlarged unit specializing in psychometric methods. This unit falls under the Psychometrics Division.

A further organizational development has been the establishment, at the South African Scientific Liaison Office in Cologne, of a psychological testing service to assist with the recruitment and selection of prospective CSIR research staff from the Continent and the United Kingdom. The appointment of an experienced NIPR staff member to work in this sphere should more than justify the costs involved.

#### Requests for assistance

It is now the policy of the NIPR to channel its activities rather more towards directed basic research than it has done previously and thus not to invite sponsored work which offers little scope for original research. Nevertheless, a considerable number of requests for assistance were received. A total of 111 enquiries from within the Republic were dealt with. Of these, 18 per cent were directly related to the white labour force while 33 per cent were directly related to non-white labour.

There was a significant increase in the number of enquiries from foreign countries, especially other African states. The total of 48 enquiries included some from Zambia, Swaziland, Lesotho, Rhodesia, Botswana, the Congo, Malawi, Tanzania, Ghana, Senegal, the United Kingdom, the United States of America, Israel, the West Indies, Switzerland and Syria. Special efforts were made to meet requests for assistance from neighbouring states and, where the NIPR was unable to assist, the enquiries were referred to other South African organizations.

#### Recently completed research

A decade of NIPR studies of Kalahari Bushmen, which centred around the development of cognitive functions, especially conceptual thinking, in primitive peoples, was concluded with the completion of a chapter on psychological studies of the Bushmen, which is to form part of a book entitled *Studies on the biology of the Bushmen*. This book is being published by the Witwatersrand University Press under the editorship of Prof. P. V. Tobias. Its purpose is to provide a record of the research undertaken under the auspices of the Kalahari Research Committee and of the results obtained during this research. The chapter supplied by the NIPR contains a synopsis of observations on Bushman behaviour; a discussion of the methodological problems encountered in an experimental approach to

investigating the psychology of the Bushmen (and other illiterate people of indigenous cultures) and attempts made by the NIPR to solve these problems; brief descriptions of all 36 tests and experiments applied to Kalahari Bushmen; a discussion of the results of these experiments and their implications for comparative and developmental psychology, and for certain psychological theories; and, finally, suggestions for further research and for the application of some of the knowledge gained to the future development of the Bushmen.

This work plays an important part in the cross-cultural research programme of the NIPR. The Kalahari experiences have led to the construction of test instruments applicable to cross-cultural studies, and to the clarification of problems concerning the development of cognitive functions, particularly conceptual thinking, not only in the Bushman but in illiterate Bantu or "undeveloped" people in general.

The tests have been included in the test battery designed for the contribution made by the NIPR to the Human Adaptability Section of the International Biological Programme.

The project leader undertook an overseas tour during the year, and found that there was very keen interest in the NIPR's cross-cultural studies; he was asked to report on them in some detail.

The study of the effects of ante-natal decompression treatment on the mental development of infants up to the age of three years was completed with the publication of the psychological and neuro-psychological results. In the psychological study no meaningful differences were found between the mental development of 89 children born after decompression treatment and 90 children born after conventional ante-natal care. In the neuro-psychological investigation, no difference in electro-cerebral maturation (as measured by the electroencephalograph) between the experimental and control groups was found, although the incidence of EEG in the control group was slightly higher.

This study has aroused much interest both in South Africa and overseas, and a senior member of staff has been invited to present a paper at a symposium on intra-uterine experience during the International Psychological Congress in London in 1969.

After long delays in the reproduction of the NIPR's courses in programmed mathematics for the National Technical Examinations, these have now been completed, and follow-up studies have confirmed that the programmes can play an important part in mathematical training in several sectors of the nation. What remains to be done is largely of a routine and administrative nature, such as the preparation of an Afrikaans version and further follow-up studies of special applications of the programmes.



Three year old child being tested during investigation into the effects of maternal ante-natal decompression treatment on infant mental development



Subject responding to projective test of personality (TAT) by creating a story

### Test construction

Test construction continued to receive a lot of attention. Both English and Afrikaans versions of a general selection test battery for use as an admission test to graduate business schools in South Africa was completed. The battery is now being standardized and several universities are collaborating in this task.

Another project concerned with the psychological testing of high-level manpower is the attempt to standardize the creativity tests of the NIPR. This is a complex task, but considerable progress has been made in developing standard scoring methods for some of the tests.

Most of the testing needs of industry still relate to the lower occupational levels, and developments in this sphere aim at providing the NIPR with a repertoire of tests applicable to South African Bantu through the whole range from those still at the tribal level to established urban industrial workers. A number of new tests in the cognitive field were completed. The need for tests to assess the personality of the Bantu is rapidly becoming more urgent as they advance in a modern, industrialized society. Good progress was made in constructing tests for this purpose and field applications were carried out in Zululand during the year.

### Human factor in road safety

At the request of the National Institute for Road Research the human factor in road safety is being investigated. Studies carried out in

the NIPR resulted in the decision to limit the present research to an investigation of road signs on 460 miles of tarred roads in the Transvaal.

The NIPR project has been based on the preliminary hypothesis that, instead of accepting the warnings, commands or information presented by road signs, the road user prefers to draw his own conclusions from his observations of the road, and to use them, rather than the signs, as a basis for his actions. Testing this hypothesis entails working through three stages, the first of which is the "rationale of the signs". This means investigating what the road authorities conceive to be the function of road signs, and the degree to which there is a definite and uniform policy behind their placing. Furthermore, it involves an investigation into what actually is communicated by the road sign system as it is understood by key personnel in the Transvaal Roads Department. This part of the project has been completed.

The second stage, which is at present in progress, is "the view of the road user". This involves a critical examination of all the road signs within the area and surveys of samples of the road-using public. The purpose of these surveys is to find out whether road users find the signs so reliable that they make a habit of altering their driving in response to them (without being influenced by any other information from the road itself), or whether they tend to ignore the signs and, if so, to what extent.

### Neuropsychological research

During the year a Mnemotron 400c Computer of Average Transients (CAT) was acquired. This device, together with the magnetic storage equipment obtained previously, put the Institute in the forefront with regard to neuropsychological and electro-physiological facilities in the Republic. The apparatus was put to immediate and intensive use, and facilitated the more refined analysis of EEG and other neuropsychological data.

The final report on a project on the EEG in 21 cases of heat stroke was submitted to the sponsor. Amongst other conclusions, it was noted that there is a very high incidence of EEG abnormality in heat stroke, especially soon after its onset. In those cases that survive, the incidence of abnormality is lower but may rise again after one month or more. It was recommended that, *inter alia*, animal studies of brain function in experimental heat stroke should be carried out in an attempt to obtain further information on the significance of the findings of the study. Such animal studies were started during the year in collaboration with the Pneumoconiosis Research Unit of the CSIR, the Human Sciences Laboratory of the Chamber of Mines, the South African Institute for Medical Research and the Johannesburg Hospital. Results obtained so far suggest that the EEG, together with the EKG, might prove to be a useful method of detecting the time of onset of neurological and/or neurophysiological changes accompanying or even preceding the onset of the clinical symptoms of the illness.

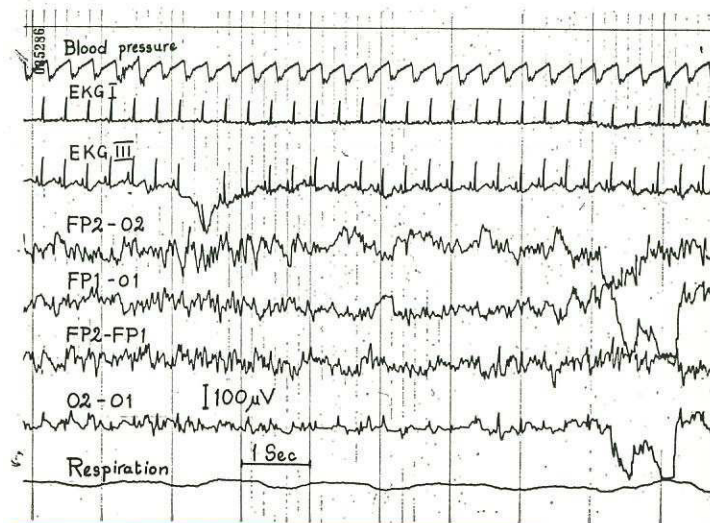
### Training of supervisors

A study has been initiated to develop a supervisory training manual for front-line supervisors. When this manual is being developed, it is intended to extend the training to cover aspects which have a bearing on successful supervision but which are not sufficiently covered by present training methods. In addition, use is being made of the programmed instruction method to permit the standardization of instructions, the application of learning principles, self-instruction and individual pacing.

The study is being undertaken in a factory producing light electronic equipment. The availability of efficiently-kept production records provides an opportunity for measuring the effects of training more accurately than usual.

Work carried out so far has indicated the need for supervisory training programmes in the following spheres —

- personnel management for supervisors
- induction of new employees
- job instruction
- human relations.



A 10-second sample of a polygraphic recording from a vervet monkey during experimental induction of a heat stroke

### Bantu in urban and border industrial areas

In conjunction with the Department of Planning and the Industrial Development Corporation the Institute is conducting a long-term comparative study of the stability and productivity of the Bantu labour force in an urban and a border industrial area. Field work was carried out in 1967 in an organization which had branches in both urban and border areas, branches which, for all practical purposes, were comparable in respect of management, production methods and composition. Comparative results between the two factories seem to reveal interesting differences but no final conclusions can be drawn as yet. During the current year a study has been made of two more textile factories which are larger than and which manufacture different products from those studied in 1967.

### Personnel selection and vocational guidance

The demand for these services continues to be great, and as a result, the division responsible finds itself compelled to concentrate on applied service functions rather than on research. During the year, numerous operational surveys were conducted, selection techniques were established, and training was given in test administration. A large variety of companies, mainly in the secondary manufacturing section, was served in this work.

### Apprentices in the building industry

After an enquiry in 1963 into the attitudes, opinions, grievances and dissatisfactions of artisans in the building industry, substantial improvements in the service conditions of

artisans and apprentices were introduced. In spite of this, the number and quality of applicants for apprenticeships remains unsatisfactory.

On behalf of the National Development Fund for the Building Industry, the NIPR is consequently undertaking an enquiry into the attitudes of building industry employers towards the recruitment and training of apprentices.

A questionnaire was sent to the largest possible number of employers to obtain factual information as well as information on attitudes and opinions. A report on this part of the work has been submitted. Interviews are now being conducted to explore the reasons underlying the attitudes and opinions expressed by employers regarding the recruitment and training of apprentices. It is also hoped to obtain opinions and suggestions for alternative means by which the skilled manpower shortage in the industry may be alleviated.

The postal survey revealed that, in general, building industry employers seemed to lack interest in the recruitment and training of apprentices. Another finding was that the majority of employers believed that increased wages would attract a better type of apprentice, particularly if higher wages were paid to those with higher educational qualifications.

#### Bantu workers in secondary industry

The Institute had for some time been considering an investigation into the job expectations, job attitudes and motivation of Bantu workers in secondary industry when it became evident that the Bantu Wage and Productivity Association was keenly interested in such a study.

The Association through its member firms, made subjects available for a study of this nature and contributed towards it financially.

Since the project is being undertaken on behalf of a nation-wide association of employers of Bantu workers, the findings will be widely publicized. Every effort will be made to make the report to the sponsors as pragmatic as possible, by emphasizing those findings which can be shown to have a practical bearing on work performance.

#### International Biological Programme

The NIPR was actively engaged in the activities of the Human Adaptability Section of this programme which entered its first year of active field work. The Director is convener of the South African Human Adaptability Committee, and the Institute is represented on the international working party established to recommend standard practices for psychological measurement.

The Institute's own projects in the South African multi-disciplinary study of human adaptation has been closely integrated with the rest of its research programme. It has undertaken

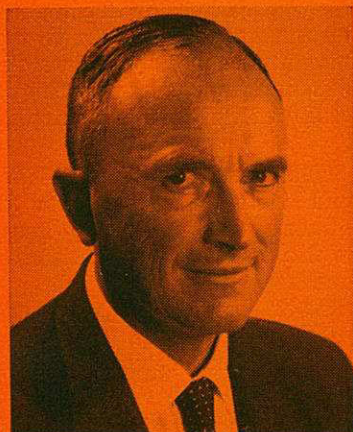
to investigate the primary mental abilities of the Bantu in cultural transition from an illiterate-rural to a literate-urban or westernized background. A battery of sixteen cognitive tests have been compiled for administration to the Venda people in the Northern Transvaal. In addition, a schedule with which to measure the extent of urbanization (acculturation) of the subjects to be investigated in the study has been formulated. Instruments have also been developed for assessing work motivation, needs and aspirations in the groups selected. Apart from their intrinsic scientific value, the findings of this project should be of practical value to government authorities as well as to employers of Bantu workers.

### Selected Publications

- BLIGH, N. A comparative study of visual and auditory responses in two ethnic groups. MA thesis, University of the Witwatersrand, 1968.
- BROWNE, M. W. On oblique Procrustes rotation. *Psychometrika*, vol. 32, 1967, pp. 125-132.
- COWLEY, J. J., GRIESEL, R. D. and THOMPSON, M. A. Food restriction in Zulu women during pregnancy and the puerperium. *Hlth. Educ. J.*, vol. 27, 1968, pp. 23-35.
- DE WET, D. R. An appraisal of sensory-motor activities. *Psychologia Africana*, vol. 12, no. 1, 1967, pp. 17-41.
- FRIEDLAND, E. E. C. Selfvertroue soos gemeet op die Willemseplank. MA thesis, University of Pretoria, 1967.
- GRIESEL, R. D. Adaptability and malnutrition. *S. Afr. J. Sci.*, vol. 63, no. 11, 1967, pp. 457-463.
- GRIESEL, R. D. Electronics and the human brain. *Radio ZS*, vol. 21, no. 6, 1967, pp. 10-13 and 28.
- LIDDICOAT, R. The effects of maternal antenatal decompression treatment on infant mental development. *S. Afr. med. J.*, vol. 42, 1968, pp. 203-211.
- NELSON, G. K. *Race, culture and brain function*. Institute for the Study of Man in Africa, Johannesburg, 1967.
- READER, D. H. The sociology of alcoholism and excessive drinking. A critical review. *Medical Proceedings*, vol. 13, no. 19, 1967.
- SKAWRAN, P. R. Der Dasup und die Universität von Pretoria. *Referat*, vol. 1, 1967.
- SKAWRAN, P. R. Konformistische und nicht-konformistische Handschriften. *Zeitschrift für Menschenkunde*, vol. 31, no. 2, 1967, pp. 57-81.
- SKAWRAN, P. R. Vom Sterben und vom Tode. *Gespräche/Gesprekke*, 1967.
- VORSTER, D. J. M. Personeel en produktiwiteit. *Business and Administration*, June 1967.
- WINTER, W. L. Size constancy, relative size estimation and background: A cross-cultural study. *Psychologia Africana*, vol. 12, no. 1, 1967, pp. 42-58.



# THE NATIONAL PHYSICAL RESEARCH LABORATORY



Dr A. Strasheim,  
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National Physical  
Research Laboratory

**T**HE 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 for 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.

Physical research and technology cover a very wide spectrum of scientific endeavour. In a country like the Republic, with its limited resources, it is impossible to cover every type of important work. The choice of our research and technological development programme must therefore be very carefully made, and the principle we have followed in choosing research projects — which has up to now paid dividends — has been that before any research is undertaken, there must be a definite need for such research. For example, in 1948 scientific knowledge concerning the intelligibility of speech in halls, churches, etc., was still in its infancy. Fortunately, one of the first divisions of the Laboratory to be founded was the Acoustics Division. The staff of this division gave their attention to the problem involved in achieving optimum intelligibility in halls. This research produced very satisfactory results and the acoustics of most halls can now be predicted from the building plans. When the acoustical properties of complicated structures have to be assessed, models of the structures have been found most useful in solving the problems involved. Many organizations in the Republic now make regular use of NPRL scientists as acoustic consultants.

The facilities at the NPRL cater for the most essential needs of the Republic in the sphere of the physical sciences and, within the NPRL, groups of research workers form nuclei of research man-power in the following fields: optics, nuclear physics, solid state physics, acoustics, spectrochemistry, infra-red spectroscopy, electron microscopy, geophysics, electron spin resonance, geochronology, oceanography, high pressure physics and natural isotopes.

# Apparatus

**Research vessel** — The NPRL research vessel, the Meiring Naudé, was commissioned during May, 1968, and has satisfied all design specifications. The anti-roll tank reduces the roll of the ship to less than five degrees in eighteen-foot waves.

**Extension to buildings** — Some of the rooms of the new eastern wing of the main NPRL building, in which the Natural Isotopes and the Geophysics Divisions are to be housed, became available for use in August, 1968. The Natural Isotopes Division has installed two small special-purpose mass spectrometers for the analysis of the stable isotopes D, C<sup>13</sup>, N<sup>15</sup> and O<sup>18</sup>.

**Nuclear physics instrumentation** — The cyclotron has now been converted to a fully variable energy machine capable of accelerating protons from 5-14MeV, deuterons from 8.5-16MeV and alpha particles from 17-32MeV.

Two 4096 channel analyzers have been acquired to facilitate and improve data handling for experiments on the cyclotron, and for use in nuclear chemistry. Money has also been made available for an on-line computer for experiments on the cyclotron.

**Single crystal diffractometer** — The automatic single crystal diffractometer has been installed and is now in operation. This instrument is used to collect the thousands of intensities needed to allow structure determinations to be accurately performed.

The first structure obtained from data collected on the instrument indicated a fivefold improvement in intensity accuracy and gave atomic positions accurate to 0.003Å. The instrument is expected to double the output of structure determination, with an improvement in positional accuracy of at least a factor or two. The following structures have been determined:

- Intermetallic compound CoGd<sub>3</sub>
  - Potassium iodide — 2 diacetamide complexes
  - Calcium dibromide — 4 diacetamide complexes
  - Nitroso free radical
  - Phragmalin (the largest molecule, containing 47 atoms, ever determined in South Africa)
- Data have also been collected for three other structures.

**X-ray direct electron excitation apparatus** — Because of the rapid development in the technology of the diffraction and measurement of

soft X-rays during the past few years it has become possible to measure the X-ray radiation from light elements (sodium to beryllium). Direct electron bombardment of the sample is used to excite this type of radiation. This technique is also of value for the analysis of the heavier elements. A primary X-ray spectrometer was recently purchased to enable the Institute to carry out research in this new field.

**Stress-strain machine** — A machine capable of deforming metal single crystals or other materials at very precise operational rates — from .005cm/minute to 5cm/minute — was recently installed in the laboratory. Push-button control permits the crosshead speed to be changed instantaneously to any of the fourteen speeds within the operational range of the instrument. Its ability to alter the strain rate instantaneously by orders of magnitude makes this instrument a very important asset in the study of dislocation dynamics in materials.

**Thin film technology** — In optical technology and instrumentation thin film technology is playing an increasingly important role. This is due to the fact that mirrors as well as band and edge filters of high performance for any part of the optical spectral region can be manufactured by these techniques. By a suitable choice of materials, such high-quality optical components can also be manufactured with the desired mechanical and chemical stabilities.

The most suitable manufacturing method involves the stacking of a number of thin layers of different dielectric materials by evaporation under vacuum. In this process, the evaporation conditions, as well as the thickness of the films, must be subjected to very close control.

To establish this important technology in South Africa equipment and technological know-how were obtained from one of the leading firms in this field. Two large vacuum coating plants were installed and put into operation in the Laboratory. These units have a working area of approximately 700mm in diameter. Owing to the high pumping speed, they can be evacuated to pressures of the order  $1 \times 10^{-5}$  torr and  $1 \times 10^{-6}$  torr within 30 and 60 minutes respectively, and maintained at these pressures even when heated evaporation processes are used. This basic equipment will be invaluable for further development work in thin film technology.

**Mask photometer** — An apparatus has been developed for the accurate measurement of the light intensity, luminous flux and colour char-

acteristics of lamps. It has been designed specifically for the determination of the light characteristics of discharge and fluorescent lamps. The design is such that the theoretical requirements of measurement are more closely adhered to than those of conventional corrected photocell instruments. The design is based on a double Ebert dispersion system with gratings and slits in a common focal plane. Masks of a suitable form dependent on the spectral correction requirements can be placed in the spectral plane.

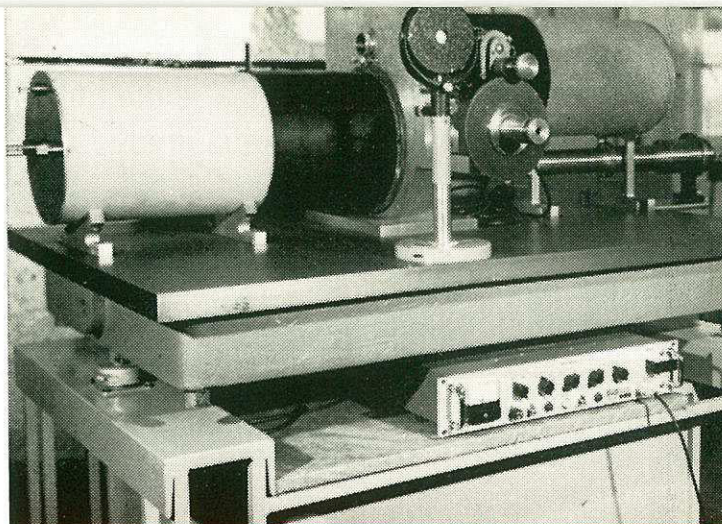
## Important Research Results

**High-speed photography of pulsed laser interaction with solid matter** — The light from a solid state laser can be focused on a very small spot. The high power-density of this light is such that virtually any known material may be vaporized at such a spot, thus making it possible to carry out spectral analysis of very small areas. In order to improve this type of analysis, however, more knowledge is required of how the material is vaporized and how characteristic light is radiated from the vapour. Studies were made of photographs taken with a high-speed rotating mirror framing camera, which was synchronized with the laser flash. The flash duration was 140 millionths of a second and during this time 9 photographs were taken.

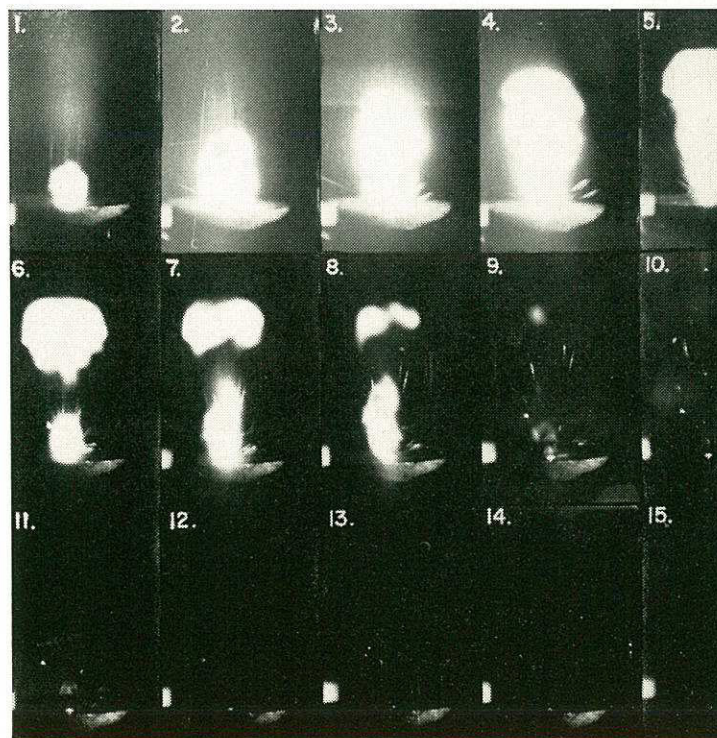
These studies have enabled the velocity of the particles and the temperature of the cloud to be calculated. A camera with a higher resolution has recently been purchased to enable even more detail to be obtained.

**Age determination of ground water** — Some 30 ground water samples have been collected in the semi-arid regions of Southern Africa. As facilities in the NPRL were not yet available, the radio-carbon ages were determined in Groningen, Holland. The ages were found to vary from 0 to 30,000 years, indicating that much of the water was not of recent origin. In one case, west of Olifantshoek, in the Northern Cape, the samples increase in age from East to West, indicating an underground flow rate of 40 metres per year.

**Two-species model** — The melting of most substances involves an increase in volume. In several cases, however, a good example of which is ordinary ice, the process of melting involves a decrease in volume. Recent high-pressure

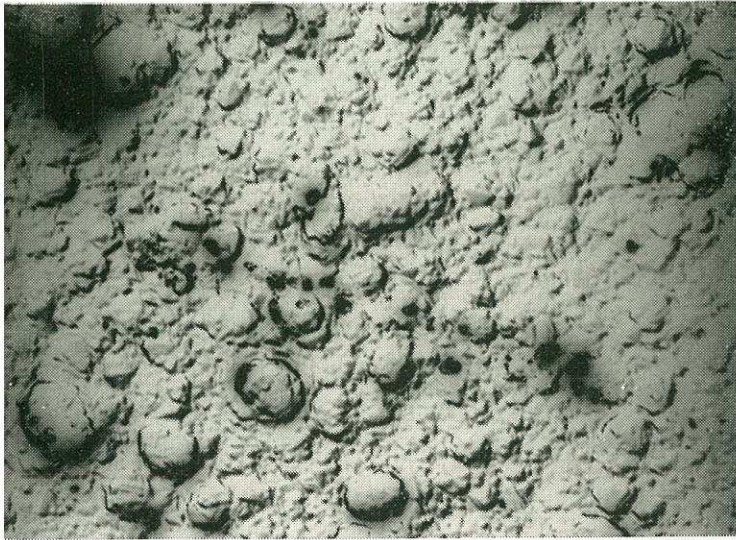


A mask photometer and integrating sphere developed by the Accurate Physical Measurements Division for the accurate measurement of the light and colour characteristics of lamps

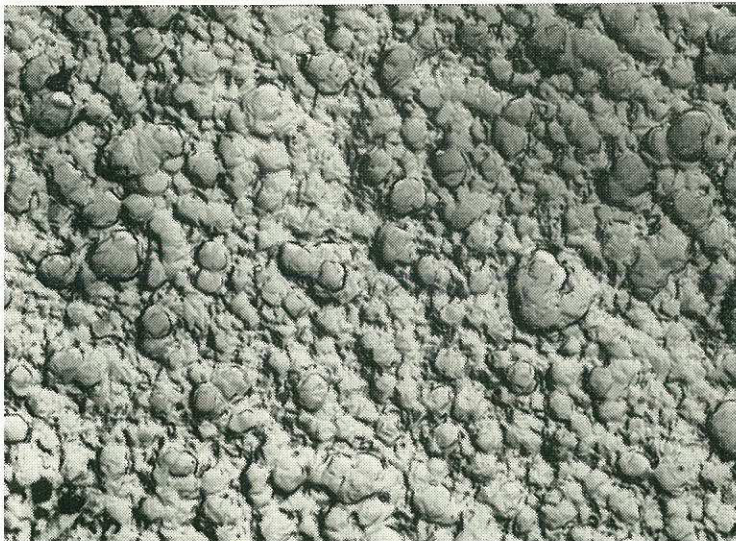


A series of high-speed photographs, showing how material is ejected when light from a neodymium-glass laser interacts with a graphite block. Duration of each photograph is 16 microseconds

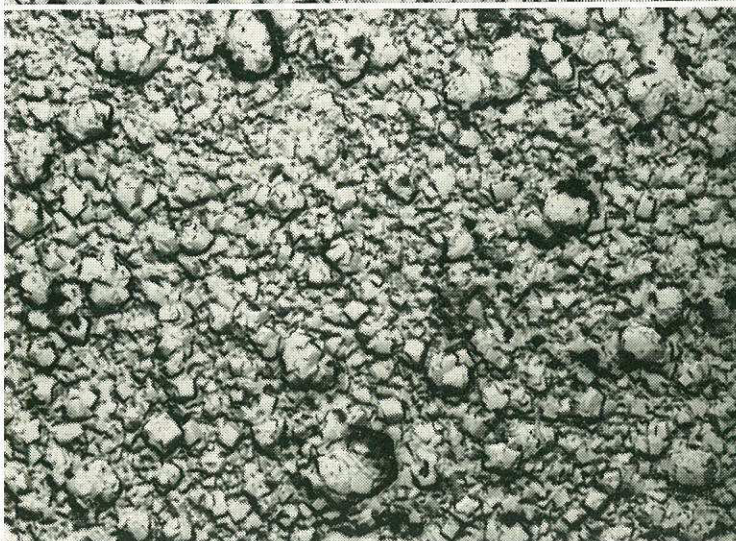
Electron micrographs of the surfaces of three lead sulphide photo detectors. (1 mm = 0.222). The structure needed for a high degree of conductivity is evident



No photo-conduction signal



High photo-conduction signal and high noise level



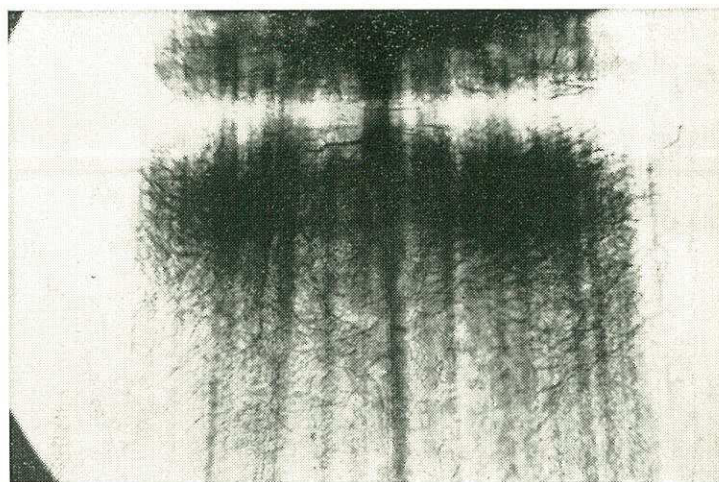
High photo-conduction signal and low noise level

studies have enabled many additions to be made to the list of substances known to melt anomalously. Until recently this phenomenon could not be explained. The NPRL has now established a two-species model which proved that the liquid in such cases consists of a mixture of two different structural species, one of which corresponds closely to the normal solid phase, and the other to a much denser solid high-pressure phase. This can be used to predict many properties of the liquid at atmospheric pressure and elevated temperatures.

**Nuclear reaction mechanism and nuclear spectroscopy** — Investigations completed during the last year have contributed to the better understanding of both direct and compound nuclear reaction mechanisms. A study of angular distributions in (d, d) and (d, p) reactions on lead-208 at energies above and below the Coulomb barrier have shown that it is possible to reduce the ambiguities in the optical model description of the inelastic scattering of complex particles such as deuterons. The description of ( $\alpha$ ,  $2n\gamma$ ) reactions by the statistical model was subjected to a stringent test by measuring the relative yields of gamma particles in nuclear systems which are nearly identical from the point of view of the statistical model. The experimental results for the nearly identical even-even hafnium targets are quite different however, casting serious doubt on the validity of the assumption of the statistical model, especially those bearing on the gamma cascade.

Measurements on prompt gamma rays and conversion electrons were also used to obtain a level scheme for the important gadolinium-146 nucleus, which is a member of the  $N = 82$  isobaric chain, as well as for the gadolinium isotopes which span the region of spherical and permanently deformed nuclei.

**Architectural acoustics** — A major difficulty in the acoustical design of enclosures mainly intended for musical performances is caused by the fact that one is dealing with an art form. This means that there is a considerable divergence of opinion with regard to what design criteria must be followed to ensure good musical acoustics. In addition, these criteria are normally described in vague and sometimes ambiguous terms such as "warmth", "clarity", "brilliance", "harshness", "fullness", "thinness", "transparency" and "coldness", to name but a few. It is the task of the acoustician to relate these subjective terms to physically measurable quantities. In the course of a current research project a relationship has been found between the spatial impression (the impression of "fullness" of sound) and the distribution of early side-wall reflections in a hall. The recognition of this relationship will be useful in determining the optimum shapes of concert halls and opera houses. The fact that these early reflections also contribute to the intelligibility of speech



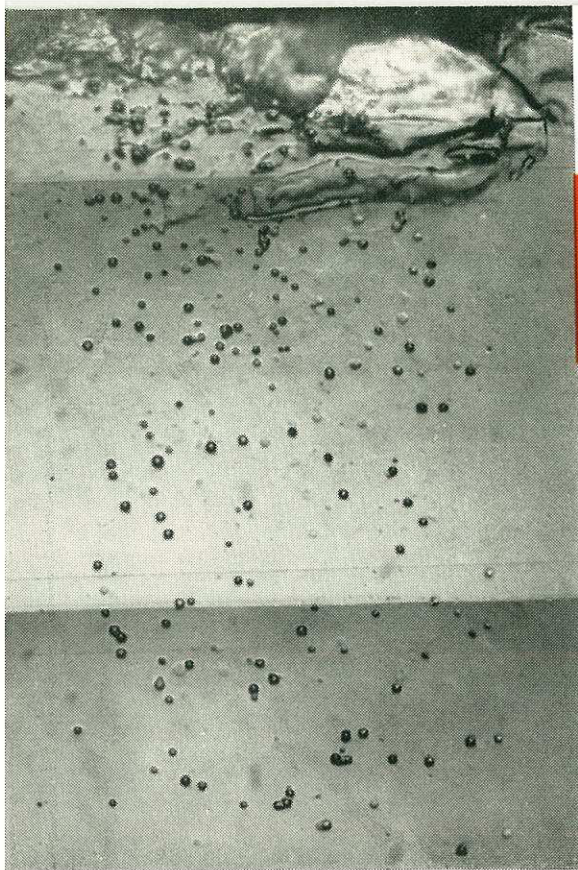
Transmission micrograph of a sodium chloride crystal, coloured by the addition of metallic sodium, after irradiation with high-power ruby laser light. The dislocations are clearly visible as fine dark nets in the beam path

means that the hitherto considerable gap between design criteria for halls intended for speech and those for music has been lessened. These research results should find useful application in two major projects currently underway, viz. the acoustics of the opera houses to be erected by the Transvaal and Cape Provincial Administrations.

**Low energy electron diffraction (LEED)** — LEED is the only technique which makes it possible to determine in detail the manner in which atoms are arranged in surfaces. This information is a basic prerequisite for an understanding of surface phenomena and, for this reason, research on LEED pattern interpretation is sponsored by SASOL.

A multiple-scattering theory has been developed which, for the first time, allows patterns to be calculated which agree with those obtained in experiments, and this indicates that the determination of surface structures will be possible in the near future. The theory has been tested on the LEED patterns from the (111) surface of nickel. This work resulted in an invitation to present a report on it in June, 1968 at the Fourth International Symposium on Materials at Berkeley, California, USA, where it was enthusiastically received.

**Interaction of high-power laser radiation with ionic crystals** — The high-power output radiation from a Q-switched ruby laser is known to interact strongly with absorbing materials such as metals. Recent investigations at the NPRL have shown that such high-intensity laser light can also interact strongly with transparent ionic crystals.



Reflection micrograph of the cleavage plane of a coloured sodium crystal after irradiation with a high-power ruby laser light

Various crystals, preponderantly sodium chloride, were coloured with colloidal sodium metal. This colouring improves the interaction of the ruby laser light with the crystalline material. If the very intense laser light is focused on the surface of such a crystal, an evaporation crater is formed, while the light path through the crystal is characterized by a change in colour. Closer examination with a microscope reveals that the dislocations (special types of crystal defects), which cannot normally be observed directly, have now been rendered visible along the beam path. Furthermore, when the crystal is cleft through the beam path, microscopic cavities are observed in the beam path. These cavities are probably due to the fact that the colloidal sodium metal is redispersed into the crystal lattice by the intense laser light, leaving behind these vacant sites.

**Study of flames** — Atomic absorption spectrometry is an established analytical technique. Unfortunately the low-temperature flames generally used cannot dissociate the refractory and stable compounds formed. A study has been made of the various flames which can be used to reduce the formation of metallo-molecular species, as well as of the processes in the flame. High temperature flames, such as the nitrous oxide/acetylene flame, although giving much greater freedom from interference by molecular formation, often cause the excessive ionization of the analytical element atoms, which can be troublesome. Attempts have been made to develop a flame which can be used for a wider range of elements and which can help create

optimum conditions with regard to sensitivity as well as freedom from interference. By diluting the main oxidizing gas (nitrous oxide) with air, it is possible to vary the temperature between that of the nitrous oxide/acetylene (2975°C) and that of air/acetylene (2150°C) and so select the most suitable temperature. Experiments have also been conducted to study the effects of diluting the flame with nitrogen and argon. Use of these flames could help to overcome completely many interference effects, especially those influencing the alkaline earths such as phosphorus on calcium, and iron on strontium. This work is continuing.

**The surface effect in plastic deformation** — Recent research has established that the flow stress is smaller in the surface region than in the interior of a crystal. This surface effect in plastic deformation occurs in a region starting at the surface and ending at about 2mm below the surface of a single crystal. This plastic strain exceeds that in the central core by about  $1 \times 10^{-5}$ , but can become an important factor in fatigue failure after a large number of cycles. This discovery is an important contribution to our basic understanding of plastic deformation.

**The evaporation of water** — A study of the physical principles involved in the evaporation of water from ponds and dams is in progress. In agreement with theories proposed in the past, it has been found that the controlling factors are associated with quite a thin boundary layer of air immediately above the water surface. It is for this reason that measurements of temperature and humidity at places away from the water surface give a rather unreliable picture of the rate at which evaporation is taking place. The Administration of South West Africa is supporting this research.

## Routine services to industry and the Government

**Cyclotron-produced radio-active isotopes** — Isotope production has been extended to the production of isotopes with a shorter life for local use only. An yttrium-87 — strontium-87 cow was developed to produce 2.8 hour strontium-87 from yttrium-87. The strontium-87 is

used for locating tumours in bone and a prototype cow has been made available to the Karl Bremer Hospital in Bellville.

For isotopes with a longer life, such as sodium-22, beryllium-7, cadmium-109 and strontium-85, the demand is still growing very fast but, owing to improvements in production techniques, only 25 per cent of the cyclotron time is required to cope with the increase in demand.

**Primary X-ray dosimetry** — Now that the characteristics of the large free-air ionization chamber have been measured, an absolute standard in the energy range of 50-300kV is available in South Africa. It has already been used for the calibration of sub-standard dosimeters used by the major hospitals.

**Oil spill** — Research along the Natal coast during the past two years has indicated that the reversal of currents experienced at Durban is due to eddies formed in the wake of the meandering Agulhas current when cold fronts pass over those areas. During the "World Glory" disaster an eddy of sixty miles diameter was formed.

With the aid of a whale-spotter aircraft, the circular striations of heavy slick which had formed as a result of the eddy, could clearly be followed and plotted. This eddy brought the oil almost to the coast at Durban, which served as a dramatic indication of the importance of further oceanographic research along the Natal coast.

Scientists of the CSIR stationed in Durban were directly involved in the operation to clear the seas around Durban from oil which had spread as a result of the "World Glory" disaster.

## Selected Publications

ANDERSON, F. A voice pitch indicator for the training of deaf children. *Tydskrif vir Natuurwetenskappe*, 1967, pp. 420-431.

FOURIE, J. T. Plastic deformation of thin copper single crystals. The separate roles of edge and screw dislocations in stage I of work hardening. *Phil. Mag.*, vol. 15, 1967, pp. 187-198.

GAFNER, G. Calculation of back-reflected LEED intensities using a plane-wave multiple scattering mechanism. In: *Proceedings of the Fourth International Materials Symposium*, 1968.

HAHNE, F. J. W. Inelastic scattering of spin- $\frac{1}{2}$  particles in the Austern-Blair theory. *Nucl. Phys.*, vol. A106, 1968, pp. 660-668.

HEYMANN, G. Core excitation in the reaction  $^{65}\text{Cu}(t, \alpha)^{64}\text{Ni}$ . *Physics Letters*, vol. 27B, 1968, pp. 280-282.

KEET, W. de V. The influence of early lateral reflections on the spatial impression. In: *Proceedings of Sixth International Congress on Acoustics*, Tokyo, 1968.

KUZMANY, H. and RITTER, G. J. Einfluss von Laserstrahlung auf Additiv-verfärbte Natriumchloridkristalle. *Z. Naturf.*, vol. 23a, 1968, pp. 944-945.

MILLS, S. J. and RAUTENBACH, W. L. Applicability of the statistical model to the description of the population of ground-state rotational levels. *Physics Letters*, vol. 27B, 1968, pp. 207-208.

MURPHY, R. J. and CRAWFORD, J. L. Electron microscope image profiles of paired and triple dislocations. *Physica Status Solidi*, vol. 27, 1968, pp. 559-572.

PISTORIUS, C. W. F. T., RAPOPORT, E. and CLARK, J. B. Unsymmetrical friction and pressure calibration in internally-heated piston-cylinder type high-pressure devices. *Rev. scient. Instrum.*, vol. 38, 1967, pp. 1741-1743.

RITTER, G. J. and MURPHY, R. J. Laser-induced etching of solid surfaces. *Tydskrif vir Natuurwetenskappe*, 1967, pp. 458-463.

STRASHEIM, A. and BRANDT, M. P. A quantitative X-ray fluorescence method of analysis for geological samples using a correction technique for the matrix effects. *Spectrochim. Acta*, vol. 23B, 1967, pp. 183-196.

VAN NIEKERK, C. B. and BURGER, A. J. The uranium lead isotopic dating of South African acid lavas. *Bulletin volcanique*, vol. 32, Fasc. 3, 1968.

VON MEIER, A. Sound insulation of stiff lightweight partitions. In: *Proceedings of Sixth International Congress on Acoustics*, Tokyo, 1968.



Mr J. Hers, Acting  
Director of the  
Republic Observatory

# REPUBLIC OBSERVATORY

**T**HE Republic Observatory is not limited in function to pure research in the field of astronomy in particular, but also performs duties of a civil nature, such as the maintenance of the national time service. This service is rendered to the public by means of the time signal and standard frequency transmitters. In addition, these signals are distributed by land line to the Post Office, the SABC and other institutions.

The principal long-term programmes of the Observatory comprise observational and theoretical research in the field of visual double stars (a field recently extended to include eclipsing binaries) and photographic observations of minor planets and comets. For half a century, the Observatory has been associated with these programmes to such a degree that they have become almost international commitments. The programme for investigating minor planets and comets has led to the discovery of several new comets and more than 500 new minor planets, many of which have been given typical South African names like Pretoria, Transvaalia, Nerina, Gaika, Umtata, Outeniqua, etc.

The short-term projects of the Observatory have included the successful search for Proxima Centauri, our nearest known stellar neighbour apart from the sun, the detection and measurement of the rotation of the minor planet Eros, the observation of the "splitting" of Nova Pictoris, the publication of a photographic star atlas of the southern sky, and the preparation of a series of colour photographs of the planet Mars.

**I**N 1925 the 26½-inch refractor was installed at the Republic Observatory, and the 9-inch telescope — the original telescope used by R. T. A. Innes to start his astronomical observations in Johannesburg — was relegated to

less important work. For many years this latter instrument was used chiefly for the observation of occultations and for various minor programmes. In 1957 a photo-electric photometer was fitted, and since then there has been a steady expansion of photometric work.

The emphasis throughout has been on the observation of photometric binary stars and eclipsing variables, and this forms a logical extension of the visual double star work which has been the Observatory's main task since about 1907. In a close binary system, eclipses may occur when the plane of the orbit lies in or near the line of sight, and such eclipses will be clearly indicated by periodic dips in the light curve. As each of the double stars may be eclipsed by the other, two minima frequently occur, a primary and a secondary one. From a detailed study of the light curve it is possible to determine the period of the system and also the sizes, shapes and other characteristics of the individual stars. The periods are generally short — of the order of a few days — indicating close pairs which cannot readily be separated in any other way.

The 9-inch telescope was at no time a very good instrument, and its deficiencies for photometry became increasingly apparent. It had an inadequate driving system and, being a refractor, it would not permit photometry in the ultra-violet part of the spectrum. These difficulties were finally overcome at the beginning of 1968 when the first reflecting telescope was installed in Johannesburg, an instrument with a 20-inch mirror, manufactured in the USA by Boller and Chivens. On April 19, 1968, this new instrument was officially dedicated by the Minister of Mines and Planning, Dr Carel de Wet, and it has been in regular use ever since. It is a general-purpose Cassegrain reflector, which uses an f/3 paraboloid



The new 20½ inch diameter mirror telescope which is electronically operated through the control apparatus in the operator's left hand



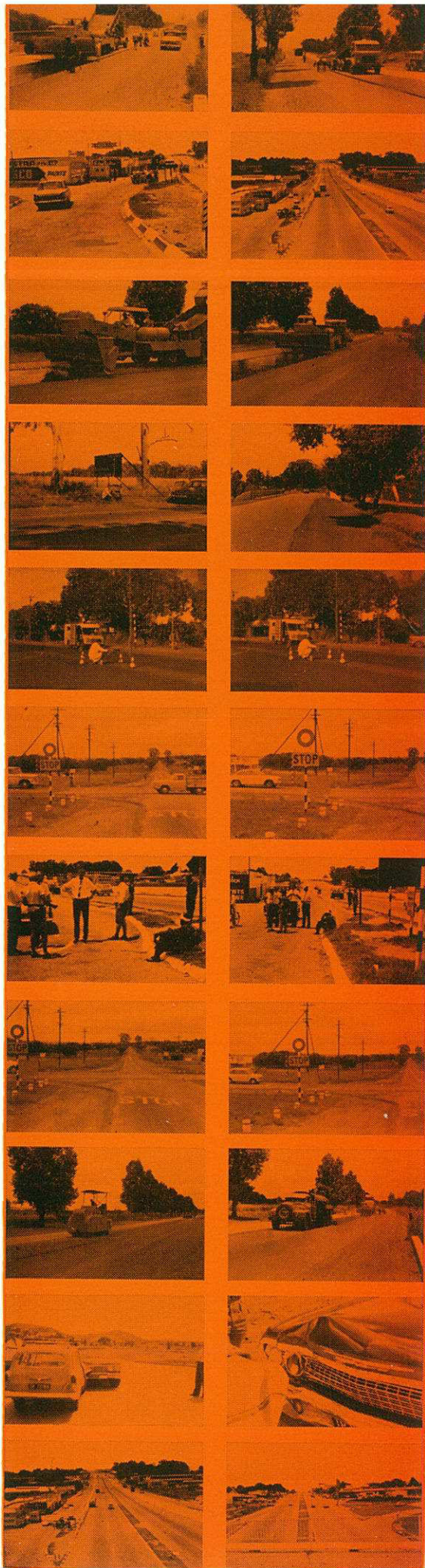
primary mirror and a 4 inch diameter hyperboloid secondary mirror, giving an effective focal ratio of  $f/18$ . Its effective dimensions are therefore not very different from those of the very much larger 26½-inch refractor, which has a focal ratio of  $f/16$ . Most of the rather arduous work involved in reducing the photometric observations has, during the past year, been done with the aid of the CSIR's IBM 360/40 computer.

A mirror of 20-inch diameter is probably the largest which can be justified under present-day conditions in Johannesburg. Visual work with the 26½-inch refractor can probably continue for many years to come, but accurate photometric work is becoming more and more difficult, chiefly owing to the increasing pollution of the air over the city and the increasing illumination of the night sky. During the past years steps have therefore been taken to find a new site for an observatory in a more favourable part of the country.

Existing weather data point to the region near the confluence of the Vaal and Orange Rivers as having the optimum number of clear nights. A number of tests have been commenced which will, it is hoped, locate one or more good South African astronomical sites and also establish a sound basis of comparison between these and similar sites in other parts of the Southern Hemisphere.

## Selected Publications

- FINSEN, W. S. The Airy-Simms eyepiece for neutralizing atmospheric dispersion. *Observatory*, vol. 87, no. 956, pp. 41-42.
- HERS, J. Night cloud in South Africa. *Mon. Notes astr. Soc. sth. Afr.*, vol. 26, no. 7, pp. 94-101.
- HERS, J. From the rotation of the earth to atomic time. *S. Afr. Surv. J.*, vol. XI, pt. 2, no. 66, pp. 3-9.
- HERS, J. A window to the south. *Mon. Notes astr. Soc. sth. Afr.*, vol. 27, pp. 75-87.
- KNIPE, G. F. G. The eclipsing and spectroscopic binary HD 161783. *Mon. Notes astr. Soc. sth. Afr.*, vol. 27, pp. 29-30.
- NEWBURG, J. L. The orbit of 208AB, ADS6914, HD73752, with some notes on the system. *Mon. Notes astr. Soc. sth. Afr.*, vol. 26, pp. 100-114.



# THE NATIONAL INSTITUTE FOR ROAD RESEARCH

**T**HE research programme of the National Institute for Road Research (NIRR) is strongly oriented towards finding solutions for a wide range of problems encountered by road and traffic authorities. Its chief aim is to develop economic construction and maintenance methods to ensure better and safer roads and streets in the Republic. Fields of research include soil conditions; the stability of high embankments; road building materials, both natural and manufactured; the design of road foundations; the evaluation of existing roads and methods of improving them; bituminous materials and road surfacings; development of techniques and instruments for controlling road building processes; road economics; traffic engineering and road accidents.

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

## Overlays to improve existing roads

A road structure designed to carry repeated heavy traffic loads consists of layers of different materials which improve in quality from the lowest foundation layer up to the surfacing. Naturally occurring or crushed aggregates are used in the foundation layers, and the surfacing usually consists of a high quality crushed aggregate bound with a bituminous binder. The life of such a structure is determined by the number of load repetitions it can bear before excessive deformation and unevenness or cracking of the riding surface takes place. At this stage, depending on the cause of failure, complete recon-



Dr P. J. Rigden,  
Director of the  
National Institute for  
Road Research

struction of the road may be necessary. This is very costly and results in considerable inconvenience to traffic, which has to be diverted while the reconstruction is being carried out.

An alternative method of restoring the riding quality, which is now being used on certain national roads in Natal, is to put down an overlay of bituminous premix material sufficiently thick to remove any local unevenness which has developed. At the same time the overlay improves the strength of the structure as a whole, thus extending its life for a further period. The construction of the overlay is a rapid procedure, and the method is particularly suitable where there is difficulty in providing a suitable deviation. By this means the life of the existing national road between Van Reenen and Mooi River in Natal, for example, has been extended for an estimated 10 years, which allows time for the construction of the proposed new national road. A similar approach is being adopted by other provincial and urban road authorities.

The construction of thick bituminous bound layers is very expensive, however, and attention must be given to designing a layer that is as thin as possible while still meeting requirements. Since there is no generally accepted overlay design, the Institute is examining designs with the object of suggesting one that is suitable for local conditions. Advantage is being taken of overlay construction in this country to evaluate performance under a wide range of conditions. This provides another example of the co-operation between research and engineering practice which is necessary for the maintenance and development of the South

African road system if these are to be carried out in the most economic and effective manner possible.

#### The transportation of abnormal loads on roads

Economic factors in the industrial growth of the Republic are involving, at an increasing rate, the transportation of bulky or heavy indivisible loads over the country's roads and bridges. This has generated a need for more information in order to investigate such factors as the destructive effect of these loads on roads, methods of determining how such loads can be safely distributed by using multi-wheeled carriers and to formulate a rational decision-making procedure regulating the transportation of such loads over roads and bridges.

At the request of the major road authorities, the Institute has been engaged in the study of various aspects of this problem, including such factors as the flexural behaviour of roads under abnormal loads, use of the equivalent single wheel load concept in performance analysis and wheel load distribution and the development of a method whereby the destructive effect of loads can be assessed and decisions taken on whether, in a particular case, a permit should be issued for an abnormally heavy vehicle to make a specific number of journeys over a given road.

In an attempt to develop a procedure to be used by road authorities, the degrees of loading of some abnormally heavy vehicles have been compared, using an empirical or semi-empirical approach, with those of the heaviest legal vehicles, applying existing road and airfield design and evaluation procedures. Good correlation has been found between the results obtained, using modified forms of the United States Army Corps of Engineers and AASHO Road Test methods and the California design formula.

A modified form of the design method used by the United States Army Corps of Engineers has been evolved and recommended for use by the authorities, both because of its simplicity and because it takes most of the important variables of road design into account. A simplified formula based on this method has been developed for use in the decision-making procedure which precedes the awarding of permits for such loads to be transported on roads.

The effect of abnormal loads on the flexural properties of roads was recently studied while 36 identical loads were moved between Vereeniging and Vanderbijlpark. Measurements made in the field included *in situ* measurements of deflection, precise levelling, visual inspections and a study of possible changes in elastic properties. This study provided a valuable opportunity of checking the recommendations on the transportation of abnormal loads.



Road accidents

### Dynamic test method for road and airfield evaluation

In the course of the last few years it has become increasingly evident that conventional static loading tests alone do not provide all the information required to assess the quality and condition of an existing road or airfield runway. Moving traffic imposes impulsive loading on a road surface which can be better simulated by impulsive test loading or by the application of vibrational forces. The Institute has been engaged for some years on a research programme aimed at understanding the behaviour of soil layers, road foundation layers and the road as a whole under vibrational loading. More recently, an analysis was carried out of behaviour under impulsive loading simulating the passage of a single heavy wheel load.

In the course of this work two experimental techniques were used: the wave-propagation method (pioneered by Jones in the United Kingdom) and the impedance measurement technique, which has been developed and exploited especially in this Institute. The two techniques provide complementary data and, if used together, can give very full information which can now be interpreted in a meaningful manner for the road engineer as a result of the Institute's work on the theory of dynamic testing. From such measurements on a road or airfield runway it is mostly possible to calculate the dynamic stiffness of the construction as a whole and to use these values to follow changes over a period of time in the behaviour of a road under traffic loading. It is also possible to assess the relative condition of a pavement from its stiffness and, in particular, from its response to a suddenly applied load. By using specially developed computer programmes, it is now also possible to estimate, from these dynamic measurements, the elastic deflections of a pavement surface under and around a moving wheel load.

While the equipment currently being used to obtain these data can only be considered as a research tool at present, the next phase of development in this project will, it is hoped, produce simplified equipment suitable for more routine use by a road authority, not only in connection with the design of new road pavements, but especially in the routine evaluation of existing pavements which may be in need of strengthening if they are to carry the ever-increasing number of heavy vehicles on the country's road network.

### Road accident research

Although the Traffic and Road Safety Division of the Institute investigates traffic problems in general, its research programme is devoted almost entirely to various aspects of the road accident problem in South Africa, one of its major aims being to provide authorities with facts on which to base decisions. Part of the effort is spent on the collection and processing of statistics on traffic and accidents for the country as a whole in order to provide a factual background to the research, the rest of the available research effort being devoted to studies of the road, the vehicle and the road user.

A major project, described in more detail below, is concerned with studying the occurrence of accidents at various points on both urban and rural road networks, with the object of relating these to road and street conditions and to specific traffic characteristics, and of finding economic ways of making roads and streets safer. Safety standards for vehicles now being introduced in overseas countries have recently been studied with a view to examining the desirability of making such vehicle features compulsory in this country.

The human factor in traffic and accidents is receiving attention in the National Institute for Personnel Research, where a study is in hand to measure road user reaction and response to road signs and markings in different road situations. Another important project is concerned with investigating road accidents on the spot with a view to acquiring first-hand information on all relevant factors. This project has so far been largely confined to accident case studies in the Pretoria urban area.

### Road features and traffic characteristics affecting safety

Traffic accidents and casualties are increasing annually despite the efforts of various authorities, and it is clear that better ways of using available resources to reduce accidents must be found — for example, by improving the efficiency of road safety education, publicity and law enforcement, and by improving vehicles and roads. Many types of improvement to road and street, designed to increase safety, are already known — the provision of costly limited-access roads or freeways, for example, and the realignment of existing roads.

Relatively minor road improvements at a limited number of places can, however, reduce the total

number of accidents significantly. In practice, the implementation of such improvements with limited funds presents several problems, such as at what places on the road they are required, what improvements should be made, and which of the possible improvements should be given priority.

#### **Determination of necessary road improvements**

In view of the merits of relatively minor improvements, research over the past few years has been concentrated on developing the most suitable procedure for South Africa to determine where and what type of improvement is needed. This procedure consists of three steps, viz. an identification of hazardous places on the road, a determination of improvements required, and a decision as to which improvements should be given priority. In the course of this work, roads in two areas were selected for detailed studies, viz. the rural bituminous roads in the vicinity of Pretoria and the Reef and the urban roads in the municipal areas of Boksburg and Pretoria.

These studies entailed the collection of accident data in collaboration with the South African Police and the Boksburg and Pretoria Traffic Departments and also an assessment of traffic volumes on various roads. Because a reliable identification of hazardous locations can only be achieved after a careful study of accident records, a convenient way of summarizing accidents according to their location on the road had to be found. The conventional accident spot map with coloured pins is useful in that it gives an overall picture, but it cannot be easily duplicated for record purposes or further distribution. To overcome this disadvantage, a simple method of listing accidents has been designed in which the accidents can be readily recorded from day to day, using a two-symbol code, reflecting the type and class of each accident, which is entered opposite a description of the location, or an identification of the nearest mileposts on rural roads. Locations with high accident frequencies can then be easily identified for further detailed studies.

It is necessary to determine the accident patterns at each location so that various possible improvements can be considered. To make possible the determination of accident patterns at particular locations, a single form has been designed to reflect a collision diagram and a tabulation of accidents according to number, severity, year, day of the week, time of the day and cost of different types of accident. The accident data summary sheet is invaluable in carrying out a field inspection in order to determine the need for obvious improvements of a relatively minor nature — for example, in road signs and markings. Such improvements can be made at little cost.

If the accident patterns persist, more detailed studies have to be made. The nature of these

studies and the use of benefit-cost ratios to motivate more costly improvements are at present being investigated.

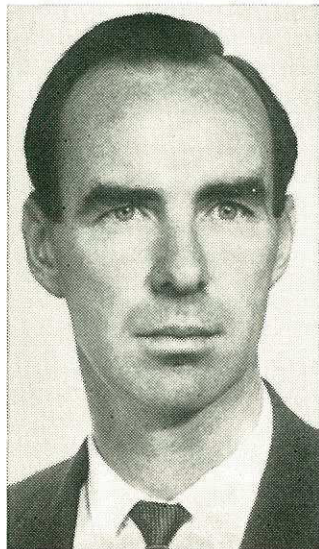
**Rural areas** — The rural road study, which comprised 620 miles of "black top" road, revealed that 50 per cent of the accidents occurred on only nine per cent of the total length of road, and that 20 per cent of the accidents occurred at only eleven places. At three of these places most of the accidents were the result of skidding during wet weather, and, after resurfacing to provide a surface less prone to skidding, the total number of accidents at these three places decreased from 75 to 7 in a year. Recommendations on road improvements at three other places, supported by accident data summaries, have been made to the road authority concerned. Another significant aspect of the accident pattern was that pedestrians or pedal cyclists were involved in 70 per cent of all fatal accidents in the area.

The evaluation of any particular recommendation regarding a road improvement, by means of a "before and after" study, takes a long time if statistically significant accident statistics are to be obtained, and a quicker method of measuring changes in the degree of hazard at any particular place is urgently needed. Work has started on the evolution of a suitable method of doing this.

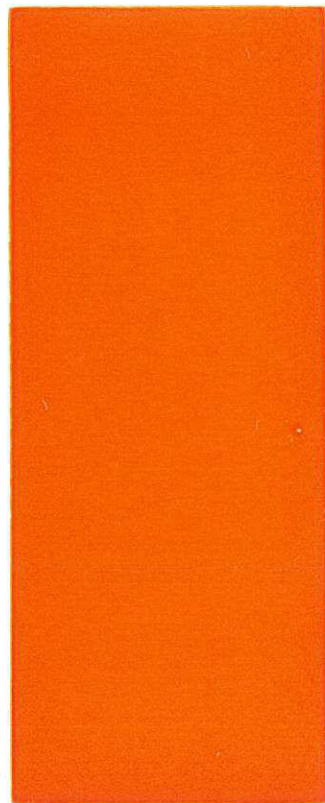
**Urban areas** — The initial study in the urban area of Boksburg was undertaken to evaluate the overall traffic and accident situation there, and at identifying points on the road network requiring more detailed study. It was found that 82 per cent of all accidents in 1965, and 89 per cent of all fatal accidents in that year, occurred on the major arterial and collector streets which comprised 23 per cent of the whole length of the network. These findings were very similar to those obtained during a study in Pretoria, where 74 per cent of all accidents in 1965 occurred on the major arterial and collector streets, which comprised 24 per cent of the network. In Boksburg, 22 per cent of all accidents on the major arterial and collector streets occurred at only 20 places on the network during 1964 and 1965. This concentration of accidents at a limited number of places should make it possible to achieve an appreciable reduction in accidents by implementing road improvements at these points; for example, a 50 per cent reduction in accidents at twenty places would reduce the total number of accidents in Boksburg by 10 per cent.

After field inspections of a number of places in Boksburg at which a relatively large number of accidents had occurred, a number of recommendations were made to the Town Council on improvements in street lighting, robot signals, road markings and road signs, and also on certain engineering improvements.

# THE NATIONAL INSTITUTE FOR TELECOMMUNICATIONS RESEARCH



Mr R. W. Vice, Director  
of the National Institute  
for Telecommunications  
Research



**B**ASICALLY, the work of the National Institute for Telecommunications Research 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.

Since its inception, the Institute has carried out a programme of research into the ionosphere and its influence on the propagation of radio waves. As part of this programme the Institute issues monthly bulletins giving ionospheric data and predictions of optimum frequencies for use in short-wave radio communication. During the past year research has been directed mainly at the natural processes controlling ionization. This work has led to strong indications that particles precipitated from the outer Van Allen belt play an important part in the control of the F-region of the ionosphere.

Research into the use of radar to study clouds and precipitation has continued. A new radar system has been built up and will be used to study, and, if possible, to determine more precisely, the correlation between radar observations and rainfall. This project could lead to the development of a radar system for measuring rainfall over wide areas, which would be of great assistance in the development and control of the country's water resources.

In its programme of research into lightning the Institute has developed a radio system for accurately locating the sources of radio noise associated with lightning strokes. It is intended to correlate these observations with photographic and radar observations of lightning. Initial experiments have shown that a degree of accuracy to within a few hundred metres can be achieved; this makes it possible not only to locate the position of a lightning stroke, but also to study its fine structure in the context of both space and time.

An important practical application of the system is the calibration of other systems for locating or counting lightning strokes.

A large part of the Institute's activity is devoted to the development of radio systems to measure distances and fix positions. Since the invention at the Institute in 1955 of the Tellurometer system of distance measurement continued research and development by the NITR has enabled South Africa to maintain its lead in the production of this equipment.

The development of an instrument to measure distance by means of a modulated infra-red beam has now been practically completed. Preliminary field tests indicate that a range of several kilometres and an accuracy to within a few millimetres will be achieved. With such a performance the instrument will have many applications in the field of civil engineering. A South African firm is now preparing to produce and market the instrument.

The Institute has continued to operate the Radio Space Research Station on behalf of the United States National Aeronautics and Space Administration (NASA).

The station actually comprises two major tracking stations, which share support facilities, the Deep Space Instrumentation Facility (DSIF) and the Satellite Tracking and Data Acquisition Network (STADAN).

The DSIF tracking station uses an 85-foot parabolic antenna to track and communicate with space probes to the moon, the planets and interplanetary space. It has played an important role in most of NASA's deep space projects.

When not required for tracking operations the antenna is used in a programme of radio astronomy. Although this programme is necessarily a limited one, it has led to significant results. Surveys of the southern half of the Milky Way have been carried out, and a study of variable radio sources is now in progress.

The STADAN is one of a world-wide network of stations established by the NASA to track and communicate with scientific earth satellites. This station, one of the busiest in the network, has also proved to be one of the most reliable.

Since early this year the Institute has taken part in the programme of satellite geodesy organized by the United States Coast and Geodetic Survey. An optical tracking facility, one of a world-wide network of similar facilities, came into operation at the Radio Space Research Station during the year.

The objectives of this programme are to determine accurately the size and shape of the earth and to provide a world-wide network of reference to which all geodetic data can be related.

## Selected Publications

TORR, D. G. Ionospheric effects due to electrons precipitated from the outer radiation belt. *Nature*, vol. 216, no. 5121, pp. 1193-1194.

TORR, D. G. Precipitated electrons as a cause of the irregular behaviours of the F2 region. *Nature*, vol. 217, no. 5123, Jan. 1968, p.45.

HALE, L. C., HOULY, D. P. and BAKER, D. C. A summary of blunt probe theory and experimental results. *Space Research*, vol. VIII, London, 1967.

REID, M. S. History and performance of a radar parametric amplifier. *Trans. S A I E E*, Sept. 1968, p.213.

Dr G. J. Stander,  
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## THE NATIONAL INSTITUTE FOR WATER RESEARCH

**A**S water research covers such an extensive field the National Institute for Water Research (NIWR) is one of the CSIR's most diversified institutes. Research is conducted on a wide front and in various disciplines such as chemistry, botany, zoology, microbiology, civil engineering, chemical engineering and geology. The projects undertaken by the Institute are generally directed towards individual problems rather than specific scientific disciplines and are often dealt with on a team basis.

Apart from the main laboratory in Pretoria, the NIWR also maintains regional laboratories at Windhoek, Bellville, Durban and Bloemfontein, as well as a Limnological Research Group at Rhodes University. The regional laboratories concern themselves mainly with problems peculiar to the areas in which they are situated.

### Industrial effluents

As all industrial effluents have to conform to certain quality requirements laid down by the Water Act, industries are compelled to give attention to the handling of water and effluents. Many industries do not possess staff with the technical knowledge necessary to meet these requirements and approach the NIWR for assistance in solving their problems. There are certain basic principles in the field of water and effluent management which apply irrespective of the nature of a specific industry and the NIWR helps industry to apply them. To this end the Institute has compiled a comprehensive guide on the subject which has been submitted for discussion to a panel of experts. The final guide will eventually be made available to all interested parties throughout the Republic.



Work is also being done on the question of water and effluent management in specific industries, and guides have already been prepared for the textile and milk processing industries and for abattoirs. As with the general guide, each of these guides has been submitted for discussion to a panel of experts in the field concerned. The final drafts of these guides are now being prepared.

#### **Wine industry**

The handling of the effluents of wine cellars often creates major problems in that offensive odours are produced and water courses polluted, particularly during the wine-making season, when the washing of machinery, tanks and floors gives rise to a high degree of pollution. A number of co-operative wineries which could not comply with certain provisions laid down by the law have lately found themselves in difficulties. These wineries approached the Co-operative Wineries Committee, who, in turn, requested the NIWR to investigate suitable methods for the treatment of effluents.

The NIWR came to an agreement with the Co-operative Wineries Committee and, during the past wine-making season, experiments have already been conducted in the laboratory as well as in a full-scale pilot plant at the Goudini Co-operative Wine Cellars. Laboratory experiments proved that winery effluents could be purified effectively with an aeration system. The full-scale pilot plant utilizes a stabilization pond which is artificially aerated to ensure that no offensive odours arise, while the purification organisms are continually supplied with sufficient oxygen to enable them to function effectively.

Positive results are expected within two years. The information obtained will be released to all wineries by the Co-operative Wineries Committee.

With regard to the effluents from brandy distilleries, research on the anaerobic treatment

of the effluents was completed in 1967. The full-scale digesters used in the investigations are still functioning satisfactorily. A comprehensive report — which may also serve as a guide — based on the investigation, has now been completed, while an Advisory Committee, under the chairmanship of the NIWR, has been appointed to ensure that anaerobic digesters for the treatment of brandy distillery effluents function effectively.

#### **Textile industry**

Mineralized effluents originating from textile mills give rise to various problems arising from the fact that, in accordance with the Water Act, the effluents must comply with specific standards of quality before being discharged into water courses. Mineral pollution of water constitutes a far more serious problem than organic pollution, since organic material can be effectively broken down to simpler compounds such as water, carbon dioxide and methane. The accumulation of minerals in water adversely affects the quality of the water and the situation is further complicated by the costly nature of the demineralization process.

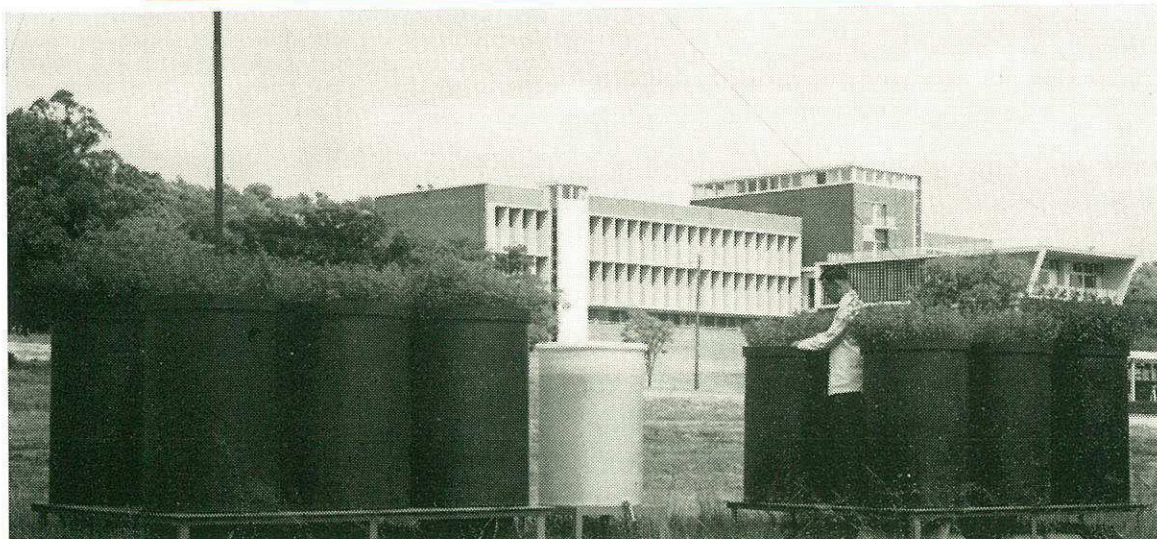
In terms of a contract with a textile mill, the NIWR is currently investigating the possibilities of evaporation as a means of eliminating mineralized effluents. Evaporation can be brought about either in open dams, for which large surface areas are a prerequisite, or by spray evaporation. The second method in particular is now being investigated.

On behalf of the same mill, the NIWR is also investigating the possibility of purifying effluent from certain processes for internal re-use.

#### **Pulp and paper industry**

Owing to a water shortage, a major pulp and paper manufacturer was obliged to use purified sewage effluent in order to increase production. As certain impurities were present, the purified sewage was, however, not suitable

A number of lysimeters filled with representative soil samples in which observations are made with regard to drainage, the accumulation of salts and the resistance of certain plants against mineralized effluents from a pulp and paper factory



for the production of high-grade paper and it could, therefore, be used for the production of lower grades only. The demand for high-grade paper, however, increased to such an extent that the mill seriously considered refining the effluent even further prior to re-use, and the NIWR was asked to assist in this subject. Gratifying results were achieved with a pilot-scale installation; in fact, a better quality paper was produced with the purified sewage than with the water supplied. The erection of a full-scale unit, in which 9 million gallons of purified effluent can be further purified to the required degree, is now in its initial stages.

The NIWR is also giving consideration to the mill's effluent problems. Research is being conducted on the biological treatment of organically polluted effluent and also on the disposal of mineralized effluent by means of irrigation. At test sites, experiments are being conducted to determine the reaction of various plants to mineralized water, and also to determine the effect of the irrigation on the soil structure over a long period. It is a well-known fact that the use of mineralized effluent has a detrimental effect on the structure of certain types of soil and, consequently, on their crop potential. At the same time, therefore, experiments are being conducted to determine the efficacy of certain methods of soil improvement with a view to counteracting the mineralization of the irrigated soil.

#### **Chemical industry**

Since 1963, the NIWR has been collaborating with a major industrial chemicals factory in research into its effluent problems. Satisfactory progress has been made, not only in improving the quality of the effluents, but also in the more economical use of water. Thus, for example, the flow of a particular effluent was reduced by 83.8%, while the nitrogen content decreased by 61.7%. The plant has also succeeded in reducing its monthly consumption of water by a total of 40 million gallons through the internal practice of strict water economy. The successful outcome of these economy measures is reflected in the fact that, compared with 1961, there has been a decrease of 43.7% in the quantity of water required for the production of commodities worth R1.

During 1968 the self-purification of a stream, into which some of the effluents were being discharged, was investigated in order to determine whether its self-purification ability could be improved.

#### **Glucose and starch production**

A new factory for the processing of maize to make glucose and starch products had to dispose of more than 100,000 gallons of effluent per day. It was decided to purify these effluents by means of anaerobic digestion, but, when the

digesters were put into operation, the problem of offensive odours was encountered. The NIWR was approached for assistance, and these digesters have been put into satisfactory working order. The NIWR also trained staff members from the factory to operate the digesters.

After completing a plant survey, the NIWR also made recommendations regarding the re-use and conservation of water in the plant, whereby a considerable decrease in water consumption was effected. This led to a corresponding decrease in the volume of effluent, thereby facilitating its management and disposal.

#### **Reclamation of purified sewage**

Some years ago, the NIWR, in co-operation with the Municipality of Windhoek, developed a process for the reclamation of purified sewage to augment the city's supply of drinking water. Since that time, the technique has been further refined by the NIWR, particularly in respect of its economic feasibility. Considerable advances have been made and there are good prospects of further improvements. Research is being conducted by means of a pilot plant with a capacity of 24,000 gallons per day. A new approach is the elimination of maturation ponds from the purification cycle and the application of advanced purification techniques directly to humus tank effluent or to settled sewage. This will effect a saving in capital costs as well as a reduction in evaporation and seepage losses and in the concentration of mineral salts resulting from evaporation.

The cost of reclamation at this stage amounts to about 22 cents per 1,000 gallons, which is not much higher than the price at present being paid by municipalities and industries. If it is kept in mind that the cost of reclamation will probably be lowered through further refining of the process and that the cost of developing water resources is progressively increasing, it may be assumed that reclamation of sewage will become more and more acceptable in future. The increasing demand for water resulting from the growing population and expanding economy of the Republic will eventually necessitate large-scale reclamation of sewage effluent.

The NIWR is at present planning a pilot plant with a capacity of 1 million gallons per day, which may serve as a basis for a thorough economic evaluation and which may be used as a model for the planning of full-scale reclamation plants.

In the Western Cape, research on the reclamation of purified sewage for industrial use is being continued. The principle applied in this case is to allow the maturation pond effluent to seep into the sandy soil of the Cape Flats and subsequently to withdraw the water from the sand.



The integrated water reclamation and water purification plant at Windhoek. The reclamation process was developed jointly by the NIWR and the Windhoek Municipality

#### **Discharge of effluents into the sea**

The marine discharge of municipal and industrial effluents is an economical method of disposal but one which can cause serious pollution of the sea and beaches. This is particularly so in densely populated areas and in popular tourist resorts, where pollution not only adversely affects the tourist industry for aesthetic reasons, but also has a detrimental effect on public health. For this reason, the NIWR has, for some time, been carrying out surveys along the Natal coast to investigate sea currents and wave and wind action. On the basis of information thus obtained, predictions can be made about the extent to which effluents will disperse if they are discharged in specific places. Monitoring of existing pipelines is also being done to evaluate the extent to which pollution is taking place.

In addition, background information is being collected on the chemical, bacteriological and biological conditions of beaches along the Natal coast. These data will make it possible to determine in advance the extent to which the discharge of waste matter into the sea will affect the beaches. The NIWR has already established pollution criteria for the Natal beaches so that it is possible to determine whether or not a beach is polluted.

Research on the marine disposal of effluents is being carried out under contract for the Natal Provincial Administration, the Durban Corporation and a number of industries.

#### **Oil pollution along the Natal beaches**

On June 13th, 1968, a large oil tanker, the "World Glory", was wrecked off the Natal coast, and the beaches of holiday resorts along the coast were endangered by severe oil pollution. The NIWR, one of the organizations called upon to assist in combating the pollution, played an active part in spraying the oil patches with synthetic detergent. The fight against pollution succeeded and the Natal beaches remained clean.

#### **Anaerobic digestion of waste matter**

The anaerobic digestion of organic material is a process applied on a large scale in the treatment of organically polluted effluents. In practice it is often found, however, that imbalances in the process occur which cannot easily be explained. The process is very complicated and influenced by many variables. Consequently the NIWR concentrates on basic research into the process. During the past year the NIWR issued a number of publications on the subject.

### Water fauna and flora

Since there is a definite relationship between the types of insects and diatoms which occur in water and the chemical quality of the water, a thorough knowledge of these organisms can be invaluable in discovering the incidence of long-term pollution. The NIWR is consequently doing basic research on the taxonomy and physiology of aquatic organisms.

The Transvaal Provincial Administration is engaged in investigating fish farming as a source of protein food for the Bantu in the Northern Transvaal. In order to effect the most advantageous conversion of other foodstuffs into protein, knowledge must be acquired about food chains in dams where the fish are bred, and the food consumption and growth rate of the fish. At the request of the Provincial Administration, the NIWR is carrying out research on these subjects.

### Dieldrin and the water environment

In co-operation with the Department of Agricultural Technical Services, the NIWR is carrying out research into the effects of dieldrin on the water environment, since a detailed knowledge of these will be necessary if dieldrin is to be applied in the combating of pests on a large scale. One aspect of this subject currently being investigated is the toxic effect of dieldrin on various types of fish and the degree to which water chemistry affects the toxicity.

### Pathogenic bacteria, viruses and parasites in water

The NIWR is making a study of the presence of pathogenic bacteria, viruses and parasites in the effluents from hospitals, in raw sewage, in purified effluents and in water environments. Little is known about this subject and much remains to be done, for example, in the adaptation and evaluation of tracer techniques.

### Service to Provincial Administrations, State Departments and local authorities

The NIWR does research on behalf of the Provincial Administrations of Natal, Transvaal, Orange Free State and the South West Africa Administration on a long-term contract basis. The Institute is also often requested by provincial and local authorities, as well as by State Departments, to solve *ad hoc* problems concerning sanitation, water supplies and effluent control.

### River research

The flow in most South African rivers is either weak or intermittent and there has to be a constant guard against pollution, since dilution cannot be depended on to reduce the degree of pollution. It is therefore desirable that thorough chemical and biological surveys should be made as soon as possible of the important rivers in the Republic, to provide criteria

against which the extent of future pollution can be measured. The NIWR has already made such surveys of all rivers in the country which (at this stage) are economically important, with the exception of the Caledon, the Orange and the Fish Rivers. Surveys of these three rivers, and of the rivers in Northern Natal and Zululand, are now in progress.

A survey of the Berg River in the Western Cape was completed some years ago and the NIWR is at present engaged in a follow-up survey to determine the extent to which conditions in the river have changed.

### Solar distillation of brackish water

The application of solar distillation as a desalination technique is being investigated by the NIWR regional office at Windhoek. This technique can be used to advantage, particularly in South West Africa, where the available water supply is often unsuitable for domestic use because of its high mineral content, and where the cost of other methods of obtaining fresh water is generally very high.

Experimental units for solar distillation have been erected at a test site at the Gross Barmen thermal springs and also at the CSIR's experimental station along the Swakop River. Units of varying design and three different sources of energy are used: solar energy, hot water from a mineralized thermal spring and waste heat from a diesel generator.

### Evaporation and the salinity of water in sand beds

The salinity of water in South West Africa is a vital problem and one which occurs predominantly where water flows in sandy river beds. In the lower reaches of the Swakop River, for example, this phenomenon is very evident. At the request of the Administration of South West Africa, the NIWR regional laboratory in Windhoek has carried out evaporation experiments with sand mixtures representative of conditions in the Swakop River.

In these experiments, which are carried out in identical tanks, water of a constant chemical composition is used, while the nature of the sand mixtures varies. Automatic electronic equipment constantly registers data on temperature, humidity and water level. The results indicate that the construction of sand-filled dams and the provision of underdrainage can probably limit the degree of mineralization in rivers with dry sandy beds.

### Water map for South West Africa

At the request of the Administration of South West Africa, the NIWR is compiling a map of underground water in that country. The map is based on the chemical quality of underground waters and can therefore be used as a guide for the establishment of industries and

communities, since the quality of available water is of great importance in this connection. Possible relationships between the chemical quality of water and the geological formations at their sources can also be deduced from the map; knowledge of such relationships will be of great geological value. The map can also be an aid in isolating areas where toxic elements generally occur in the water.

### Effluent purification

The effluents from sewage purification works contain relatively high concentrations of phosphorus (in the form of phosphates) and nitrogen (in the form of nitrates and ammonia). If these effluents are discharged into water courses, as is the normal procedure, the phosphorus and nitrogen serve as nutrients to algae, which then proliferate. The water becomes less suitable for further use, not only on account of the algae clogging the filters, but also because dead algae pollute water organically. This phenomenon is known as secondary pollution. Countermeasures are being investigated by the NIWR. The rotation of discs covered with a layer of algae in the purified effluent, is a method currently being tested. The algae metabolize the carbon dioxide in the water and thus raise the pH. The elevated pH has a twofold advantage: in the first place the phosphates are precipitated in the form of calcium phosphate and, secondly, ammonia tends to be transformed into the anionic form which escapes into the atmosphere. Another method being tested in this connection is the activated sludge process.

By means of a pilot plant, research is also being continued into the anaerobic digestion of raw effluents.

## Selected Publications

- ARCHIBALD, C. G. M. New and interesting Cyanophytes from the Kowie River System in the Eastern Cape Province (South Africa) II. *Nova Hedwigia*, vol. XIII, no. 3/4, 1967, pp. 389-395.
- ARCHIBALD, R. E. M. Some new and rare Nitzschiae (Diatomaceae) from the Vaal Dam catchment area. *Portugaliae Acta Biologica*, B, vol. 8, no. 1-4, pp. 227-238.
- HEMENS, J. and MASON, M. H. Sewage nutrient removal by a shallow algal stream. *Water Research*, vol. 2, 1968, pp. 277-287.
- KOTZÉ, J. P., THIEL, P. G., TOERIEN, D. F., HATTINGH, W. H. J. and SIEBERT, M. L. A biological and chemical study of several anaerobic digesters. *Water Research*, vol. 2, 1968, pp. 195-213.
- SCHOONBEE, H. J. A revision of the genus *Afroturus* Lestage (Ephemeroptera: Heptageniidae) in South Africa. *Memoirs of the Entomological Society of South Africa*, no. 10, March 1968, 44p.
- STANDER, G. J. and FUNKE, J. W. Conservation of water by re-use in South Africa. Paper presented at the symposium on "Conservation of water by re-use" Part IV, 59th Annual Meeting, American Institute of Chemical Engineers, Detroit, Michigan, 4-8 Dec. 1966. Reprinted from *Chemical Engineering Progress, Symposium Series*, vol. 63, no. 78, 1967.
- TOERIEN, D. F., SIEBERT, M. L. and HATTINGH, W. H. J. The bacterial nature of the acid-forming phase of anaerobic digestion. *Water Research*, vol. 1, no. 7, July 1967, pp. 497-507.
- TOERIEN, D. F. and KOTZÉ, J. P. The effect of hexoses and a hexose polymer on the levels of some enzyme activities of a bacterium isolated from an anaerobic digester. *Water Research*, vol. 1, no. 8/9, August/September 1967, pp. 595-603.
- TOERIEN, D. F. and SIEBERT, M. L. A method for the enumeration and cultivation of anaerobic "acid-forming" bacteria present in digesting sludge. *Water Research*, vol. 1, no. 6, 1967, pp. 397-404.
- TOERIEN, D. F. Modification of the Astell roll tube apparatus for the enumeration and cultivation of anaerobic bacteria. *Lab. Pract.*, vol. 16, no. 3, 1967, pp. 320-322.
- VAN DUUREN, F. A. Removal of micro-organisms from water. *Wat. and Wat. Engng*, August/November 1967. Part 1: Introduction; water-borne diseases and the micro-organisms involved. August 1967, pp. 321-325; Part 2: Coagulation. September 1967, pp. 414-417; Part 3: Flocculation. October 1967, pp. 454-457; Part 4: Data. November 1967, pp. 454-459.
- VAN DUUREN, F. A. A short guide to swimming pools. Their water treatment and purification. *Publ. Hlth*, Johannesburg, January 1968, pp. 31-35.
- VAN VUUREN, L. R. J., STANDER, G. J., HENZEN, M. R., VAN BLERK, S. H. V. and HAMMAN, P. E. Dispersed air flocculation/flotation for stripping of organic pollutants from effluents. *Water Research*, vol. 2, 1968, pp. 177-183.
- WYLIE, S. C. *Variables in the flocculation of some Natal river waters*. CSIR Research Report no. 264, Pretoria, CSIR, 1968, 19p.
- STANDER, G. J., CILLIE, G. G., BAILEY, R. D. and ROSS, W. R. *Investigation of the full-scale purification of wine distillery wastes by the anaerobic digestion process*. CSIR Research Report no. 270, Pretoria, CSIR, 1968.

# THE SOUTH AFRICAN WOOL TEXTILE RESEARCH INSTITUTE



Dr D. P. Veldsman,  
Director of the  
South African Wool  
Textile Research  
Institute

**A**LTHOUGH the South African Wool Textile Research Institute (SAWTRI) is one of a number of national institutes constituting the CSIR, it is unique as far as the financing of its activities is concerned. A number of organizations (the South African Wool Board, the Mohair Board and the national trade associations of wool washers and carbonizers, wool combers and worsted manufacturers) make funds available on the basis of contributions guaranteed for five years. The CSIR makes an annual grant to meet expenditure, the amount being more or less equal to that provided by the organizations referred to above.

The first guarantee period ends with the present financial year, five years after the Institute was incorporated into the CSIR as a national research institute in 1964. The contributing organizations have already guaranteed a further five years' contribution. An additional capital grant has been made by the Mohair Board to be used for the purchase of special equipment required for processing scouring types of mohair.

### **Industrial liaison**

Liaison between the SAWTRI and the local wool and mohair industry is effected by a research advisory committee on which the supporting organizations are represented. The Committee is responsible for the formulation of a broad research policy based on the availability of funds. Further liaison is achieved through two technical advisory sub-committees, the members of which are scientists and industrialists appointed because of their personal knowledge of the Institute's research spheres, and they accept responsibility for the supervision of the more technical aspects of the research programme.

In addition to the committee and sub-committees mentioned above there is a South African Wool Board/SAWTRI co-ordinating committee instituted with a view to discussing matters of common interest relating to the need for specific research and for the practical application of research findings.

Some thirty industries concerned with textile manufacture and related activities (e.g. machine and dyestuff manufacturing) are associated with the SAWTRI, each being a contributor of a minimum amount of R100 per annum, a sum which they guarantee for five years.

The SAWTRI is represented on a number of committees of the South African Bureau of Standards which deal with textile matters as well as on two departmental committees concerned with wool and mohair production.

### **Technical services to industry**

Although SAWTRI is mainly concerned with research, investigations are made, on an *ad hoc* basis and in consultation with the South African Wool Board, of problems experienced in the industry. In addition, the SAWTRI undertakes the testing, at fixed tariffs, of a wide variety of textile materials. Some of these investigations may lead to research projects, should the problems be of general interest.

The SAWTRI is also responsible for checking that the mills concerned apply the regulations of the International Wool Textile Organization (IWTO) on the regain testing procedure for scoured wool.

### **Textile symposia**

In order to strengthen contact and exchange ideas with the processing industry, the SAWTRI arranges symposia from time to time on related topics. During a visit recently by Dr P. P. Townend of the University of Leeds, England, a symposium on worsted spinning was arranged which was addressed by him and three members of the SAWTRI staff. A large number of delegates from the Wool Textile Industry attended this symposium.

The Institute also made available various facilities to the Eastern Cape Branch of the South African Chemical Institute on the occasion of their symposium in Port Elizabeth on protein chemistry and wool research. Two staff members of the SAWTRI read papers on the research work in progress at the Institute.

### **Dissemination of information**

Information is supplied verbally during visits to factories by research and technical personnel or during visits to the SAWTRI by representatives of the textile industry. Information is also released during discussions at committee meetings, at symposia or during the handling of technical enquiries. Information is also supplied in SAWTRI publications, which are distributed free of charge.

The SAWTRI *Annual Report* is regarded as a "shop window" for its activities, and 1,750 copies are distributed annually in this country and overseas.

Research reports of a technical nature are published in a series entitled *SAWTRI Technical Reports*. This publication is issued mainly to firms giving financial support to the SAWTRI as well as to associated institutions overseas. A number of international textile journals also publish abstracts of these reports.

*SAWTRI Bulletin* is a quarterly publication containing general information about the Institute, its staff and their activities. Technical articles written in "mill language", short technical reports, surveys of important work done elsewhere and reports on the activities of the International Wool Secretariat (IWS), etc., are published in the *Bulletin*.

Articles of a fundamental nature are published almost exclusively in recognized journals, in South Africa and overseas. Textile technological papers which are likely to be of interest to a large number of readers, are also widely published.

### **Training in textile technology**

Since the introduction of courses in textile technology at the University of Port Elizabeth in 1967, practically all the SAWTRI senior research staff have lectured at the University on a part-time basis. In his capacity as Professor Extraordinary of Textile Technology, the Director is a member of the Senate of this University. Fifteen students are already following the courses, the wool textile industry having granted bursaries to more than half of them. A few members of the SAWTRI staff are following the courses on a part-time basis.

Members of the SAWTRI research staff have enrolled at the local university for post-degree study in textile technology and are incorporating their research results in theses.

The correspondence courses in weaving technology and in weft knitted structures are still being followed by candidates throughout South Africa. Certificates have been issued to students who have passed the examinations.

#### Applied research

Textile technological research is directed towards providing data on the South African wool and mohair clips but, at the same time, the SAWTRI endeavours to contribute towards knowledge of a practical nature in the fields of processing, dyeing and finishing these fibres.

#### Processing characteristics of South African wool

Because the SAWTRI is mainly concerned with a study of locally produced wool, the behaviour of different types of South African wool during processing into end-commodities is extensively investigated. Recent investigations have been concerned with the processing of lambswool, using a modified worsted system, and a comparative study of typically over-crimped wool types.

Merino lambswool was successfully processed into machine knitting yarns without combing. Jerseys were knitted, dyed and shrinkproofed by treating them with DCCA (an alkaline salt of dichloro-isocyanuric acid) and potassium permanganate. The jerseys so treated were less prone to felting and were softer than those knitted with adult Merino wool yarn of the same fineness. After shrinkproofing, the garments were less inclined to pill than untreated garments.

Certain types of wool have more crimps per inch than pure Merino wool of the same fibre diameter. This phenomenon occurs in strains such as German Merino, Dohne Merino and Letelle, which are all bred in South Africa. Examples of these three wool groups, as well as of a normally crimped pure Merino wool, were processed according to the continental system and a comparison was made between the woven fabrics. The over-crimped wool types produced bulkier cloth throughout, which had better wrinkle resistance and wrinkle recovery properties.

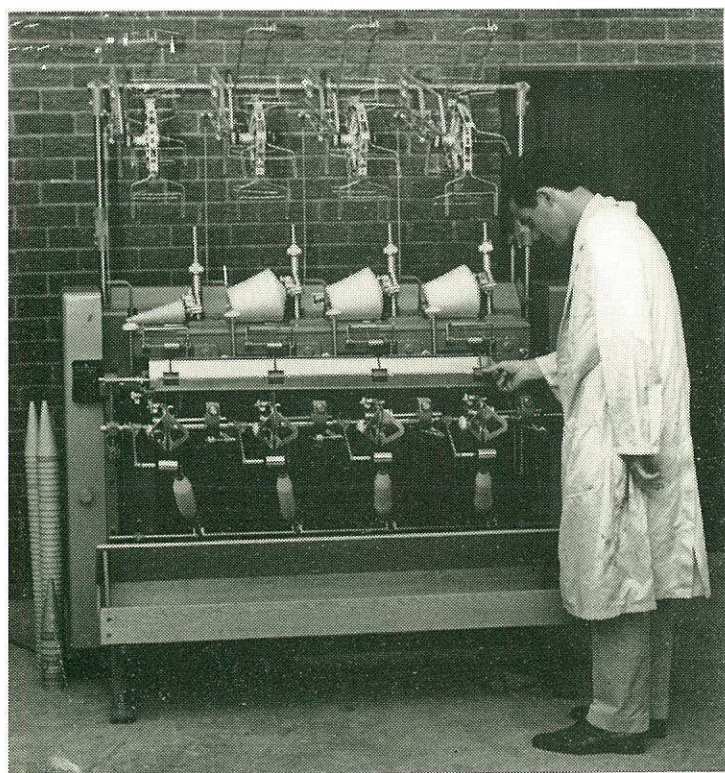
Knitted fabrics manufactured from machine-knitting yarn made of the overcrimped wools mentioned can be made completely machine-washable by treatment with 4.5% DCCA.

#### Knittability of wool yarn

Yarn of normal strength and a high degree of evenness which is spun from sound wool may still break during machine-knitting at the usually high rate of yarn intake. The reason for this is that friction occurs between the yarn and the needles as well as other parts of the knitting machine. Should the yarn break, a hole in the fabric is formed, resulting in a loss to the manufacturer.

Yarn friction can be decreased by applying the correct amount of a lubricant such as paraffin wax. Too much wax, however, may in itself cause a rise in friction and thus it is necessary to apply the correct amount of wax.

Yarns are often waxed by being passed under a wax disc. It has been determined that the weight of the disc does not affect the eventual yarn friction to any considerable degree. However, the amount of wax applied to the yarn depends on the temperature at which the yarn is waxed and on the melting point of the wax itself. The amount of wax required to limit yarn friction to a minimum can be applied in single or repeated waxings. According to the findings of the SAWTRI it is preferable to express the amount of wax in terms of the weight of wax per unit length of the yarn, especially when yarns of different counts are being compared.



Experimental waxing of hosiery yarn on the Schweiter cone winder



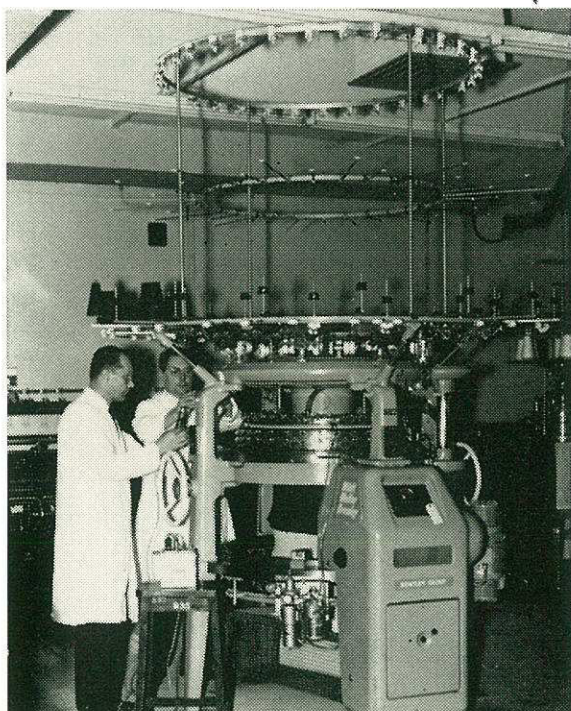
### Weaving problems

Weft skewing in fabrics is one of the weaving problems that has received attention. Although the skewing of fabrics often occurs in practice to such an extent that the cloth is rendered useless, research workers have not yet been successful in clarifying the causes of this phenomenon.

Fourteen fabrics of widely divergent patterns were woven and the skewing measured. The results agreed well with those obtained by other workers in this field. From the results, a formula was developed by means of which the skewing could be calculated. A good correlation was obtained between the calculations and the experimental results. The formula is based on the weaving diagram from which the resultant skewing force is calculated. Consequently, a weave structure can be analysed to determine whether the structure will be inclined to skew without having to weave the fabric. Full details of this investigation have been published in *SAWTRI Technical Report No. 106* (see list of publications).

### Characteristics of knitted structures

An extensive investigation was made of the characteristics of Swiss and French double piqué fabrics knitted on the same machine from the same batch of yarn at three different rates of yarn intake. Fabric characteristics such as thickness, air permeability, wrinkle recovery, pilling, abrasion resistance and felting propensity — all of interest to the consumer — were examined, and an attempt was made to obtain a relationship between these characteristics and a new tightness factor. This factor takes into account the changes which take place in the fabric during steaming or wet relaxation. Many of the characteristics mentioned above are linearly proportional to the tightness factor, while others are not related at all. When all factors are taken into consideration, it seems that Swiss double piqué is the most desirable of the knitted structures when knitted to the "median" ratio of yarn intake.



### Dyeing of wool and mohair

Because reactive dyes are linked to the animal fibre by chemical reaction, fabrics so dyed are highly colourfast during wet processes. The reactive dye can react with the available amino groups in wool and mohair and this method has already been applied in industry. It would be possible for the same dyes to react with the free thiol groups in the fibres mentioned, but in the natural state these fibres contain a limited number of these groups.

The SAWTRI has developed a process whereby dyeing can be effected simultaneously with the formation of thiol groups by reduction of the wool with sodium bisulphite. The dye must obviously not be attacked by the reducing agent and this is prevented by using dyes derived from reactive aromatic chlorine compounds. Effective levelling agents are added and satisfactory dyeing can be achieved even at as low a temperature as 60°C.

The same technique was applied to reduce smudging during spray-printing with dyestuff dissolved in a urea solution. An accelerated penetration of the dye, a high colourfastness during wet treatment and a financial saving was achieved in this manner.

Brighter coloured wool articles could be obtained when dyed at a low temperature (85°C) and by simultaneously treating them with a brightening agent. In some instances sodium formaldehyde-sulphoxylate was used successfully for this purpose. As an alternative to this method, dyes prone to attack by the reducing action of this reagent could be applied together with hydroxylamine.

It often happens that single kemp fibres in mohair appear practically white in the dyed product. It has been established that the dyeing behaviour of the two types of fibres is the same but that the apparent differences after dyeing are due to the peculiar light reflecting properties of the kemp fibres. Because light is reflected from the medulla in a kemp fibre colour saturation appears to be less. The contrast between similarly dyed kemp and mohair fibres may be so great that the former appears to be undyed. This phenomenon is more pronounced in certain colours than in others.

The Wildt-Mellor-Bromley circular knitting machine on which double piqué structures have been knitted for comparative purposes

### Easy-care properties for wool garments

One of the most important requirements of wool garments nowadays is shrink-resistance — even when washed in a domestic washing machine. Various shrink-resistance treatments have been developed and/or improved and it has been found possible, for example, to make hand-knitting yarn machine-washable by treating it with an alkali salt of dichloro-isocyanuric acid (DCCA, 3.3 per cent active chlorine per weight of wool). In cases where the end-commodity is required to be white or to have an exceptionally soft handle, about one quarter of the DCCA is replaced by potassium permanganate.

DCCA is sold in various forms. The products differ as to solubility, chlorine content and their influence on wool articles in respect of handle and whiteness. The choice of a shrinkproofing reagent is, therefore, partly determined by the requirements of the end-commodity.

Shrink-resistant articles dyed in a strongly acid medium proved to be more liable to shrink than when dyed in neutral or weak acid media. Even in the latter case it is still advisable to neutralize the acid medium in the end-commodity very carefully.

Washing tests have indicated that wool articles which have been rendered shrink-resistant are usually less prone to soiling than untreated products. This characteristic becomes progressively more pronounced with the level of treatment.

These findings have led to the development of a process by which wool fabric can be treated to render it suitable for making up into machine-washable men's shirts. This treatment involves

shrinkproofing with DCCA applied in conjunction with a very low percentage of potassium permanganate, reductive and fluorescent bleaching with sodium formaldehyde-sulphoxylate and a stilbene-type of optical bleach, flat setting with sodium bisulphite and, finally, treatment with thio-urea/formaldehyde resin to counteract yellowing.

### Fundamental wool protein research

Apart from the applied research projects referred to above, which are of direct interest to the textile industry, fundamental research on animal fibres is also being conducted, such as:

#### Chemistry of wool protein —

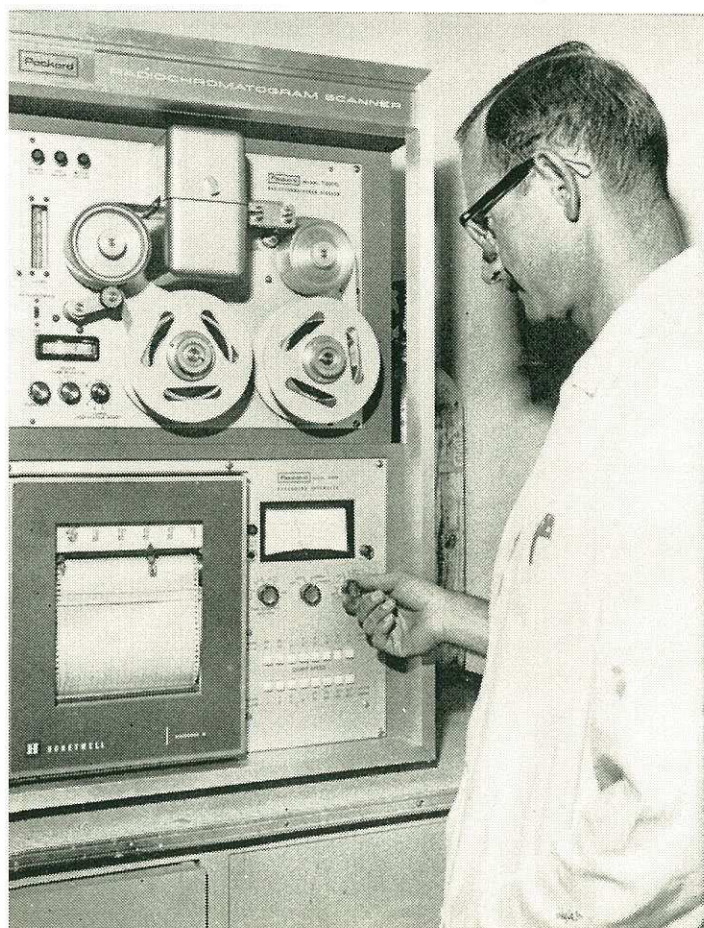
A group of SAWTRI staff members working in Pretoria under the supervision of a senior officer of the National Chemical Research Laboratory has recently achieved an important break-through in this field. They have succeeded in isolating a fragment (III-B2) of wool protein in pure form and establishing the sequence of the 97 amino acid residues in the fragment.

The complex nature of wool protein may be appreciated if it is considered that at least sixteen such fragments have been obtained from the high-sulphur fraction (SCMK-B) isolated from reduced wool. In addition, there is a low-sulphur fraction (SCMK-A) the structure of which is probably as complex.

#### Chemistry of the sulphur-sulphur bond —

Because this chemical linkage (also known as the disulphide bond) is most important in the chemical and physical behaviour of animal fibres, attention is being given to sulphur chemistry. For the sake of convenience, relatively simple, pure chemical substances (e.g. cystine and glutathione) or proteins of known structure (e.g. insulin and ribonuclease) are used for this purpose. Special compounds with disulphide groups have also been synthesized for experimental purposes.

Recently it has been shown that photolysis of the disulphide bond by hypophosphite ions under irradiation with ultra-violet light takes place completely at random. This reaction, which involves thiyl radicals, differs completely from the more selective photolytic reactions in the absence of hypophosphite found by other research workers.

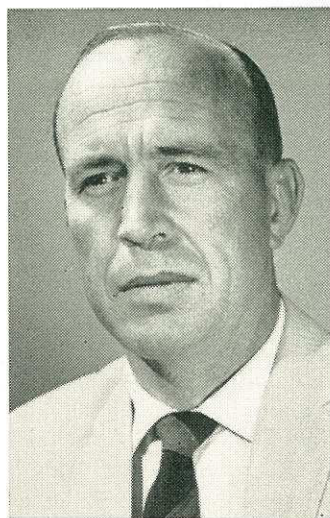


The Packard radio chromatogram scanner being used in protein chemistry research

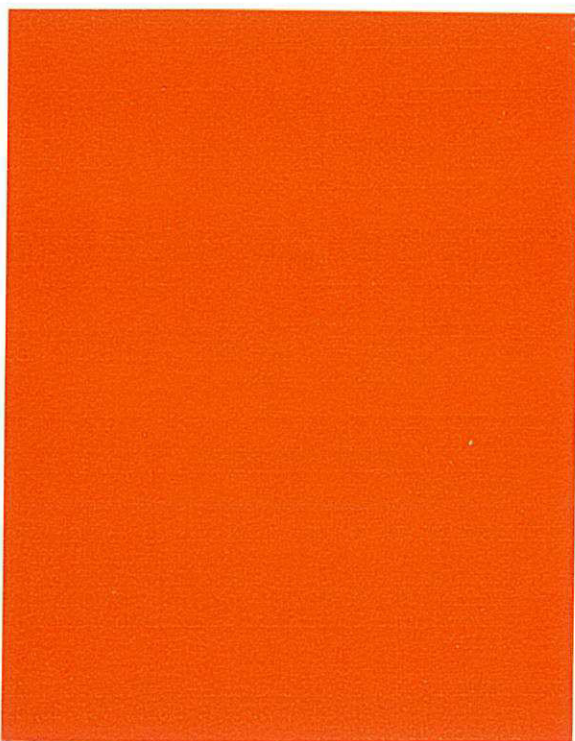
## Selected Publications

- CILLIERS, W. C. *On the processing characteristics of South African Merino wools. IV: Processing lambswool on a modified worsted system.* SAWTRI Technical Report no. 107, Port Elizabeth, South African Wool Textile Research Institute, May 1968.
- CILLIERS, W. C., ROBINSON, G. A. and SLINGER, R. I. *The processing characteristics of South African wools. IV: High-crimp wools.* SAWTRI Technical Report no. 110, Port Elizabeth, South African Wool Textile Research Institute.
- DEN HEIJER, Z. M. M. The effectiveness of pre-treatments to aid resin deposition on wool fabrics. *SAWTRI Bulletin*, vol. 2, no. 3, Sept. 1968.
- DEN HEIJER, Z. M. M., ABRAHAMS, K. and VELDSMAN, D. P. Shrinkproofing of wool with DCCA salts and permanganate. *SAWTRI Bulletin*, vol. 2, no. 2, June 1968, p. 19.
- HUNTER, I. M. A comparison of the gravity type and the Schweiter horizontal waxing units. *SAWTRI Bulletin*, vol. 2, no. 2, June, 1968, p. 12.
- HUNTER, I. M. The kinetic friction of wool worsted yarns. I: The influence of cone hardness and rewaxing. *SAWTRI Bulletin*, vol. 2, no. 3, Sept. 1968.
- HUNTER, I. M. The kinetic friction of wool worsted yarns. II: The influence of room temperature, wax melting point and yarn count. *SAWTRI Bulletin*, vol. 2, no. 3, Sept. 1968.
- HUNTER, I. M. and SLINGER, R. I. *A study of the physical properties of South African pure wool worsted hosiery yarns.* SAWTRI Technical Report no. 102, Port Elizabeth, South African Wool Textile Research Institute, Feb. 1968.
- JOUBERT, F. J., DE JAGER, P. J. and HAYLETT, T. A physico-chemical study of the high-sulphur proteins isolated from reduced Merino wool. In: Proceedings of conference on *Die skaap en sy vag*, 4-6 October 1966, University of Stellenbosch, Nasionale Pers Bpk., p. 235.
- KERLEY, L. A. Some factors influencing puckering and cockling in fully fashioned garments. *J. Text. Inst.*, vol. 59, no. 9, Sept. 1968.
- KERLEY, L. A. and SWANEPOEL, O. A. Abrasion testing of knitted fabrics at constant riding resistance. *Text. Res. J.*, vol. 38, no. 557, 1968.
- KING, N. E. An analysis on the use of resonance circuit apparatus for measurement of the dielectric constants of wool. *Text. Res. J.*, vol. 38, no. 554, 1968.
- KRIEL, W. J. and ALBERTYN, D. *Wool scouring investigations: The influence of various distributions of a non-ionic detergent.* SAWTRI Technical Report no. 104, Port Elizabeth, South African Wool Textile Research Institute, March, 1968.
- KRUGER, P. J. The influence of the backwashing process on the continental system of wool yarn manufacture. *SAWTRI Bulletin*, vol. 2, no. 3, Sept. 1968.
- ROBINSON, G. A. *Weft skewing in wool worsted fabrics. I: Influence of weave construction.* SAWTRI Technical Report no. 106, Port Elizabeth, South African Wool Textile Research Institute, May 1968.
- SCHEEPERS, G. E. and SLINGER, R. I. *The influence of fibre crimp form on the felting and compressional properties of wool.* SAWTRI Technical Report no. 103, Port Elizabeth, South African Wool Textile Research Institute, Feb. 1968.
- SCHULZE, J. E. Dimensional stability of knitted outerwear fabrics. *SAWTRI Bulletin*, vol. 2, no. 1, March 1968, p. 12.
- SCHULZE, J. E. *The characteristics of double piqué wool fabrics knitted with different rates of yarn intake. II: Some other physical properties.* SAWTRI Technical Report no. 109, Port Elizabeth, South African Wool Textile Research Institute, Sept. 1968.
- STOCKER, J. and KERLEY, L. A. Increasing the versatility of standard double-knit machines — a simple modification to produce plush fabrics. *S. Afr. Text.*, vol. 17, no. 1, Jan. 1968, p. 29.
- SWANEPOEL, O. A. Factors in dyeing wool and mohair. *Textile Month*, vol. 1, no. 84, April 1968.
- SWANEPOEL, O. A. and BECKER, J. *Aspects of the shrinkproofing and bleaching of wool.* SAWTRI Technical Report no. 105, Port Elizabeth, South African Wool Textile Research Institute, April 1968.
- SWANEPOEL, O. A. and HANDLEY, C. C. Polymers in the prevention of wool shrinkage. *Chem. Process. Lond.*, vol. 3, no. 17, March, 1968.
- SWANEPOEL, O. A. and MELLETT, P. Dyeing of wool with vinyl sulphone reactive dyestuffs. In: Proceedings of the conference *Die skaap en sy vag*, 4-6 October 1966, University of Stellenbosch, Nasionale Pers Bpk., p. 273.
- SWANEPOEL, O. A. and VAN DER MERWE, J. P. *Continuous reactive dyeing of wool in urea medium.* SAWTRI Technical Report no. 108, Port Elizabeth, South African Wool Textile Research Institute, July 1968.
- SWART, L. S. and JOUBERT, F. J. The fractionation of the high-sulphur proteins from oxidized mohair. *Text. Res. J.*, vol. 38, no. 36, 1968.
- VAN RENSBURG, N. J. J. Reductive after-treatments of peroxide bleached wool. *Text. Res. J.*, vol. 38, no. 318, 1968.
- VAN RENSBURG, N. J. J. and BURROUGHS, Mathilda A. Yellowing of bleached wool during dyeing. *SAWTRI Bulletin*, vol. 2, no. 1, March 1968, p. 20.
- VELDSMAN, D. P. The influence of certain fibre properties on the processing characteristics of S.A. Merino wool. In: Proceedings of the conference *Die skaap en sy vag*, 4-6 Oct. 1966, University of Stellenbosch, Nasionale Pers Bpk., p. 263.
- VELDSMAN, D. P. The research problems being tackled by SAWTRI. *S. Afr. Text.*, vol. 16, no. 12, Dec. 1967, p. 59.

# INFORMATION AND RESEARCH SERVICES



Mr D. G. Kingwill, Director of Information and Research Services

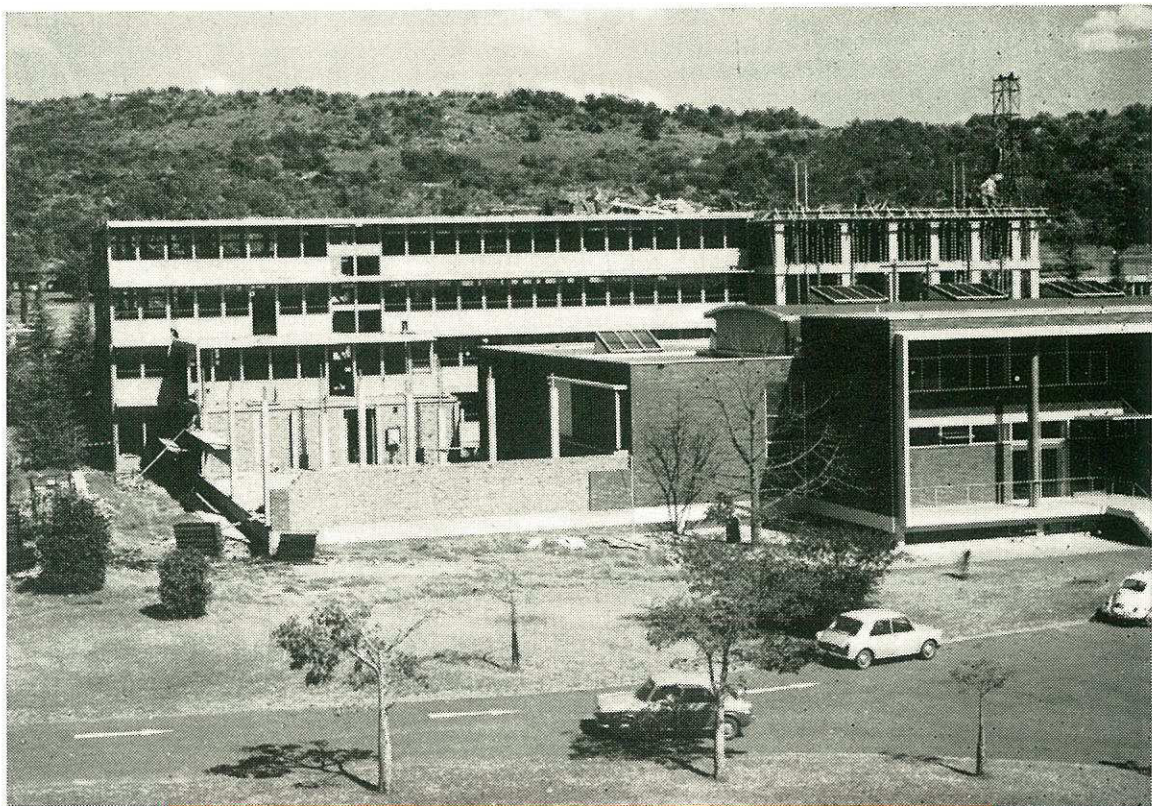


**T**HE Council's Information and Research Services (IRS) are concerned with all aspects of the collection and dissemination of scientific and technical information (both within the CSIR organization and at national level), the communication of information about scientific research to all sections of the community, the development of industrial research and the advancement of science in South Africa.

## Central Library

The services of the CSIR Library are available not only to the CSIR's staff but to all scientists, research organizations, industries and others who need access to scientific and technical publications. The following statistics give some indication of the increasing demands being made on these services.

Year	Publications issued on loan and photocopies provided	Books and pamphlets ordered	Periodicals (subscriptions) and exchanges)
1964	23,767	2,366	2,414
1965	31,660	2,478	2,648
1966	43,598	3,424	2,907
1967	44,995	3,704	3,136
1968	52,450	4,440	3,413



The CSIR library building which is being extended to provide much needed space for the growing collection of scientific and technical literature as well as accommodation for information and related services

It is widely recognized that more than arithmetical increase of staff is involved in handling the ever-growing volume of publications. Improvements in the services provided invariably lead to increased demands on those services. Furthermore, the training of librarians has not kept pace with advances in documentation techniques. Not only is the training inadequate, but insufficient numbers are being trained and, in an occupation favoured by women, staff turnover is high.

In these circumstances, the CSIR library has difficulty in meeting its obligations, particularly where the development and application of new documentation techniques are concerned, which are essential if this library is to provide guidance to other special libraries. Nevertheless, progress has been made in the introduction of a computerized system for handling serials records, and in improving the mechanized system of recording loans which was introduced some years ago. With the experience gained in these two projects, the library is now in a better position to mechanize

the production of the national union list of serial titles, *Periodicals in South African Libraries*. High priority has been given to speeding up the production of this reference tool, which has become indispensable to all reference and research libraries.

#### **Information Processing Group**

The Information Processing Group was formed early in 1968 to study the possibility of applying new techniques, such as electronic data processing, to the indexing and retrieval of scientific and technical information and, together with staff of the CSIR Central Library, to study the mechanization of library procedures. These investigations have become a matter of urgency because of the circumstances mentioned above.

The projects being carried out by the Group include the computerized production of indexes (Keyword-in-context (KWIC) indexes) to current journal literature in the field of water research, to CSIR and university research projects, to CSIR publications, and to pamphlet

collections in specialized subject fields. In addition, the CSIR central library was assisted further when the computerized journal recording system was introduced. This system facilitates the checking-in of journals as they are received and the maintenance of up-to-date journal records. Other activities included participation in the co-ordinated indexing project of the CSIR's Chemical Engineering Group and the presentation of a paper at a recent symposium on scientific and technical information held in Lourenço Marques.

#### **Industrial Information Centre**

As a service to industry in Natal, the CSIR, in collaboration with the Natal Chamber of Industries and the University of Natal, maintains an Industrial Information Service. This operates from the main library of the University of Natal in Durban and provides a bibliographic service for members. The members are mainly industrial firms, but during the past year there has been an increase in the number of consultants who make extensive use of the services available.

#### **Technical Information Service**

The main function of the Technical Information Service (TIS) is to provide liaison between the CSIR and small to medium-sized firms in the manufacturing industry and to disseminate technical information to such firms.

This is carried out by means of factory visits, the handling of technical enquiries from industry in so far as these are not dealt with directly by CSIR institutes, participation in the organization of symposia and conferences, the preparation of brief guides of topical interest, and the establishment of contacts with similar services in other countries.

Activities in which the Technical Information Service participated during the year, included: the SAAAS symposium on scientific and technical information in Lourenço Marques, at which a paper was presented by the TIS; the CSIR symposium on foundries and air pollution; the CSIR symposium on special steels, and the preparation of a guide on the selection of engineering construction materials.

The visits to individual firms have clearly indicated the importance of personal contact because, despite the availability of guides and directories, many industrialists have been found to be unaware of the services that government or semi-government laboratories can render.

The TIS is still in its infancy. Owing to the small staff and the large number of *ad hoc* activities, the provision of more sophisticated information services to industry, as well as regional services, has had to be postponed.

#### **Conferences and symposia**

The Conference and Symposium Secretariat was established for two purposes:

Firstly, as the Secretariat of the Council's Advisory Committee for the Development of Research for Industry (ACDRI) it assists in implementing the policy of this Committee by arranging technical symposia dealing with specialized topics of interest to industry. These symposia are intended to make specific industries aware of the facilities available at the CSIR and other organizations, and are arranged whenever a need for research has been identified.

The following symposia were arranged during 1968:

- **Symposium on spectroscopy** held at the CSIR during February, in collaboration with the National Physical Research Laboratory
- **Symposium for the motor industry**, held at the CSIR on February 2nd, in collaboration with the National Mechanical Engineering Research Institute
- **Symposium on finger jointing of timber**, held in Pretoria at the test site of the National Building Research Institute on March 27th in collaboration with the Timber Research Unit
- **Symposium on foundries and the Air Pollution Act**, held in Pretoria on August 1st at the request of the S.A. Institute Foundrymen
- **Seminar on particle size analysis**, held at the CSIR on November 6th in collaboration with the Chemical Engineering Group and the Chamber of Mines of South Africa.
- **Symposium on special steels**, held in Pretoria on November 28th. This symposium was initiated by the Technical Information Division of the CSIR to provide a forum for the exchange of information and the discussion of problems encountered by both producers and users of special steels.

Secondly, the Secretariat assists CSIR institutes or outside organizations and professional bodies with arrangements for national and international conferences.

The CSIR is at present involved in the organization of a number of international conferences scheduled to take place in South Africa, viz. the Symposium on the Chemical Control of the Human Environment organized under the auspices of the International Union of Pure and Applied Chemistry (IUPAC) (Johannesburg — 1969), the International Symposium on Gondwana Stratigraphy of the Gondwana Com-

mission of the International Union of Geological Sciences (IUGS) (Cape Town and Johannesburg — 1970) and the International Conference on Water Purification (1972), as well as a national symposium on stainless steel (Johannesburg — 1969) and a national building research conference (Pretoria — 1969).

#### Foreign Language Information Service

In addition to translations from foreign language scientific and technical sources, undertaken on behalf of CSIR institutes (and other organizations), this Division continues to assist in tracing foreign language sources of scientific and technical information.

During the past year, heavy demands were made on the Division for translation, liaison and interpretation services in connection with the symposium on scientific and technical information, which was held in Lourenço Marques in association with the 66th Annual Congress of the South African Association for the Advancement of Science. Similar demands were met in connection with discussions concerning a co-operative research project in Mozambique and the visits of Portuguese scientists and documentalists to South Africa.

#### Communication and use of information

A study of the generation, communication and use of information by scientific research workers in South Africa is being undertaken by the Regional Representative in Natal. A comprehensive questionnaire was sent to every research worker in the physical and biological sciences, and over 2,000 completed forms (some 65 per cent) were returned. These were edited, coded and the data transferred to cards for computer processing. A considerable amount of analysis of the computer printout has been done and three papers have been submitted to the *South African Journal of Science* for publication. A paper on the subject was read at the symposium on scientific and technical information in Lourenço Marques, and a comprehensive report is in preparation.

#### Publishing Division

This Division provides a central editorial service for the CSIR, and is responsible *inter alia* for maintaining language and documentation standards and for compiling and publishing general information and publicity material on the work of the CSIR as well as guides to sources of scientific and technical information in South Africa.

Apart from the annual report, the most important general information publication issued by the CSIR is the monthly journal *Scientiae*. During the year under review a number of issues were devoted to activities in specific spheres of research, such as physical research, road research and astronomy in South Africa.

Similar issues are being planned for the next year.

One issue of the monthly four-page bulletin *TI* — which features new apparatus, techniques or services at the CSIR likely to be of particular interest to industry — was devoted to the National Training Centre for Scientific Instrument Makers which was officially opened in November.

In addition to the three directories dealing with *Research organizations in South Africa*, *Scientific and technical societies in South Africa* and *Scientific and technical periodicals published in South Africa*, and the *Register of current scientific research at South African universities*, an annual index of *CSIR Research projects* is being published by this Division. The last two are produced with the aid of a computer, and this technique will, in future, also be used for the preparation of *CSIR Research Review*, the six-monthly bibliography of publications issued or supported by the CSIR. The computer programmes for this purpose have been prepared by the Information Processing Group.

In collaboration with the Public Relations Office, two new guides have been published, viz. a calendar of scientific and technical meetings in South Africa and a brochure giving details of the major functions of the various divisions of the CSIR's national laboratories and services.

#### Press Office and Science Features Division

This Division is responsible for science publicity, science writing, liaison with the press and radio, a national science conference and symposium publicity service, the production of popular films on science subjects, and numerous other activities related to the popularization of science.

A 35mm documentary film, *The New World of Wool*, was produced for the CSIR and the South African Wool Board during the year, while a further documentary, *The Buildings in Your Life*, is well under way. Meanwhile, *Your Highway Tomorrow*, produced in 1967, is still on the national circuit and will be seen by an estimated 500,000 viewers.

The head of the Division was appointed editor of the new quarterly journal *Scientific Progress*, published by the Scientific Advisory Council, and the first issue appeared in October.

In July, the Division handled the publicity for the convention of the S.A. Institution of Civil Engineers, held at the University of Pretoria, and achieved considerable press coverage. Publicity was also arranged for several CSIR symposia.



Filming during the production of "The Buildings In Your Life", the latest film in the CSIR series 'Science In Your Service'. The location is a CSIR-designed high school near Pretoria

### Functions and visits

The Public Relations Office is mainly responsible for arranging official functions at the CSIR as well as visits to the CSIR by the general public, university and high school students.

Major functions arranged during 1968 included:

- The commissioning of the new 20 in. reflecting telescope at the Republic Observatory in Johannesburg on April 19th by the Minister of Planning
- The official opening of the primate centre at the National Nutrition Research Institute on August 1st by the Minister of Health
- Training Centre for Instrument Makers
- The official opening of the National at the CSIR on November 22nd by the Minister of Planning.

The latter function was arranged in conjunction with a visit to the CSIR laboratories by leading industrialists and other prominent personalities.

In addition, visits were arranged for some 600 high school students, 100 overseas visitors and 600 local visitors.

### Industrial Research Development

The Council's Advisory Committee on the Development of Research for Industry (ACDRI) has given close attention to the encouragement of technological innovation in industry. Detailed schemes for providing support for research in private industry and for technical development projects have been recommended to the Council.

These proposals are of special significance, as, with the increasing amount of rationalization in industry, effected by means of mergers and take-overs, the co-operative research institute becomes a less attractive channel of support for industrial research. Such institutes function most satisfactorily when they have a reasonably large number of member-firms of more or less the same size. However, industrial support for three of the existing co-operative research institutes supported by the CSIR has continued at a satisfactory level; these are the Fishing Industry Research Institute, the Leather Industries Research Institute and the Sugar Milling Research Institute. It is also gratifying to be able to report that contributions to the South African Paint Industries Research Institute have increased.

On the recommendation of the Committee, the Council has agreed in principle to the establishment of a textile research unit for fibres other than wool, though details have still to be worked out in consultation with the textile industry.

### Industrial Economics Division

An unprecedented turnover in staff (including the loss of two successive divisional heads) has necessitated major reorganization of the Industrial Economics Division, which in future will consist of two separate sections, viz. the Techno-Economics Section and the Research Economics Section.

*Techno-Economics Section* — This Section functions essentially as the Professional Secretariat for the Advisory Committee for the Development of Research for Industry (ACDRI). In this capacity, the Section undertakes techno-economic surveys to identify research oppor-



tunities which may be exploited by CSIR laboratories and institutes. The Section is also responsible for follow-up work on the surveys, i.e. to establish effective liaison between CSIR laboratories and institutes and the industries concerned, or to take the necessary initiative in the establishment of research facilities if these do not already exist.

During the past year this Section completed a survey of the research needs of the packaging industry, the results of which have now been published.

Towards the end of the year arrangements were concluded with the Board of Trade and Industries whereby the Section would co-operate with the Board on a survey of the basic chemicals industry requested by the Minister of Economic Affairs.

*Research Economics Section* — This Section is responsible for carrying out surveys of expenditure on research and development. In this connection it acts as a professional secretariat to the Committee on Research Expenditure (CORE) of the Prime Minister's Scientific Advisory Council.

The Section is also responsible for studying the general economic impact of science and assessing how this can influence scientific policy-making.

Formal arrangements were made for the Department of Planning to finance partially the activities of the Section. The work being undertaken for CORE would therefore be on a contract basis.

The Section has completed its analysis of research and development expenditure in all sectors of the economy in South Africa and is busy preparing a series of reports for submission to the Committee on Research Expenditure. These reports will give the first overall coverage of data in respect of expenditure on research and development throughout South Africa and, it is hoped, will be released generally during 1969.

#### **Science Co-operation Division**

The activities of the Science Co-operation Division are centred mainly on the Council's commitments as national member on behalf of South Africa of a group of international scientific organizations. These organizations together form the International Council of Scientific Unions (ICSU), a body which sets out to promote international co-operation in the scientific field.

In administering the national membership of ICSU and its member unions the Science Co-

operation Division is advised by a number of national committees of experts, for which it also provides the organizing secretariat. Thus liaison with ICSU is effected in such a way that the whole scientific community of South Africa benefits. As a direct result of this liaison, South Africa has been participating for more than ten years in various international projects initiated by the member unions of ICSU, such as the International Geophysical Year, the International Indian Ocean Expedition, the International Years of the Quiet Sun, the Upper Mantle Project and the International Biological Programme.

Official national participation in the Upper Mantle Project ended at the end of 1968, while national activities under the International Biological Programme have now gained momentum.

The South African Antarctic research programme has entered its second five-year period. Funds for the latter programme are administered by the Department of Transport on the advice of the Scientific Committee for Antarctic Research, for which this Division also provides the secretariat.

Participation in the International Geophysical Year and the International Indian Ocean Expedition has also led to a co-ordinated permanent research programme in the field of oceanography.

During the next two years two international symposia arising from South Africa's membership of ICSU are to be held in the Republic. The first of these, which will deal with the chemical control of the human environment, is being organized in collaboration with the International Union for Pure and Applied Chemistry (IUPAC) and will take place in Johannesburg in July 1969. The second, which will deal with the Gondwana System, is being planned for 1970 under the auspices of the International Union for Geological Sciences (IUGS).

#### **Overseas offices**

The South African science offices in Washington, London, Cologne and Paris are rendering valuable services to the South African diplomatic missions, to the CSIR and other South African research organizations and to universities.

The Paris office, which was opened at the beginning of 1968, is now fully operational.

In addition to arranging interviews and study tours for visiting South African scientists, the heads of the overseas offices represented the CSIR and other South African organizations at conferences and other scientific meetings overseas. Considerable success was also achieved in efforts to maintain contact with post-graduate

students from South Africa studying overseas and to keep them informed of developments and opportunities in South African research.

Three-monthly reports containing news of significant trends and developments in science, and particularly of scientific policy, are regularly submitted to the CSIR by the overseas offices.

Towards the end of 1967, a staff member of the National Institute for Personnel Research (NIPR), was seconded to the Cologne office to apply the full personnel selection procedures of the NIPR to staff being recruited overseas.

### Regional offices

While the Council's headquarters and most of its research laboratories are located in Pretoria, it is fully aware of its function as a national organization and is represented in other provinces and in South West Africa.

In addition to the regional offices in Durban (Natal) and Bellville (Western Cape), a regional office for the Cape Midlands came into operation during the year. This office is based on the South African Wool Textile Research Institute in Port Elizabeth.

Some years ago the Council established regional research liaison committees for Natal, the Cape Midlands and South West Africa with a view to maintaining contact with the provincial and municipal authorities and with industry. The annual meetings of these Committees provide a forum in which directors of CSIR research institutes can discuss research of regional interest with the appropriate bodies. The last meeting of the Natal Regional Research Liaison Committee was coupled with a symposium on the engineering aspects of road safety.

## UNIVERSITY AND MEDICAL RESEARCH

The division responsible for the administration of *ad hoc* university research grants and grants to units at universities and other institutions in the natural, engineering and medical sciences, reports directly to the Executive on all professional matters.

A brief report on the administration of funds for medical research and research in the natural sciences at universities appears below.

The budget of the University and Medical Research Division for the year under review was as follows:

General Sciences ... ..	R717,900
Medical Research ... ..	654,900
	<hr/>
	R1,372,800

In addition funds for the following research were administered.

Pneumoconiosis Research Unit ...	R291,000
Asbestosis Research Project ...	R 48,500

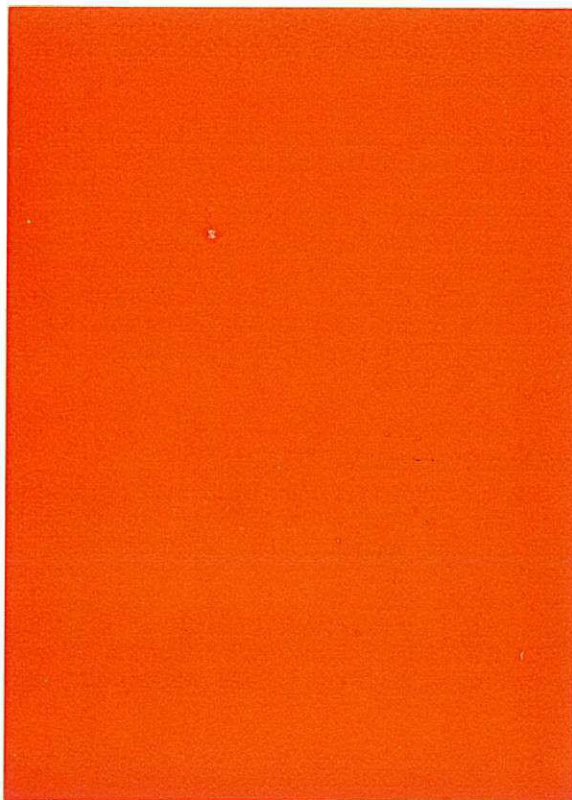
The Pneumoconiosis Research Unit is sponsored jointly by the State and the Chamber of Mines of South Africa and the Asbestosis Research Project by the State and the asbestos mining industry.

The State also allocated a special grant of R250,000 during the year which enabled the Council to make awards of a non-recurring nature (mostly research equipment) to a large number of university staff members.

In addition to 170 *ad hoc* grants to university and museum personnel and independent research workers, the Council awarded the following numbers of bursaries for post-graduate research and training at the universities in the general sciences:

Post-B.Sc. ... ..	163
Post-B.Sc. (Hons.) ... ..	94
Post-M.Sc. ... ..	34
Senior and Overseas ... ..	80

Nineteen scientists from universities were given grants to enable them to attend overseas international scientific conferences.



#### MEDICAL RESEARCH GROUPS AND UNITS

The medical research units and groups supported by the C.S.I.R. are as follows:

- Amoebiasis Research Unit, Institute of Parasitology, Durban (Director: Dr. R. Elsdon-Dew).
- Arthropod-borne Virus Diseases Research Unit, Poliomyelitis Research Foundation, Johannesburg (Director: Dr. J. H. S. Gear).
- Bacterial Genetics Research Unit, Institute of Pathology, University of Pretoria (Director: Prof. J. N. Coetzee).
- Bilharzia Research Group, sub-divisions at Nelspruit (Head: Dr. R. J. Pitchford), University of Potchefstroom (Head: Prof. J. A. van Eeden) and South African Institute for Medical Research, Johannesburg (Head: Dr. J. H. S. Gear).
- Cardio-Pulmonary Research Unit, University of the Witwatersrand (Director: Dr. J. B. Barlow).
- Cardio-Vascular Pulmonary Research Group, University of Cape Town (Director: Prof. V. Schrire).
- Clinical Nutrition Research Unit, University of Cape Town (Director: Prof. J. F. Brock).
- Degenerative Diseases Research Group, University of Stellenbosch (Director: Prof. A. J. Brink).
- Dental Research Unit, University of the Witwatersrand (Director: Prof. C. J. Dreyer).
- Endocrine Research Group, University of Cape Town (Director: Prof. W. P. U. Jackson).
- Human Biochemistry Research Unit, S.A. Institute for Medical Research, Johannesburg (Director: Dr. A. R. P. Walker).
- Iodine Metabolism Research Unit, University of Stellenbosch (Director: Dr. A. van Zyl).
- Iron and Red Cell Metabolism Research Unit, University of the Witwatersrand (Director: Prof. T. H. Bothwell).
- Nutritional Anaemia Research Group, University of Natal, Durban (Director: Prof. E. B. Adams).
- Photobiology Research Group, University of Pretoria (Director: Prof. G. H. Findlay).

- Pneumoconiosis Research Unit, Johannesburg.
- Protein Research Unit, University of Cape Town (Director: Prof. J. E. Kench).
- Renal Metabolic Research Group, University of Cape Town (Director: Prof. L. Eales).
- Tissue Damage and Cell Metabolism Research Unit, University of Stellenbosch (Director: Prof. F. M. Engelbrecht).
- Tuberculosis Research Group, Veterinary Research Institute, Onderstepoort (Director: Prof. B. C. Jansen).
- Virus Research Unit, University of Cape Town (Director: Prof. A. Kipps).

#### GROUPS AND UNITS FOR RESEARCH INTO THE NATURAL SCIENCES

- Chromatography Research Unit, University of Pretoria (Director: Prof. V. Pretorius).
- Cosmic Rays Research Unit, Potchefstroom University (Director: Prof. P. H. Stoker).
- Geochemistry Research Unit, University of Cape Town (Director: Prof. L. H. Ahrens).
- Marine Research Unit, Oceanographic Research Institute, Durban (Director: Dr. A. Heydorn).
- Natural Products Research Unit, University of Cape Town (Director: Prof. F. L. Warren).
- Oceanographic Research Unit, University of Cape Town (Director: Prof. J. K. Mallory).
- Palynology Research Unit, University of the Orange Free State (Director: Prof. E. M. van Zinderen Bakker).
- Solid State Physics Research Unit, University of the Witwatersrand (Director: Prof. F. R. N. Nabarro).
- Desert Ecological Research Unit, Namib Desert Research Station, Gobabeb (Director: Dr. C. Koch).

# THE TECHNICAL SERVICES DEPARTMENT



Mr J. J. van der Staaij,  
Director of the  
Technical Services  
Department

**T**HE Technical Services Department (TSD) undertakes the design and manufacture of research equipment and also renders other essential services such as those provided by the sections for 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 on condition that such work is not undertaken anywhere else in the Republic.

## Special services and facilities

Owing to the exceptional facilities and craftsmanship at its disposal, the TSD, as in the past, has been able to render services to private organizations which could not be rendered by industry.

A numerically controlled milling machine, operated by a magnetic tape, has now made it possible for the TSD to manufacture, in a much more economical manner than previously, workpieces of a most complicated shape with a high degree of accuracy.

## Services to related organizations

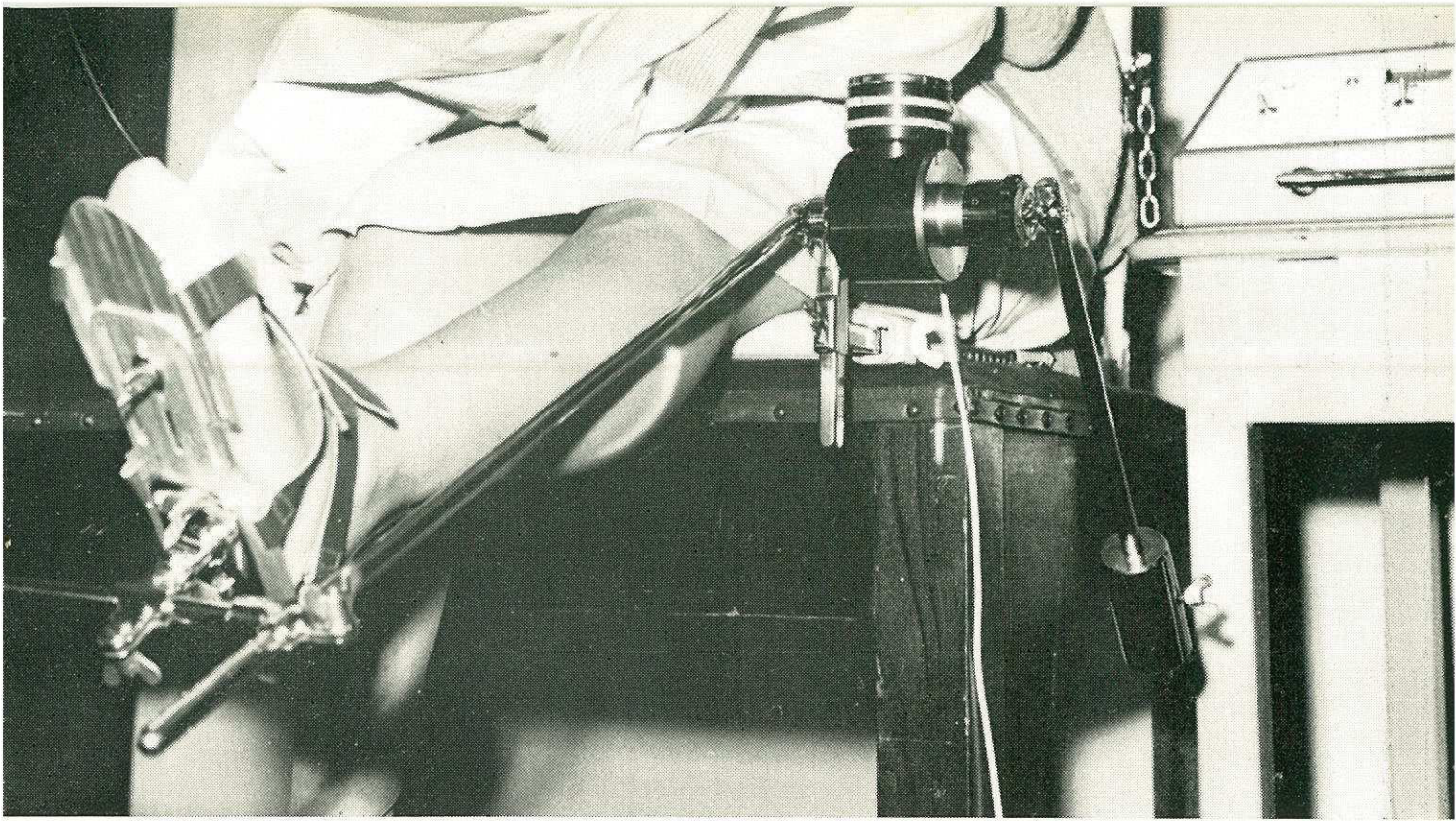
A variety of services were rendered and, among several pieces of apparatus designed and manufactured, was one for the SABS enabling this organization to test carbon paper, while an instrument designed to control the cheese-making process was manufactured for the Dairy Board. A drying oven for the quick drying of wine lees with an exceptionally high degree of efficiency for the recovery of potassium bitartrate — basic substance for tartaric acid — was designed and manufactured for the Wine Industry.

## Services to industry

A good deal of equipment was manufactured for industry. A notable example was the construction of equipment for an entirely new process for rotating pressure profile forming, with which motor-car parts can be manufactured within seconds in their finished form.

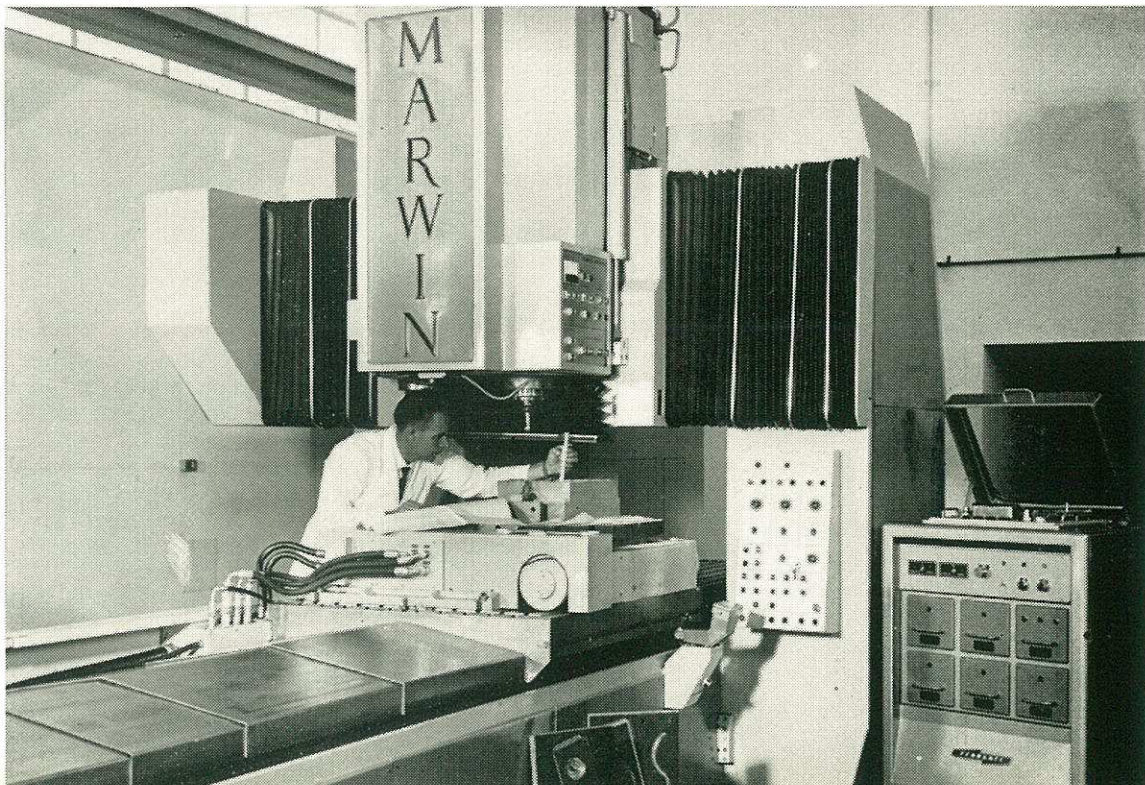
## Medical equipment

An apparatus was manufactured for the application of a new idea in occupational therapy, developed by the Pretoria College of Occupational Therapy. In addition, a pulse simulator was produced for the Department of Surgery of the University of Stellenbosch for the testing of artificial heart valves.



A new therapeutic device manufactured by the TSD for the Pretoria College of Occupational therapy

The numerically controlled milling machine recently installed in the TSD





Dr E. C. Halliday,  
Head of the Air Pollution  
Research Group

**Air pollution has always been a threat to the health and can even cause death. Even vegetation, buildings and various materials are affected. In order to determine the extent of this problem in South Africa and to combat it by effective control measures the Air Pollution Research Group was formed.**

**The Group studies the type and concentration of pollutants, dispersion processes, as well as meteorological data and has an extensive collection of pamphlets on the subject, which can be obtained on request by industries and organizations concerned with air pollution.**

**Reports on the work of this Group previously formed part of the National Physical Research Laboratory reports.**

#### **Smokeless cooking**

The culmination of six years' experimental development and sociological evaluation was the recent demonstration of a pre-production prototype of the SCOTT<sup>R</sup> smokeless solid-fuel cooker for use in non-European housing. It was shown in Pretoria to representatives of several neighbouring municipalities.

With the declaration of some thirty municipal areas in the Republic as smoke controlled areas (Act 45 of 1965), the provision of a means of reducing smoke from domestic sources has assumed new importance. It is expected that the availability of this new type of stove will be of considerable assistance to local authorities and Government departments concerned with housing.

# **AIR POLLUTION RESEARCH GROUP**

#### **Industrial stacks**

Part II of the Atmospheric Pollution Prevention Act (scheduled processes) has been declared to apply to the entire Republic and many processes have been added to the original schedule. Industries using such processes must now apply for provisional registration and will be required by the Department of Health to adopt the "best practicable means" of dealing with noxious emissions from stacks. In many cases the "means" may comprise building a taller stack and/or scrubbing equipment for the waste gases.

It has been mentioned previously that the Group has undertaken a study, sponsored by the Department of Health, of dissipation from stacks. The remote-controlled sampling equipment which, in a field test, is to be placed to surround a simulated stack or tower, has now been completed by the Group and enables scientists and technicians to collect and count special fluorescent tracer particles released from the stack.

#### **Information to industry**

The information service to industries and other organizations has been extended with the appointment of more staff. The latest classified catalogue sheets of accessions, listing some 2,000 new publications acquired for the Group's pamphlet library are now available from the Information Officer of the Group.

#### **Town planning**

Micrometeorological investigations of proposed industrial sites have been continued. The Richards Bay area, the site of a future harbour town, was investigated by the Group with a view to industrial siting. Again, special radio telemetry equipment developed by the Group was used to transmit air temperatures to the operator from a sensor carried aloft by a special kite-balloon.

#### **City surveys**

For many years now the Group has been collecting and collating the results obtained in a nation-wide network of measurements of smoke and sulphur dioxide (prime pollutants arising from combustion) which have been undertaken by the Municipalities of Cape Town, Durban, Johannesburg and Germiston. The Group itself has performed the measurements in Pretoria.



The mobile laboratory of the Air Pollution Research Group

The results, now expressed in the new *soiling index* notation, have recently been published comprehensively for the first time. The Group has also published a booklet describing fully the technique of making smoke measurements.

#### Remote chemical analyses

In order to carry out more sophisticated analyses of pollution at places remote from Pretoria, the Group has acquired a mobile laboratory. The mobile laboratory is at present equipped to measure carbon monoxide and hydrocarbons emitted from vehicle exhausts, ozone, sulphur dioxide and smoke. Analysis for nitrogen oxides — another major source of pollution — will probably be started soon.

#### Advice on gas cleaners

Development and application of a punched-card system for the filing of literature references connected with the control and prevention of polluting emissions from the chemical industry has continued.

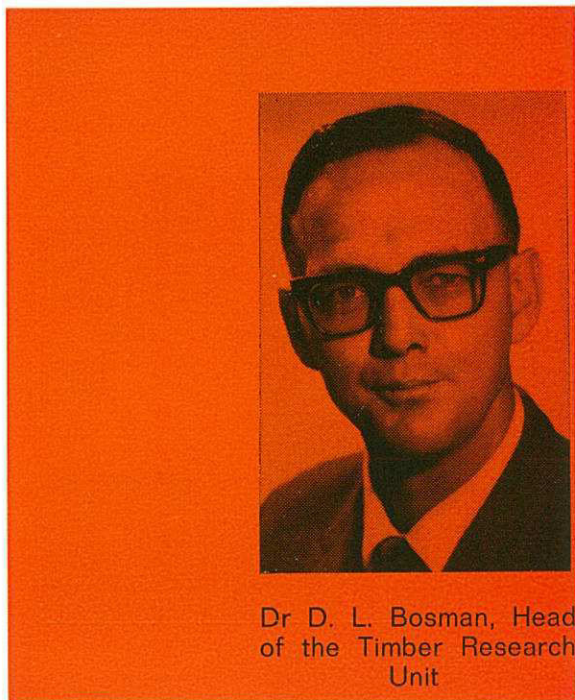
#### Publicity film

The Group's information office has assisted with the script of a publicity film which is being sponsored by the Department of Health.

### Selected Publications

- KEMENY, E. & HALLIDAY, E. C. Smoke concentrations in South African towns. Part II: Data for October, 1962 to September, 1964, *Public Health*, vol. 67, no. 10, October 1967, pp. 465-469.
- KEMENY, E. & HALLIDAY, E. C. Smoke concentrations in South African towns. Part III: Data for October, 1964 to September, 1966, *Public Health*, vol. 68, no. 2, February 1968.
- KEMENY, E. & HALLIDAY, E. C. *Methods recommended for the measurement of air pollution in South Africa; determination of smoke and soot.* Pretoria, CSIR, 1968.
- LATSKY, C. E. Hierarchical scheme for document classification and storage. Paper no. 67-175 presented at the 60th Annual Meeting of the Air Pollution Control Association, Cleveland, Ohio, 1967. Pretoria, CSIR, 1967.
- LOUW, C. W. *Atmospheric pollutants and their analysis.* Pretoria, CSIR, 1966.

# THE TIMBER RESEARCH UNIT



Dr D. L. Bosman, Head  
of the Timber Research  
Unit

**T**HE Timber Research Unit (TRU) offers a wide variety of specialized research and technical services to both producers and consumers of forest products.

More specifically the aims of the Unit are:

- to promote the effective exploitation of South African timber resources;
- to assist in developing satisfactory products;
- to assist in developing and improving manufacturing processes, and
- to promote the effective use of timber products.

The work of the TRU covers various fields and includes research into timber engineering and wood processing, fibre and chemical research and techno-economic studies. The results of this work are disseminated by the Unit's Research Application and Information Services Division through the media of publications, symposia, lectures, representation at conferences and on technical committees, and through direct contact with the industry.

## TIMBER ENGINEERING

The main objective of the Timber Engineering Division is the effective structural utilization of South African timber, and the Division has continued work on its three main projects which, it is hoped, will culminate in the production of economical standard roof designs.

### Stress-grading

The development of the mechanical stress-grading method for application in the local timber industry is progressing satisfactorily. This method involves the classification of structural timber according to grade, each grade having safe, reliable and realistic design stresses assigned to it. This procedure is designed to help realize the full strength-potential of the available material. All preparatory work, i.e. literature surveys, collection of samples, development and provision of testing facilities and planning of projects, has been completed, and the main research programme is now underway. There are already indications that machine stress-grading of South African pine timber will result in a 100 per cent improvement on the visual grading methods at present being used. The new grading method is expected to be applied in practice in 1970.

### Finger joints

The project dealing with the structural properties of finger-jointed timber has been completed, and the results of final experiments in this connection were presented at a highly successful one-day symposium held at the CSIR. The results of this project have been incorporated in a SABS Code of Practice and have been used to provide design data for finger-jointed timber.

### Mechanical joints

A detailed survey of literature on joints formed with nails, bolts, connector plates and other fasteners has been completed as a basis for a research programme aimed at establishing data for the design of joints in South African structural timber. Progress is being made in the development of an efficient jointing method for roof trusses using locally produced nails and plywood.

### Roof trusses

The results of a development study on the subject of roof trusses have been published, and a research programme — based upon this study and on an overseas study tour — has been drawn up to develop sound, economical designs for roof structures in South African timber that



can be fabricated on the site or by industrialized methods. The first of these designs is expected to be produced in 1970.

## WOOD PROCESSING

The Wood Processing Division is chiefly concerned with improving the quality of South African timber products, and more especially with problems associated with the seasoning of wood.

### Seasoning

The now compulsory grading of structural timber has served to emphasize the importance of seasoning and the need to improve present-day timber drying practice in South Africa if the requirements of the grade specifications with regard to moisture content are to be met. A general survey of kiln drying practice was undertaken and timber seasoning plants were visited to see the types of kiln in use and to determine the main seasoning problems confronting the timber industry.

A detailed survey of available literature concerning the role played by air movement, temperature and humidity in the drying of timber was completed by the project leader, who then undertook an overseas tour to study the latest developments in kiln drying.

The information gained from these sources is intended as a preliminary to further research aimed at developing a suitable method of evaluating kiln efficiency and at improving kiln drying techniques in South Africa.

A symposium on timber seasoning was arranged by the Department of Forestry in collaboration with the TRU, the South African Bureau of Standards and the South African Lumber Millers Association.

### Wood quality

A comparison of the quality of some exotic timbers grown in South Africa with that of the same species grown in their native habitat indicate that there are differences in their physical properties. These properties have an important bearing on the processing and proper utilization of the timbers. Some of these properties, such as density and shrinkage, have been investigated; however, there is a need for basic research into the effect of these and other physical properties (such as permeability) on the quality of dried wood under different drying conditions.

Certain physical and mechanical properties of two types of wood mosaic flooring were investigated on behalf of sponsors.

An inexpensive tensile testing apparatus developed by the Timber Research Unit for the quality control of finger joints

## Board products

The results of short-term tests to evaluate the durability of wood-base board products used as external cladding for buildings were incorporated in a paper prepared for presentation at the first International Bio-deterioration Symposium held at Southampton University. The long-term investigation of these products is nearing completion.

Accelerated ageing tests were also conducted on mineral-coated chipboard and plywood panels.

## Glued wood products

Industry was assisted in developing techniques for the manufacture of plywood from South African pine using different adhesives, including a locally produced adhesive made from wattle bark extract.

## FIBRE AND CHEMICAL STUDIES

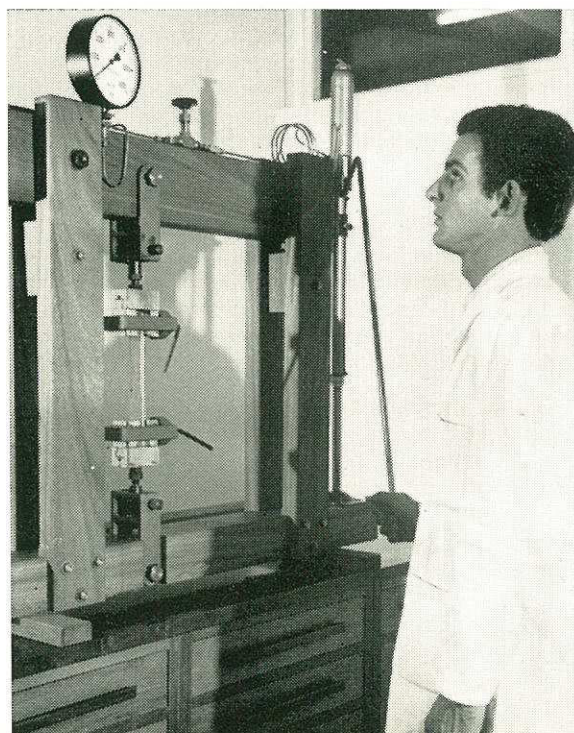
This work covers two main fields: adhesives and wood gluing, and pulp and paper.

### Adhesives and wood gluing

In a study of the gluability of South African timbers, the influence of resin in pine is being determined. The durability of urea-based adhesives is open to question and is being investigated by means of ageing tests on glued specimens placed in various parts of the country. A suitable test was developed for the quality control of finger-jointed timber and an apparatus for tension-testing the specimens was developed for use by the timber industry.

### Deterioration of pulp wood

The influence of the storage of pulp wood on the quality of paper pulp, and consequently on the economics of paper production, is being investigated. Methods designed to prevent biological deterioration which are currently being evaluated, are the treatment of pulp wood with fungicides and with certain strains of a scavenger fungus, *Trichoderma viride*. The influence



of the drying of pulp wood on the drainage properties of pulp, which affect the running speed of paper machines, is being studied.

#### Preservation of paper

The permanence of paper is being investigated for the State Archives with a view to ensuring the preservation of archival material. The work involves a study of the factors contributing to the deterioration of paper in order that recommendations may be made regarding the preservation of existing documents and the manufacture of more permanent paper for future use. Recommendations were made on the restoration of documents by means of de-acidification in order to decrease the rate of deterioration and by reinforcing them with special laminating materials.

#### Requirements of pulp wood

The relationship between the quality of pulp and various physical and chemical properties of pulp wood is being determined so that criteria can be established for growing a better quality of wood for pulping. The procedure followed is to evaluate the pulp obtained from selected trees and to correlate its quality with relevant wood properties. Wood fibre geometry is one of the most important factors influencing the quality of pulp and special equipment to determine fibre dimensions was imported. Ultimately, the results obtained during this work will be used by the Department of Forestry for the breeding of trees.

#### TECHNO-ECONOMIC STUDIES

A techno-economic service is provided for the divisions of the Unit as well as for the timber industry.

##### Techno-economic surveys

These surveys assist in defining research projects in the timber industry against an economic background. They provide a basis for assigning priorities to the various possible research projects and for identifying the needs of industry, particularly in the field of research. As a result of recommendations made in a comprehensive techno-economic survey carried out in 1965, currently available consumption statistics and predictions of the future demand for timber and related products have been critically analysed.

##### Cost and other specialized studies

The economic implications of problems of primary importance to the timber industry are investigated, such as the recently completed analysis of the market for stress-graded structural timber in South Africa.

The cost of research projects already defined is analysed, mainly for the information of the TRU. During the year under review the importance of the different cost factors in the manu-

facture of finger joints in South Africa was determined.

#### Problems in industrial engineering

This work is aimed at improving efficiency in the timber industry and involves the application of quantitative and qualitative management techniques, in fields such as production planning, inventory control, production processes and techniques, maintenance, etc., in the timber processing industry. Work is in progress on the determination of a standard to measure over-all kiln drying efficiency with a view to improving current industrial practices.

### Selected Publications

- BANKS, C. H. *Spiral grain and its effect on the quality of South African timber*. Paper presented at the XIVth Congress of the International Union of Forestry Research Organizations, Munich, September, 1967, 26p.
- BANKS, C. H. *Kiln drying conditions — a development study*. CSIR Development Study, Pretoria, CSIR, February 1968, 80p.
- BANKS, C. H. *Different types of kiln and choice of the correct type in relation to volume of production, types of timber and range of sizes, and final moisture content*. Paper presented at the Symposium on Timber Seasoning, Pretoria, August 1968, 10p.
- BOSMAN, D. L. The future of timber as an engineering material. *Timber*, vol. 5, no. 4, March 1968, pp. 7, 11, 12.
- BOSMAN, D. L. The importance of research in expanding the market for timber. *Timber*, vol. 5, no. 6, May 1968, pp. 14-17.
- BRYANT, P. A. V. Quality control in timber engineering. *Timber*, vol. 5, no. 2, January 1968, pp. 17-18.
- LOUW, F. and MÜLLER, P. H. *The influence of knots and bolt holes on the strength of finger joints*. Paper presented at the Symposium on Finger Jointing in Timber, Pretoria, March 1968, 18p.
- MÜLLER, P. H. *Working stresses for finger joints in structural pine timber*. Paper presented at the symposium on Finger Jointing in Timber, Pretoria, March 1968, 36p.
- MÜLLER, P. H. Mechanical stress-grading of structural timber in Europe, North America and Australia with a research programme on this field for South Africa. *Wood Science and Technology*, vol. 2, 1968, pp. 43-72.
- MÜLLER, P. H. *The strength properties of South African pine structural timber*. Paper presented at the Symposium on Structural Timber, Salisbury, August 1968, 17p.
- SCHARFETTER, H. *Adhesives and quality control in finger joint manufacture*. Paper presented at the Symposium on Finger Jointing in Timber, Pretoria, March 1968, 13p.
- SCHARFETTER, H. *The choice and application of adhesives for structural timber*. Paper presented at the Symposium on Structural Timber, Durban, May 1968, 9p.
- VAN VUUREN, M. J. C. and VISSER, J. H. *Report on an investigation into the cost of manufacturing finger joints in South Africa*. Paper presented at the Symposium on Finger Jointing in Timber, Pretoria, March 1968, 15p.
- VENTER, J. S. M. Ageing and preservation of paper. *South African Archives Journal*, no. 9, 1967, pp. 11-16.

# THE FISHING INDUSTRY

# RESEARCH INSTITUTE



Dr. G. M. Dreosti,  
Director of the  
Fishing Industry  
Research Institute

**T**HE Fishing Industry Research Institute (FIRI) is affiliated to the University of Cape Town and has its main laboratory on the University campus and a second laboratory at Walvis Bay.

For its annual income FIRI depends on voluntary contributions from the fishing industry. Firms directly engaged in fishing or fish processing in South Africa or South West Africa may become members of FIRI by guaranteeing annual subscriptions. Firms with an indirect interest in the fishing industry may contribute to the income of FIRI as associate members. All subscriptions guaranteed for five years are matched on a rand for rand basis by the CSIR, and this money is used exclusively to finance FIRI research projects. The total annual income of the Institute has increased from about R19,000 at the time of its establishment to over R220,000.

The fishing industry was the first to take advantage of the opportunity offered by the research association scheme of the CSIR to establish industrial research in 1945/46. The fishing industry provides much scope for fruitful research in such diverse disciplines as physics, engineering, chemistry, microbiology and nutrition. The primary function of the Institute is to carry out fundamental and applied research for the fishing industry. Subjects that are being or have been investigated include: the canning, chilling, freezing, salting and smoking of fish; the production, curing, storage and transport of fish meal and the evaluation of its nutritional value; the production of fish protein concentrate (fish flour) for human consumption; effluent clarification and the recovery of solids during this process; the development

and use of fish products and the design of special analytical methods for such products.

FIRI is also collaborating in a fish-tagging programme, organized by the Department of Sea Fisheries, with a view to studying the impact commercial fishing has on the fish population.

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

The Institute provides scientific or technical advice on specific problems and conducts tests for individual members at their expense. It performs analyses of finished products as well as raw materials at the expense of the industry and conducts routine analyses of fish meal, tomato paste, fish oils and water, and fresh, frozen, salted, smoked, dried and canned fish, etc. The Institute also keeps its members informed of the latest scientific and technical advances considered to be of interest or of use to the fishing industry.

All South African and South West African fish meal is purchased and paid for on the basis of FIRI analyses. These analyses also serve to keep the Institute in touch with the problems of the industry, and the results provide a good basis for the formulation of regulations, specifications and standards for raw materials and finished products.

The value of the analytical department to the industry is illustrated by the fact that over 2,000 samples per year are analysed.

## Hake

There was a more intensive exploitation of the stocks of Cape hake (*Merluccius capensis*), while the exports of Cape hake, frozen at sea and ashore, to Britain increased. A large-scale co-operative venture carried out by FIRI and the Torry Research Station in Aberdeen, initiated in 1966, was completed in 1968. The experiments performed included freezing ashore after chill-storage at sea, freezing ashore after treatment with salt-polyphosphate dips, and freezing at sea. The results obtained have been of great assistance in the proper handling of fish at sea with a view to obtaining top-quality frozen products. It appears to make no difference whether fish is chilled in ice or in refrigerated sea water before freezing. The importance of rapid chilling and bleeding before freezing was confirmed. The experiments also confirmed that fish frozen whole and thawed resulted in considerably more broken fillets than those filleted before freezing and thawing.

It was shown that dipping fish in salt-polyphosphate solutions prior to freezing resulted in a product with a better colour and texture and in flesh which was more coherent, tender and juicy and less broken. The treatment also reduced drip formation on thawing and reduced weight loss during frying, whether the fish was fried immediately after dipping or first stored in the frozen state. However, the treatment did not reduce the uptake of oil by the fish during frying.

Work was commenced on the estimation of the amount of hypoxanthine in hake muscle as a possible test of freshness. Preliminary tests showed a good correlation between the hypoxanthine content and the duration of storage in ice for one batch of hake of the same catch, but from batch to batch there was considerable variation in the relationship between freshness and hypoxanthine content.

## Treatment of fish with smoke condensate

Further experiments were carried out to improve on the use of the FIRI smoke condensate. By using the condensate, the labour and costs of hanging the fish individually in a smoke-house are avoided. Thickening of the smoke solution with about 0.5% CMC resulted in sufficient adherence of the smoke condensate to impart a good smoke flavour in a single spray or dip. In order to obtain a good pellicle, dipping or soaking should be carried out after drying the fillet.

Good results have also been obtained with minced snoek and snoek cutlets.

## Fish canning

The addition of sulphur dioxide to the tomato purée used in canned fish was studied. Both the colour of the tomato purée and its flavour

were greatly improved by the addition of the SO<sub>2</sub>. In experiments in which oil and/or sulphur dioxide were added to the tomato purée, the best fish in tomato packs turned out to be those to which both oil and sulphur dioxide had been added.

## Fish meal

As in the past, FIRI devoted an important part of its research to improvements in the production and handling of fish meal. South Africa and South West Africa are together the second largest exporters of fish meal in the world. The high quality of this fish meal can be regarded as the result of the close co-operation between the fish meal industry and FIRI, its research institute. The Director of FIRI has been elected unanimously as chairman of the Scientific Committee of the International Association of Fish Meal Manufacturers (the IAFMM), which is an indication of the international appreciation of the work done by FIRI on fish meal.

As recommended by FIRI small amounts of antioxidant were added to fish meal during the year under review. The Institute assisted in the application of antioxidant on an industrial scale. Two different devices for adding the substance have been designed and tested, both intended to give an alarm and attract the attention of plant operators if the flow of antioxidant is interrupted. The desirable effects of adding antioxidant were checked under practical conditions in a stacking test.

Considerable attention was given to the analytical detection of ethoxyquin in treated fish meals, but no satisfactory method has yet been found to recover the added ethoxyquin, after storage of the meal. Immediately after it has been added the antioxidant can be recovered completely. A storage test has been started to continue the study of the effect of ethoxyquin treatment during a long period of storage. In contrast to reports from overseas, the loss of vitamin E in fish meal seems to be only slightly inhibited by the use of ethoxyquin, except where short storage periods are concerned.

Laboratory and factory tests have shown that the loss of volatile nitrogen during the storage and processing of anchovy and pilchards is minimal.

Oxygen absorption tests on fish meal were carried out to obtain further information on the curing process of this product. The influence of curing on the fatty acid content of fish meals was studied by the use of gas chromatography. The tests showed that there were no differences in composition between the total or free fatty acids for the different methods.

Further improvements were made in the FIRI adiabatic and isothermal calorimeters, which are used to estimate the heat spontan-

ously generated in fish meal. Encouraging results were obtained also by means of a simplified method without resorting to precision calorimetry.

The addition of a suitable pellet binder to anchovy meal considerably increased the capacity of a laboratory pelleting machine. The treated pellets were harder and caused much less dusting during pneumatic conveying.

Fish meals artificially inoculated with salmonella showed a drop in salmonella counts during pelletization and, moreover, the salmonella infestation of the pelletized meal decreased at a much faster rate than that of the non-pelletized meal. Further tests on the relationship between the maximum temperature during pelletization and the survival of salmonella are being contemplated.



Formation of scum and deposit in effluent from fish factories in an experimental settling tank

The use of excessive amounts of fish meal in animal feeds can cause tainting of the animal products. The extent to which they are tainted is affected by the degree of curing — i.e. controlled oxidation — of the meal, which, in turn, depends on the duration and temperature of storage, the packaging material, the use of antioxidants, etc. Tainting tests on chicken were completed, and tests to ascertain whether the flesh of pigs can become tainted as a result of the inclusion of fish meal in the diet were started, in co-operation with the Stellenbosch-Elsenburg College of Agriculture.

#### Fish oil

Experiments were continued with a view to reducing loss in fish oils during refining.

#### Effluent

A survey was made of the composition of effluents from fish factories in the Republic. Regardless of the fish species involved, the off-loading water derived from fresh fish in good condition contained, on an average, about 1.0% of fat-free organic matter. In the case of old, broken fish this figure rose to 3% or more. In most cases the fat content was low, rarely rising above 0.5% and averaging about 0.3%. In the case of high oil content, it was relatively easy to recover by heating and centrifuging up to 90% of the oil in the scum which accumulated in the settling tank. However, while the recovered oil had an iodine value of 180 and a satisfactory colour, it contained between 4% and 8% free fatty acids. The scum had a moisture content of more than 90%, and was uneconomical to dehydrate. In any case, the salt content of the dried product would be too high. With a laboratory basket centrifuge the water content of the scum could be reduced by only 10 per cent.

Considerable attention has been paid to the possible uses of recovered proteinaceous materials, which showed a low nutritional value. In most cases, the digestibility of the proteins was lower than for fish meal. The recovered proteins showed a very low availability of methionine in comparison with ordinary fish meal, though the available lysine was similar to that of fish meal.

In a preliminary experiment, the availability of methionine could be increased considerably by adding antioxidant to the recovered material before it was dried.

# THE LEATHER INDUSTRIES RESEARCH INSTITUTE



Dr S. G. Shuttleworth, Director of the Leather Industries Research Institute

**T**HE Leather Industries Research Institute (LIRI) had its origin in research grants made in 1936 by the hides, skins and tanning industries, which were followed in 1941 by the establishment of a research institute to serve the needs of the hides and skins industry, the wattle industry, the tanning industry and the footwear industry, as well as of the suppliers and bulk consumers of the products of these industries. When the CSIR was established, the LIRI became its first co-operative industrial research institute.

Since its inception, the LIRI has endeavoured to maintain a balanced research programme, making regular contributions to overseas scientific journals and applying the results of this basic research to the practical problems of local industries.

Through its overseas publications, the LIRI has become the recognized world leader in several branches of fundamental chemistry, and has earned an international reputation. As a result of this, our local industries have been able to benefit from applied scientific work carried out by overseas leather research organizations, even when such work is of a confidential nature.

The hides and skins industry, which is worth R28 million, supports a long-term programme of fundamental research aimed at studying the structure and properties of the soluble and insoluble proteins, an investigation which may lead to the discovery of new uses for the unwanted sections of hides and skins which make poor leather. It also supports a programme which is of immediate practical application, and which is aimed at improving the techniques of handling and preservation of the hides. The fundamental work is carried out in fully modernized protein research laboratories, the equipment of which was made possible by a special grant from the Livestock and Meat Industries Control Board, while the applied work involves large-scale tests on thousands of hides which are studied at all stages from the raw state to finished leather.

The wattle industry, which is a valued exporter, operates on a quota basis, owing to the impact of substitutes for outersole leather, the product for which most of the tannin extracts of agricultural origin are used. In addition to research aimed at improving methods of using wattle extract as a tanning material, the LIRI is assisting the industry in finding alternative uses for this substance, and good progress has

been made during the past year in investigating the use of wattle extract as a waterproof chipboard and plywood adhesive, the use of modified derivatives for lubricating oil-well drilling muds and the use of modified derivatives in weather resistant wood veneers. In the field of fundamental research, several additional dimeric and trimeric flavanols have been isolated and identified — a major achievement in the organic chemistry of condensed tannins.

The tanning industry has lost a large proportion of its outsole leather market to rubber and synthetic substitutes, but it has made up for this loss by supplying the footwear industry, which is constantly expanding, with upper leather, which is mainly tanned with salts of chromium. However, a growing number of synthetic substitutes, backed by the vast research resources of the world's major chemical industries, are being marketed, and the leather industry needs the assistance of the LIRI more urgently than ever before if leather is to retain its reputation as the quality material for footwear and other end products.

The footwear industry has evolved from a craft industry using leather, threads and nails to a modern mass producing industry which has to base its techniques on an ever-increasing flood of new materials and manufacturing techniques. The role of the LIRI in this context is to provide scientific know-how and testing equipment to enable the industry to manufacture in bulk products which are judged by their individual performance under a wide variety of stresses and weather conditions.

During the past 33 years, LIRI has acquired a valuable store of scientific and technical knowledge related to the industries it serves. While research bulletins and other publications are constantly being issued, the gulf which usually exists between research and industry is being bridged by personal contact. Members of staff are on every factory floor at frequent intervals, and more than 300 employees of these factories are receiving tuition from the LIRI by correspondence courses backed by lectures given in the factories and by short intensive courses held at the LIRI.

#### **Grading and selection of South African hides and skins**

As a result of large-scale statistical trials on the relationship between green hide grading and tanned leather, carried out by the LIRI in collaboration with industry, new grading regulations have come into operation which enable tanners to buy more selectively to suit the requirements of specific types of leather. At present South African tanners have to import a considerable proportion of their hides from countries such as Australia, where they are obtainable in quality grades, even though the

intrinsic quality of Australian hides as a whole is no better. It is expected that the arrival on the market of the new "poromeric" type of synthetic upper materials will force tanners to buy their hides much more selectively if their materials are to compete successfully with such products.

#### **Regulations governing the curing of hides**

Large-scale experiments on hide curing carried out by the LIRI have drawn the attention of the industry to the losses suffered through delays in curing and through the re-use of salt. New regulations governing the curing of hides have been formulated and are awaiting approval by the National Marketing Council and the Minister.

#### **Fundamental research on proteins**

The laboratory for fundamental research into proteins established at the LIRI by the Livestock and Meat Industries Control Board to investigate new uses for the poorer parts of hides and skins, is rapidly gaining an international reputation for its work. During the past year more than 1,200 requests have been received from overseas for copies of the publications in this field by the staff of the LIRI, and two American organizations have invited LIRI personnel to contribute general reviews of work carried out by them in the collagen field.

#### **Chipboard adhesives**

Considerable progress has been made during the year by LIRI in pilot plant and large-scale tests on the use of modified wattle extract as an adhesive for the chipboard industry. Tests carried out on chipboards based on wattle adhesives formulated in the LIRI and using pilot plants in South Africa and Germany have shown that water resistant chipboard can be produced with properties equivalent to those of the standard phenolic resin chipboards. These tests have been supplemented by two large-scale tests in a South African chipboard factory which have proved that a water resistant chipboard based on wattle can be produced using pressing times well within those required for phenolic resins and using a process which takes only 1 to 2 minutes longer than pressing times of the faster curing urea formaldehyde resins used for non-water resistant chipboards. Attempts are being made to reduce the pressing times still further.

#### **Plywood adhesives**

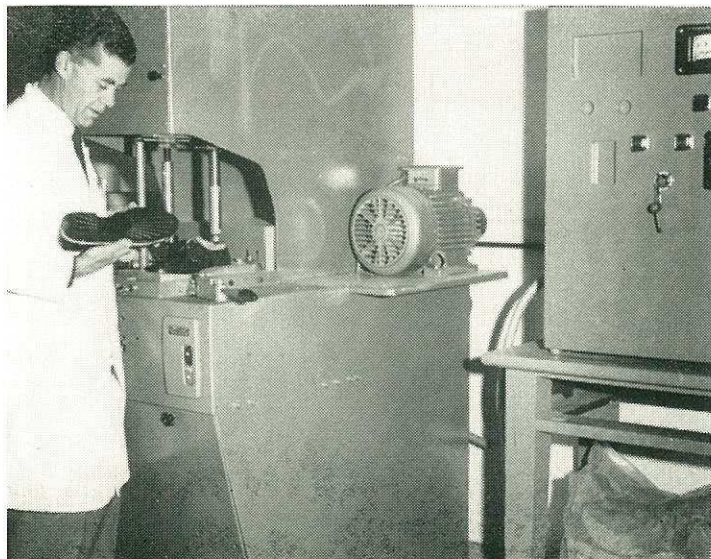
Work has also been carried out on the production of a wattle-based equivalent of a B stage phenolic adhesive used in the plywood industry, and a stable powder formulation has been developed which can be dissolved in water when required for adhesive purposes in cases where water resistance is necessary.



An oil well drilling mud lubricant being prepared for testing after the high pressures and temperatures experienced in deep drilling

#### Oil well drilling mud thinners

A new, easily manufactured combination of chrome and wattle-derivative has been developed and has been tested by the Southern Oil Exploration Corporation (SOEKOR) oil-well drilling laboratory. The results of the tests have proved satisfactory and five tons of this thinner has been supplied for the purpose of large-scale drilling tests. The results obtained so far indicate that the original product developed by LIRI, which contains no chromium, yields satisfactory results down to a level of 6,000 feet, the new chrome-wattle compound being more suitable for greater depths.



#### Wood veneers

The development of weather-resistant wood veneers based on wattle has reached the stage where manufacturers are being invited to investigate the economic implications of manufacturing these veneers on a large scale. Panels exposed to the sun for two years have shown no signs of crazing, which indicates that the ability of the wattle molecule to filter the ultra violet radiation comprises a built-in protection against weathering.

#### Foot measuring devices

Reports received on the results obtained after using 120 specially developed foot measuring devices for fitting miners' boots to Bantu mine workers, show that the incidence of foot rub, which was previously said to be as high as 50 to 60 per cent, has now virtually been eliminated. The principle of these foot measuring devices was formulated in the light of a survey carried out by the LIRI of the shapes of Bantu mine workers' feet and of the existing lasts used for manufacturing miners' boots.

#### Properties of upper material

The development of a new type of synthetic upper material, which is claimed to promote better foot health and comfort and which is known as "poromerics", has aroused wide interest among footwear manufacturers both in South Africa and overseas. The footwear section of the LIRI is conducting tests on four of these new products with a view to comparing them with typical upper leathers. This work has been assisted by the installation of a R5,000 Instron Tester, which evaluates the relative plasticity and elasticity of these materials when subjected to the repeated stretching and relaxation which they will undergo in actual wear. Results indicate that considerable differences exist which must be recognized by shoe manufacturers in order to ensure foot comfort. It has also become apparent that certain properties of the synthetics such as retention of last and foot shape are not as satisfactory as those of leather. Although these new materials have certain properties which make care easy, their ability to absorb and transmit perspiration is much lower than that of leather.

#### PVC soling materials

Another machine recently installed at the LIRI is a PVC extruder which can either mould PVC soling directly on footwear or produce PVC blanks for testing. The machine is used to help the footwear industry solve problems which have arisen with the recent increase in the use of PVC soling. Use of this kind of soling has increased faster than the knowledge

PVC injection moulded soles being made in the LIRI footwear pilot plant for wear trials



of the best blends of PVC and plastic materials for footwear and investigations into methods of making these compounds cheaper. Footwear produced in the LIRI plant is being given trial wear, and the results are being compared with various laboratory evaluations in order to formulate standards.

#### New adhesives

The increased use of PVC soling has been due to the comparatively recent development of new types of adhesives based on polyurethane, which has made it possible for PVC to be bonded to footwear uppers. Footwear factories are confronted with an increasing variety of adhesive formulations, each of which is suitable for bonding some of the wide range of soling and upper materials used in shoe manufacture. One of the main tasks of the footwear section of the LIRI is the testing and evaluation of adhesives; it also provides an advisory service for factories to help them solve problems which have arisen in the use of these modern adhesives.

#### New techniques of impregnating and finishing

The new "poromeric" shoe upper material is the latest of a variety of leather substitutes on the market which are threatening the position of leather and which are backed by enormous research facilities. The South African tanning industry has made great progress in reorganizing and modernizing its factories and in utilizing chemical and synthetic aids in the production of leathers which approach the regularity and consistency of appearance which characterize the synthetic products. In these developments the LIRI is playing an important role; it carries out experiments on new materials and processes, and it evaluates the quality of new leathers produced by local tanners. Very often a new technique, while it facilitates improvement in one direction, may cause a drop in quality in another.

LIRI scientists discovered that both local and imported leathers have tended in recent months to have poor wet rub fastness. This has been traced to the use of emulsifying agents in water-based synthetic resin impregnating materials and nitrocellulose emulsion top sprays. The local industry has been notified of this danger and investigations into alternative techniques are being carried out.

#### Adaptability of shape and shape retention of leather

One of the characteristics which makes leather superior to synthetics in adaptability to foot shape and in comfort, is its ability to assume the shape of the last in shoe manufacture and to adopt the shape of the foot in wear. Investigations carried out by scientists of the LIRI have shown that these properties are related to the bending modulus of single fibres and the friction of these fibres when passing over each other. The effects of various factors such

as heat, humidity, tannage and oiling have been studied, and the results obtained have helped to indicate how the advantages of leather can be maintained and improved.

#### New process for making chamois leather

A new method for making chamois or wash leather has been developed by the LIRI and has attracted considerable interest locally as well as enquiries from overseas. Samples have been sent to America for evaluation, but the process is being kept secret for the time being in order to give local industry an advantage.

### Selected Publications

- ABRAHAMSON, K. D. and WILLIAMS-WYNN, D. A. The effect of heat and moisture on the plastic and elastic properties of chrome tanned leathers. *J. Soc. Leath. Trades Chem.*, vol. 52, 1968, pp. 111-121.
- ABRAHAMSON, K. D. and WILLIAMS-WYNN, D. A. Some physical properties of leather fibres. Part I: Fibre friction. *J. Soc. Leath. Trades Chem.*, vol. 52, 1968, pp. 180-193.
- ABRAHAMSON, K. D. and WILLIAMS-WYNN, D. A. Some physical properties of leather fibres. Part 2: Bending modulus. *J. Soc. Leath. Trades Chem.*, vol. 52, 1968, pp. 347-354.
- BUDZIKIEWICZ, H. and DREWES, S. E. M + 2 peaks, hydrogenation of double bonds in the mass spectrometer. *Liebigs Ann. Chem.*, vol. 716, 1968, pp. 222-223.
- COOPER, D. R. and BRYANT, J. V. Evaluation of reactions with soluble collagen for studying tannery processes. *J. Soc. Leath. Trades Chem.*, vol. 52, 1968, pp. 270-281.
- COOPER, D. R. and DAVIDSON, R. J. Further studies on the chromatographic separation of the collagen molecular sub-units. *J. Chromat.*, vol. 34, 1968, pp. 332-341.
- DAVIDSON, R. J. and COOPER, D. R. The effect of  $\gamma$ -irradiation on soluble collagen. *Biochem. J.*, vol. 107, 1968, pp. 29-34.
- DAVIDSON, R. J. and COOPER, D. R. Intermolecular relationship between neutral-salt-soluble and acid-soluble collagen. *Nature*, vol. 217, 1968, pp. 168-169.
- DREWES, S. E. The mass spectra of derivatives of some flavan-3, 4-diols. *J. Chem. Soc. (C)*, 1968, pp. 1140-1148.
- DREWES, S. E. and ILSLEY, A. H. Isolation of 3-methoxy-fisetin from *Acacia mearnsii*. *Chemical Comm.*, 1968, pp. 1246-1247.
- HARRISON, R. A. A proposed last measuring system for europoint incorporating a standard method of determining joint girth. *J. Br. Boot Shoe Instn.*, vol. 15, 1968, pp. 59-63.
- RUSSELL, A. E., SHUTTLEWORTH, S. G. and WILLIAMS-WYNN, D. A. Further studies in vegetable tannage. Part IV: Residual affinity phenomena on solvent extraction of collagen tanned with vegetable extracts and syntans. *J. Soc. Leath. Trades Chem.*, vol. 52, 1968, pp. 220-239.
- TOWNSEND, A. C. The absence rate in industry. *South African Manager*, no. 22, 1968, pp. 9-12.
- VAN DER MERWE, R. Productivity bargaining — its philosophy, procedures and problems. *South African Manager*, no. 21, 1968, pp. 13-17.

# THE SOUTH AFRICAN PAINT RESEARCH INSTITUTE

**M**EMBERS of the South African Paint Research Institute include manufacturers of paint, manufacturers of raw materials for industry and prominent consumers. Much of the work in this Institute is devoted to solving problems encountered by such organizations. In addition, it has a responsibility to the national economy in that its duties involve research in the vital field of protection by surface coatings in the very arduous conditions prevailing in this country.



Prof. G. M. Hamilton,  
Director of the South  
African Paint Research  
Institute

#### Gas liquid chromatography

The Institute has now been accumulating experience in this field over a period of nearly five years. During this time techniques have been developed for the qualitative and quantitative analysis of solvents, oils and resins, and details have been made available to interested parties.

#### Infra-red spectroscopy

Infra-red spectroscopy is in constant use in analyses and other investigations, and has proved particularly valuable in assisting manufacturers to match imported products. A considerable collection of relevant spectra has been built up.

#### Electrical conductivity of paint films

Most corrosion of metals is electrolytic, and can be prevented or slowed down by the resistivity of a protective surface coating. It has been shown that a figure of  $10^8$  ohms/cm<sup>2</sup> and upwards provides satisfactory protection. An apparatus has been constructed in the Institute which is capable of measuring and recording changes in resistivity within the range  $10^{10}$  to  $10^6$  ohms and this is being used as an investigational tool in fundamental work particularly in work on the protection of iron and steel.

### Adhesion of coatings

A direct "pull-off" method for determining the adhesion of surface coatings to the substrate and for determining intercoat adhesion, has been formulated and is at present being used to determine the adhesion of epoxy tar finishes to steel, and the time which may elapse between successive coats without there being any loss of intercoat adhesive strength.

### External exposure

A technique for the assessment of coatings by means of external unaccelerated exposure, when the changes are followed by weight differences, has proved satisfactory. In addition, normal long-term exposure tests have been made, particularly with a view to assessing corrosion resistant finishes on steel, and these have often yielded valuable results. For example, a locally produced zinc dust made into a zinc-rich paint has been exposed for nearly four

years, and results have been entirely satisfactory.

### Marine finishes

A raft has been constructed and is being maintained in Durban Bay for the testing of anti-fouling paints. A number of members of the Institute have availed themselves of this facility to assess their products, whether already established or still in the experimental stages.

### Alkyd resins

These compounds constitute the basic raw material of many surface coatings, and a number of cases where cans have corroded, and also where "nibs" or small particles have formed in a paint, have been traced to undesirable components in the resin. A post-graduate bursary was awarded in order to expedite this work.

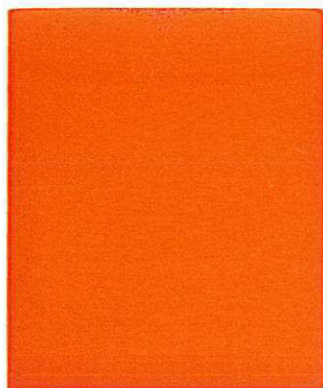
Examination of test panels for anti-fouling paints



# THE SUGAR MILLING RESEARCH INSTITUTE



Dr M. Matic, Director of  
the Sugar Milling  
Research Institute



**T**HE 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.

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

The main functions of the SMRI are —

- **Research.** This includes a study of the fundamental aspects of processes such as milling, diffusion, juice clarification and crystallization of sugar, and covers also the utilization of by-products. It also deals with the raising of steam and power and with engineering aspects of the design and performance of mills, carriers, evaporators and vacuum pans.
- **Service to the sugar industry.** This consists of advisory work, trouble shooting, analyses of sugar — particularly sugar for export — and statistical compilation of manufacturing data.
- **Training in sugar technology.** The SMRI conducts, in conjunction with the Natal College for Advanced Technical Education, a four-year full-time course in sugar technology, during which period students are employed by the Institute. The cost of the course is borne by the SASMAL.

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

#### Automatic sampler for sugar cane

Increased manufacturing costs and a highly competitive export market have encouraged a re-examination of process economy in the local sugar industry. It has long been realized that cane with the highest rate of sugar to impurities can be processed at the lowest cost per unit.

The present basis for payment to cane growers provides no incentive for them to deliver cane of good quality to the factories. Direct sampling and analysis of each consignment of cane entering the factories, however, could be the basis of a payment system which would favour cane of better quality.

To this end the SMRI has, over the past few years, designed and tested a number of systems for the automatic sampling of cane. All of

these were designed to sample at a point after the preparation by shredding but before the expression of juice. The most promising sampler was equipped with a sliding gate which allowed samples of shredded cane to gravitate intermittently through an aperture in the conveyor chute. After simulation tests at a factory, and a statistical study, it was predicted that the sampling accuracy would be more than adequate.

A commercial unit was recently installed at a factory. The sampler gate was pneumatically operated and automatically controlled to take thirty samples from every thirty tons of cane. Each sample was automatically disintegrated and sub-sampled on a rotary sampling table, the rejected portion being returned to process by means of a screw conveyor. A special laboratory was designed and installed, complete with equipment for rapid analysis of the cane samples. A new feature was an automatic tracing device incorporating logic modules, which accurately identifies individual consignments at the sampling point. A programme was prepared to make possible the calculation and statistical analysis of laboratory results by computer.

Performance tests have now entered the second year. Besides confirming the predicted accuracy of the system they have, after the most critical assessment, indicated that the system is mechanically reliable, economical and simple to operate. The application of the pro-

posed system is now in the hands of a committee specially appointed to investigate adoption of this new method for cane testing. During the year a paper on the subject, which provoked considerable interest, was presented at the congress of the International Society of Sugar Cane Technologists in Taiwan.

#### **Enzymatic removal of starch from cane juice**

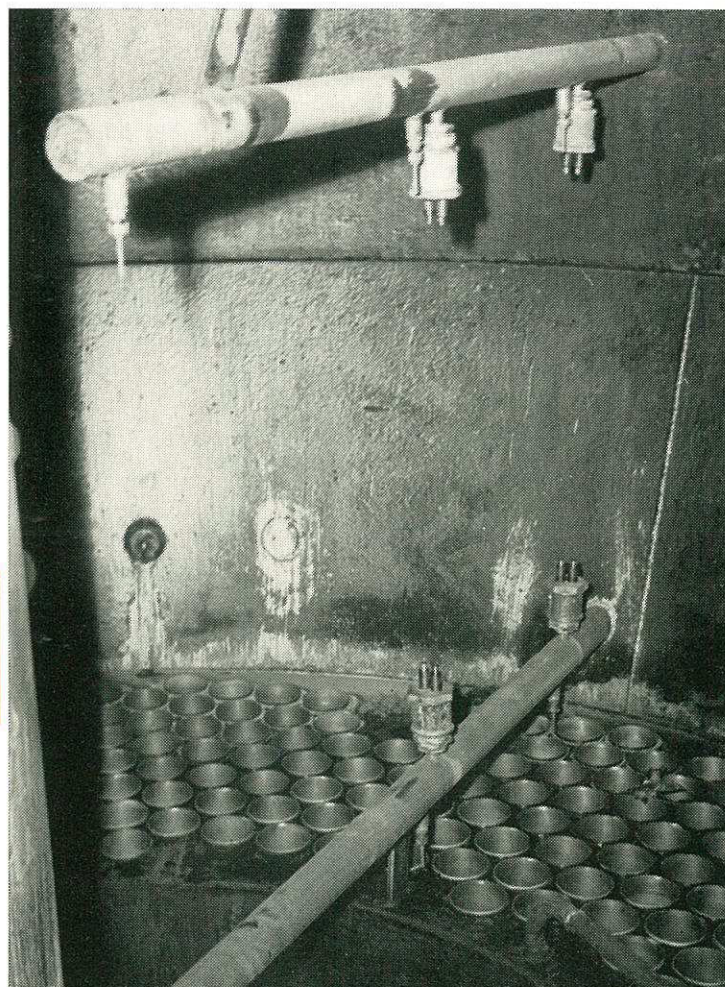
Starch is an impurity in raw sugar which decreases the filtration rate when the sugar is refined. Various methods of starch removal have therefore been investigated.

The SMRI has recently successfully hydrolyzed starch by adding the bacterial enzyme  $\alpha$  amylase to cane juice or syrup. This enzyme is available commercially and is also used in textile desizing and in biologically active detergents.

Starch is normally present in cane juice in granular form. For the enzyme to attack it, the starch must first dissolve, which it does when the juice is heated to 65°C, after which the  $\alpha$  amylase is added. Other enzymes, e.g. malt enzyme, are not suitable as they are not thermostable.

It has been shown in factory tests that 5 to 10 ppm of bacterial enzyme added to cane juice, at a temperature of 80°C and a pH of 6.5, will remove 80 per cent of the starch pre-

Vacuum pan control:  
Interior of vacuum pan, showing thermometer  
and conductivity probes at two different levels  
above the calandria



sent in the juice. The enzyme may be added either at the juice or the syrup stage, provided that the temperature is at the required level.

#### **Vacuum pan control**

Further investigation has been carried out into the movement of massecuites (crystal and liquor mixture) and methods of controlling crystallization in vacuum pans.

At a raw sugar factory, tests were conducted on a vacuum pan equipped with a stirrer and readings of temperature and conductivity probes in the pan body have indicated that the stirrer causes an unexpected rise in temperature throughout the massecuite. This means that the massecuite is boiled at a higher supersaturation than is usual for a low grade sugar and that the production of false grain (spontaneous nucleation) is far more likely to occur in a stirrer-equipped pan than in one without a stirrer. More rapid circulation of the massecuite results in a shorter boiling cycle, owing to improved heat transfer across the tubes of the calandria (internal heat exchanger).

The false grain is extremely fine and causes considerable difficulties in the subsequent centrifuging operation to remove the molasses film from the crystal surface, by blocking both the crystal interstices and the centrifugal screen.

It is hoped that the introduction of control equipment will reduce the occurrence of false grain while still allowing boiling at optimum supersaturation.

A different problem was presented at a refinery, where too many conglomerate crystals were being produced in the vacuum pans and an investigation into boiling procedure was called for. Conglomerate crystals are those which do not crystallize singly but appear to be the result of an attraction between several small crystals which bond together and grow into a large, irregularly shaped grain. A potentiometer to measure boiling point elevation, and a supersaturation meter were fitted to one vacuum pan and a series of readings was recorded. After various trials of different boiling techniques the percentage of conglomerate crystals has been reduced considerably. It is hoped that the positive results shown will lead to the introduction of more automatic control in the industry, to improve the quality and crystal recovery in all grades of sugar boilings.

#### **Extraction of sugar by diffusion**

The conventional process for extracting sugar involves initial disintegration of cane, followed by one dry milling in which over half of the sugar is extracted. The remaining sugar is extracted by alternate saturation and milling in a type of countercurrent washing process. Extractions of the order of 95 per cent are commonly achieved with this process.

In South Africa the last of the above extraction steps has been replaced at four factories by a process involving a single diffuser. In this process the cane, from which juice has been partly extracted, is conveyed on a horizontal perforated tray under a succession of juice sprays of progressively lower sugar content and finally a spray of pure water. At each of these stages the juice around the cane particles is displaced by the more dilute sprayed juice. The displaced juice percolates to the bottom of the cane bed and finally falls into a receiving tank from which it is pumped to the preceding stage spray. This constitutes a countercurrent leaching process. The advantage of this process is that it reduces the number of mills required by at least half and results in a considerable saving in installation and operating costs. Furthermore, extractions of up to 98 per cent have been attained and the juice extracted is of a higher quality.

The SMRI has played a leading role in adapting the new process to the sugar industry and in research into the actual mechanisms involved. These investigations have led to the conclusion that, while displacement washing is the mechanism by which sugar is removed from the cane bed, true molecular diffusion of sugar controls the rate of extraction. This molecular diffusion occurs during the passage of sugar from within the cane particles to the surface, and the subsequent surface washing and displacement have no rate-controlling effect except in the case of plugged beds.

These findings have been published both locally and overseas and it appears that they will play a useful role in resolving a long standing controversy and in determining future procedures and trends in the design of diffusers.

### **Selected Publications**

- BRUIJN, J. and JENNINGS, R. P. Enzymatic hydrolysis of starch in cane juice. *Proc. S. Afr. Sug. Technol. Ass.*, vol. 42, 1968, pp. 45-52.
- EUCHANAN, E. J. The calculation of stage efficiency and its application to diffuser design mechanism. *Proc. S. Afr. Sug. Technol. Ass.*, vol. 42, 1968, pp. 65, 73.
- PERK, C. G. M. 43rd Annual Summary of Laboratory Reports. *Proc. S. Afr. Sug. Technol. Ass.*, vol. 42, 1968, pp. 7-28.

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# **FINANCIAL STATEMENTS**

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	1968 R	1967 R	CURRENT ASSETS	1968 R	1967 R
CURRENT LIABILITIES					
Advances for investigations and services ... ..	1,078,828.59	928,766	Stores stock ... ..	333,639.75	—
Sundry creditors and credit balances ... ..	3,160,988.75	3,140,553	Wool stock ... ..	333,639.75	261,619
			Sundry debtors and debit balances ... ..	772,376.50	978,289
			Investigations and tests in progress ... ..	658,133.06	566,424
			Advances and deposits:		
			Research grants ... ..	414,196.17	—
			Other ... ..	2,795,630.40	3,209,826.57
			Investments ... ..	3,029,759.68	2,963,646
Cash:					
At S.A. Reserve Bank ... ..				245,703.21	—
Petty cash imprests ... ..				18,949.00	264,041
TOTAL ... ..	<u>4,239,817.34</u>	<u>4,069,319</u>		<u>8,288,387.77</u>	<u>8,271,044</u>
GRAND TOTAL ... ..	<u>R32,258,899.95</u>	<u>R28,437,052</u>		<u>R32,258,899.95</u>	<u>R28,437,052</u>

NOTE:

\* Contractual obligations against the General and Building Funds as at 31st March, 1968 was R1,046,820.00 and R1,770,159.00.

PRETORIA: 16 September, 1968.

S. M. NAUDÉ  
President

J. H. VISAGIE  
Secretary/Treasurer

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

PRETORIA: 22 October 1968.

H. R. P. A. KOTZENBERG  
Controller and Auditor-General.



**A. Operating Expenses**

ACTIVITIES	EXPENDITURE										FUNDS	
	Salaries	Supplies and services	Subsistence and transport	Scientific services	Grants and subsidies	General expenses	Amount recovered	Total	Parliamentary grant	Recoverable expenditure		
	R	R	R	R	R	R	R	R	R	R		
CSIR laboratories and departments ... ..	8,805,263	4,411,652	463,283	415,109	219,000	1,044,021	1,914,089	13,444,239	6,273,700	7,170,539		
Grants and subsidies ... ..	429,895	18,260	24,049	35,437	1,307,434	57,396	113,352	1,759,118	1,718,340	40,778		
<b>T O T A L</b> ... ..	9,235,158	4,429,912	487,332	450,546	1,526,434	1,101,417	2,027,442	15,203,357	7,992,040	7,211,317		

**B. Capital Expenditure**

ACTIVITIES	EXPENDITURE										FUNDS	
	Books/Journals	Technical equipment	Furniture/Office equipment	Vehicles	Stores stock	Buildings	Total	Parliamentary grant	Recoverable expenditure			
	R	R	R	R	R	R	R	R	R			
CSIR laboratories and departments ... ..	78,340	1,711,639	67,957	16,000	4,560	1,150,000	3,028,496	1,959,600	1,068,896			
Grants to universities, etc. ... ..	—	133,128	512	—	—	—	133,640	132,360	1,280			
<b>T O T A L</b> ... ..	78,340	1,844,767	68,469	16,000	4,560	1,150,000	3,162,136	2,091,960	1,070,176			
<b>GRAND TOTALS</b> ... ..							18,365,493	10,084,000	8,281,493			

## CLASSIFICATION OF ECONOMIC SECTORS REFERRED TO IN INDEX

1. Agriculture, forestry and fisheries
2. Gold mining (including uranium)
3. Coal mining
4. Other mining and quarrying
5. Processed foodstuffs (excluding beverages)
6. Beverages and tobacco
7. Textiles
8. Knitting mills
9. Clothing
10. Leather and leather products (excluding footwear)
11. Footwear
12. Wood and wood products (excluding furniture)
13. Furniture and fixtures
14. Pulp and paper products
15. Printing, publishing and allied industries
16. Basic industrial chemicals
17. Miscellaneous chemicals
18. Products of petroleum and coal
19. Rubber products
20. Plastic products
21. Non-metallic mineral products
22. Basic iron and steel industries
23. Non-ferrous metal basic industries
24. Fabricated metal products (excluding machinery and transport equipment)
25. Machinery (excluding electrical machinery)
26. Electrical machinery and equipment
27. Transport equipment (excluding motor vehicles)
28. Motor vehicles
29. Miscellaneous manufacturing industries
30. Construction
31. Electricity, gas and water
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