CSIR Annual Report 1969

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Council for Scientific and Industrial Research

Twenty-fifth Annual Report 1969

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Introduction

P.O. Box 395 Pretoria
1st May, 1970

Sir,
I have pleasure in presenting to you the Twenty-fifth Annual Report of the Council for Scientific and Industrial Research. This Report covers the period 1st January, 1969 to 31st December, 1969.
Balance sheets and statements of income and expenditure for the financial year ended 31st March, 1969, 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

As in previous years, the work of the various research laboratories and institutes and other services of the CSIR are briefly reviewed under appropriate headings in this report. However, there have been several significant developments and organizational changes which merit special mention here.
Most significant of these was the establishment on 1st July, 1969, of the Medical Research Council (MRC) in terms of the South African Medical Research Council Act (Act No. 19 of 1969).
At its inception the CSIR was entrusted with responsibility for exploring and developing the whole field of medical research in South Africa. On the advice of the Medical Research Committee under the chairmanship of Prof. S. F. Oosthuizen, Chairman of the South African Medical and Dental Council and a Council Member of the CSIR, it was decided not to set up any medical research institutes but rather to support timely and promising research at existing institutions. This was done by means of ad hoc grants to outstanding individuals and by supporting units, groups and projects at universities and other institutions under the direction of leading medical scientists.
By 1969 the CSIR's annual commitment for the support of medical research in accordance with this scheme had grown to R708,000. In addition the CSIR administered R340,000 per annum on behalf of other bodies interested in specific fields of medical research including the Department of Mines and the gold and asbestos mining industries. These amounts did not include the annual budget of the CSIR's National Nutrition Research Institute which for the period 1968/69 amounted to R360,000.
It became increasingly clear, however, that the scope and responsibility of medical research have grown to such magnitude that the time was ripe for South Africa to follow the example of other countries to establish an independent Medical Research Council. The task of administering funds for medical research as well as the various institutions concerned with medical research has now been consolidated under this one body.
At the CSIR those divisions of the National Nutrition Research Institute concerned with nutritional diseases have been transferred to the Medical Research Council and now form the National Research Institute for Nutritional Diseases of that Council, while those divisions concerned with food technology have been reorganised as the National Food Research Institute of the CSIR.
Dr. J. J. Theron, formerly Director of the CSIR's National Nutrition Research Institute, has been appointed Vice President and Chief Executive Officer of the MRC and he is also Acting Director of the National Research Institute for Nutritional Diseases. Mr. J. P. de Wit, formerly Assistant Director of the National

Nutrition Research Institute, has been appointed Director of the National Food Research Institute.

Following a general pattern of the gradual reorganization of government-supported scientific research activities in South Africa, the Government, acting on the advice of the Scientific Adviser to the Prime Minister, decided that the Hermanus Magnetic Observatory be incorporated in the CSIR. This became effective on the 1st April, 1969. The history and development of the Magnetic Observatory is depicted under the appropriate heading in this report.

Two important new facilities developed by the CSIR were commissioned during the year, namely the Laboratory for Natural Isotopes and Geophysics of the National Physical Research Laboratory in Pretoria and the new laboratories in Stellenbosch of the Hydraulics Research Unit of the National Mechanical Engineering Research Institute.

The Natural Isotopes and Geophysics Laboratory was officially opened on April 10th. In view of the importance of this laboratory in the study of underground water sources, a symposium on ground water was organized to coincide with the opening. This facility now houses the sensitive measuring apparatus for determining the age of underground water using natural C-14. At the same time the necessary space has been provided for the active group of geophysicists of the NPRL.

The new home of the Hydraulics Research Unit, situated on a five morgen site of the University of Stellenbosch, consists basically of an enormous hall where model studies can be carried out indoors, a set of laboratories, workshops and offices, a 600ft wind tunnel and an outdoors area where models can be constructed. This Unit, together with the hydraulics laboratories of the Department of Water Affairs and of the Universities of Stellenbosch, Cape Town, Witwatersrand and Natal is doing work of great importance to South Africa. Its investigations cover a wide variety of problems ranging from the construction of storage dams to the training of rivers and the design of new harbours. The magnitude of this work becomes evident if one considers the problems associated with the extremely low rainfalls in certain areas of this country, coupled with high evaporation and the ephemeral character of most of its rivers, as well as the fact that its coastline is more than 2,000 miles in length.

In addition to the work of its national research laboratories and institutes the Council continues to play an important part in the general advancement of science in South Africa and particularly in fostering international links in science. In this field an outstanding event during the year was the organization of an international symposium on the chemical control of the human environment under the auspices of the International Union of Pure and Applied Chemistry (IUPAC) in association with the South African Chemical Institute. Among the more than 300 delegates were forty from overseas including leading scientists who were invited to give lectures at plenary sessions.

The election of Dr. G. J. Stander, Director of the CSIR's National Institute for Water Research, as president of the International Association of Water Pollution Research (IAWPR) and of Dr. T. L. Webb, Director of the CSIR's National Building Research Institute, as member of the executive committee of the International Building Research Council (CIB) has brought international recognition to the CSIR and South African science in general.

At the end of the year the Council suffered a severe loss when the Deputy President, Dr. N. Stutterheim, resigned to take up an appointment in private industry. Dr. Stutterheim was a member of the CSIR executive for ten years prior to which he had been Director of the National Building Research Institute. As a scientist Dr. Stutterheim had distinguished himself in the field of cement technology, particularly in the production of cement from blast furnace slag in South Africa.

National Chemical Research Laboratory

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

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

The Laboratory is organized into divisions of organic chemistry, biochemistry 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

The increase in production by municipalities last year was about 8 per cent giving a total production of 151 million gallons with a value of R31.5 million. This indicates that the extremely rapid increase of past years is at last beginning to level off.

Much interest was shown both here and overseas in a commissioned article in a leading journal and one result was an invitation from a prominent firm for enzyme manufacture in Denmark for the Head of the Bantu Beer Unit to visit them at their own cost. This was accepted and the opportunity was also used to visit various institutes connected with brewing in Europe.

In collaboration with the Bantu Beer Unit the South African Bureau of Standards has drafted a standard specification for manufacture and quality of Bantu beer and this is currently being considered by all interested parties. A natural consequence of its application is the need for reliable analytical methods, a field to which the Unit has contributed actively since its inception. At present existing methods are being reviewed and the Unit is also engaged in examining methods for automated analysis.

The malting quality of the numerous available varieties of kaffir corn grown under various conditions is being studied in a project sponsored by the Maize Industry Control Board. Another part of the project deals with pearling of kaffircorn and has been brought to the stage of pilot plant brewing studies. The results look very promising.

The vital souring stage in Bantu beer production has also been investigated further but here a serious gap between research and production is apparant, due to the lack of adequate training of brewers in most municipalities.

Corrosion

The Corrosion Group has had to deal with a steadily increasing number of enquiries from public bodies, industry, government departments, provincial bodies, municipalities as well as from individual members of the public. Most of these require at the very least an inspection and a report with recommendations. This means that, while the Group is unquestionably playing a valuable role, time avilable for its research activities has necessarily been limited.

A study of the corrosion of metals in contact with wood indicated that the pH of the wood, its ability to take up moisture and the presence of timber preservatives are all important factors.

Sulphate-reducing bacteria were shown to be responsible for repeated corrosion failures in various places such as the black clay soils of the Pretoria North area and the waterlogged soil adjacent to the Steenbras–Cape Town water main. Particular attention was given to methods of predicting possible bacteriological activity.

Pharmacological substances

The search for substances with anti-tumour activity is being carried out in collaboration with the National Institutes of Health, Bethesda, USA. During the past year fractions with such activity have been obtained from a number of South African plants. Some of these had to be rejected as activity was due to tannins, but further identification of the active substances is being followed up in the other cases.

A new project along these lines has been the synthesis of modified nucleosides. Natural nucleosides form the vital constituents, of DNA, the basic constituent for reproduction and growth in all living organisms, and it is thus not surprising that certain closely related substances have been found to interfere with the uncontrolled proliferation of cancer cells.

The search for steroids with useful hormonal properties has been continued by modifying steroids obtained from certain cucumber species. This year a derivative with good promise has been prepared and is now being made in larger quantities for further testing. The work depends largely on successful cultivation of certain cucumber species by the Horticultural Research Institute of the Department of Agricultural Technical Services and the year was marked by one successful crop while another was almost a total loss, due to hail.

Mycotoxins

The study of these toxic substances produced by fungi found on foodstuffs for both man and animal by the CSIR group of chemists and microbiologists has awakened considerable interest among workers in this field throughout the world. Discussion of this work resulted in one of the largest and most active sections in the recent international symposium on

"Chemical Control of the Human Environment" held in Johannesburg during July, 1969. Many chemists from overseas contributed papers in addition to those presented by South African workers.

New work presented at this symposium covered a number of aspects: establishment of the structures of a number of new toxins, discovery of relationships between certain groups of toxins by chemical conversions of one to another, and investigation of biochemical pathways by which the toxin is produced by the living fungus.

Insect pheromones

This general term has been applied to substances which, in very small traces, affect the behaviour and development of insects and thus provide a possible means of insect control. In the past year pheromones which enable an ant species to recognize an invader have been identified for three ant species in the course of a collaborative project with the Department of Agricultural Biochemistry at the University of Natal.

Bilharzia

Attention has been mainly devoted to the biochemical aspects of molluscicides used to kill snails which act as hosts for the schistosomes responsible for bilharzia in human beings. A series of disubstituted acid amides has been selected, and the uptakes necessary for death have been compared. The substances appear to act by inhibiting utilization of oxygen.

Another study being carried out in collaboration with the Blair Research Laboratory, Salisbury, Rhodesia, indicates that a snail becomes a host by producing a substance which attracts miracidia, the form assumed by the schistosome in water. The substance has still to be purified and identified.

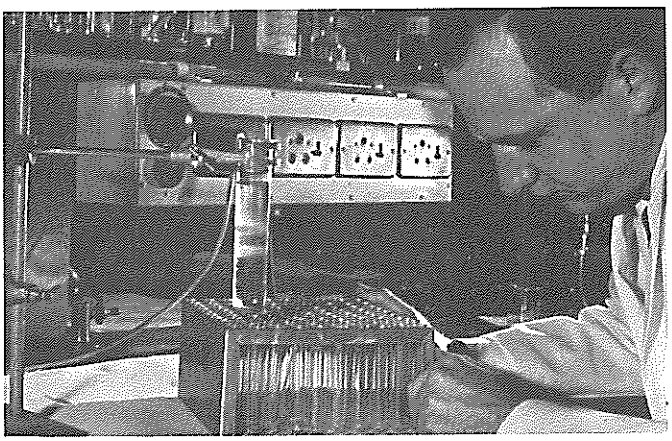
Liquid ion-exchangers

These are primarily used in recovery and separation of metals by solvent extraction processes. The work is therefore carried out in consultation with the National Institute for Metallurgy. Particular attention has been paid to extraction of copper and of nickel. For the former, a group of exchangers has been made which are comparable in capacity with a commercially available compound, but which can cover a wider range of conditions. In the case of nickel, a number of compounds have been prepared but none so far has proved staisfactory for metallurgical purposes.

Photodegradation of plastics

In order to counter the drastic action of highveld sun on plastics used out-of-doors for building purposes, a study is being made of various types of compound which can be admixed with the plastic to stabilize it. A limitation to such work is the confidence which can be placed in accelerated test methods. Use of ultra-violet lamps does not give satisfactory results so that polypropylene, which is highly susceptible to weathering, has been chosen as base material for ordinary out-door exposure. Given the acceptability of the method, which must yet be proven, some promising results have been obtained.

After fractionation of liver cell nuclei into two bands by slow centrifugation the bands are drop collected.



Digestion and metabolism in ruminants

Two members of the combined group of the CSIR and the Veterinary Research Institute at Onderstepoort attended the Third International Symposium on the Physiology of Digestion and Metabolism in the Ruminant at Cambridge, U.K., in August 1969, to present papers on the work of the group.

Further studies have been made of the problems associated with use of urea as a supplement for low-protein feeds such as teff hay. As a result of work done by the group, biuret has now been accepted extensively by farmers as a safer supplement than urea, despite the higher cost.

A balance of the daily requirements of glucose for ruminants and its synthesis from available precursors has never been made. The daily requirements have been determined and a study of sources is under way.

Cancer biochemistry

In this long-term programme attention has been given in the past year to fractionation of nucleai from cells in cancerous tumours by a method of density gradient centrifugation developed in the NCRL. A homogeneous fraction of tumour nuclei which were very much larger than those found in normal cells has been isolated. Comparison of the proteins extracted from these nuclei with those from normal nuclei showed the same twenty odd components but one of the proteins was present in about half the usual amount. This protein was found to be derived from the informofers, recently discovered particles in the nucleus, which are thought to play a part in the passage of messenger RNA from the nucleus, where it is made, to the cytoplasm, where it functions. Messenger RNA is the agent which bears the code for synthesis of proteins, which takes place in the cytoplasm of the cell.

Protein chemistry

In the study of snake venoms the complete amino-acid sequence for a cobra neurotoxin has been elucidated. Over twenty such neurotoxins have been isolated and a comparative study is now being made, together with immunological tests, to determine the position and nature of active sites. However, conformations of the molecules are also essential for this work and this depends primarily on determination of X-ray crystal structures. Unfortunately, attempts at growth of suitable crystals have not yet been successful.

An important requirement for sequence work is highly specific proteolytic enzymes of which only a limited number is available. As puff-adder venom contains several highly active proteolytic enzymes these are being separated in pure form. One pure enzyme has so far been isolated.

Phosvitin is a phosphoprotein of very unusual nature which forms a quarter of the dry weight of egg yolk. Previous studies of this important substance have revealed inconsistencies which have now been resolved by showing that it can be separated into two constituents with somewhat different characteristics.

Analytical chemistry

A solid international reputation has been built up by this Laboratory through its systematic and painstaking study of difficult separations by use of ion-exchange columns. Despite the dramatic advance of methods such as X-ray fluorescence, absorption spectroscopy and neutron activation for routine analyses due to their accuracy and speed, it must be remembered that in the long run ion-exchange and other chemical methods are required for preliminary separations and for

ultimate standards, apart from the fact that they are often preferable for non-routine work.

Recognition of this work has taken the form this year of invitations to the leader of the research group concerned to attend a number of international conferences where he presented papers and, more important, was consulted by various users of his methods.

Pneumoconiosis

In the course of the biochemical studies of silicosis being carried out on behalf of the Pneumoconiosis Research Unit, it has been shown that macroscopic nodules appeared in the lungs of monkeys injected intratracheally with silica dust four or six months previously. These nodules were high in silica and collagen content, and, when isolated they showed depressed activity for total protein biosynthesis, together with an increase in collagen biosynthesis. The results were similar to those obtained in rat liver after silica injection and provide justification for use of the latter as a model system, a most important step, since experiments with large animals are notoriously difficult and expensive.

Human growth hormones

A new project being undertaken in collaboration with the University of Natal is the preparation of human growth hormones. The true hormone is being prepared from human pituitary glands in a high state of purity. As this, however, is naturally a very limited source of material, a second project is in progress to prepare a closely related hormone from placentas. This is much less active, but does offer a much more abundant source. Clinical evaluation of the preliminary products at the University of Natal shows that a stage of 80 per cent purity has been reached, and further improvement upon this is expected in the near future.

Chemistry of gold and platinum metals

The research tempo in the study of gold complexes in aqueous solution has been considerably accelerated by an addition to the staff made possible by a grant from the Chamber of Mines of South Africa. An encouraging feature of this support has been the considerable interest in the fundamental research being carried out in its relation to practical problems arising in the industry.

As a result of certain problems arising from the use of xanthates for the flotation of pyrites from gold-bearing ores, work on reaction of xanthates with a number of metal ions in aqueous solution has been initiated and is showing promising results. The National Institute for Metallurgy has seconded a staff member to work with the NCRL and students from various universities have also been placed in the laboratory work for varying periods on its research problems.

Since South Africa is the main producer of platinum, studies on the chemistry of complexes of metals of the platinum group are fully justified. Both preparations of new compounds and studies of reaction mechanisms in aqueous solution have been achieved. An application of this research has been the separation of several platimun group metals by use of common reagents and by utilizing known differences in reaction rates. Extensive support of the programme by the Chamber of Mines is under consideration.

Thickening of milled gold ore pulp

In collaboration with the Chamber of Mines and one of the gold mining groups, a pilot plant thickener of 6ft diameter was set up beside a full-scale thickener and the two were fed in parallel. It was shown that, when operating at the underflow density normally used at the plant, the two behaved comparably. Thus a pilot plant can be used to design large thickeners.

The experiments, however, were not wholly satisfactory since feed pulp concentrations in practice are not constant. Much more attention needs therefore to be given to operation of thickeners in an unsteady state.

At present laboratory work on flow patterns of solid and liquid in a thickener is being studied with radioactive tracers. The radioactive silica needed for the work has, however, a half-life of only 2.5 hours, so that it must be produced at Pelindaba and then taken as quickly as possible to the laboratory.

Cooling by air or water

Computer programmes have been developed to facilitate comparison of the total cost of cooling with air versus cooling with water. Their primary purpose is to provide a service to industry in considering the feasibility of air cooling in areas with a shortage of water.

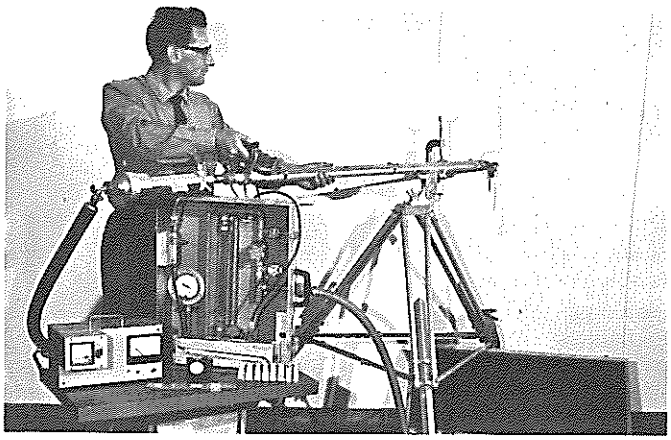
Air pollution control

Further work has been completed on dust sampling procedures from chimney stacks. Previously, a computer programme to deal with a cross-sectional survey was worked out; but it has subsequently been shown that, if fluctuations in dust concentration are not excessive and are random in character, cumulative sampling is accurate enough and is naturally much simpler and faster.

The recovery of small amounts of sulphur dioxide from power station emissions, using manganese dioxide, is feasible; at this stage this method is, however, not sufficiently attractive to justify further work.

A computer programme for dispersal of the plume from chimney stacks has been written, making use of equations which have been fairly widely accepted in the extensive literature on this subject.

Stack sampling equipment.



National Physical Research Laboratory

Dr A. Strasheim, Director of the National Physical Research Laboratory.

The main function of the National Physical Research Laboratory (NPRL) is to contribute to the development of physical science in the Republic through research aimed at the adaptation of existing knowledge as well as the discovery of new facts 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.
The facilities at present 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.

The most important event during the year was the opening of the Natural Isotopes and Geophysics Laboratories. The opening of these two laboratories marked a major step forward by the NPRL in its progress towards meeting the scientific needs of the Republic. At the time of this opening, a symposium on ground-water in South Africa was arranged by the Information and Research Services of the CSIR. In the papers delivered at this symposium, ground-water conditions In South West Africa and Botswana were described and also the geophysical techniques used in prospecting for ground-water.

Another important symposium held in the Laboratory this year concerned Physics in Industry. From the papers delivered and the discussions held, the following points emerged:

- The training of physicists in the Republic is of no practical assistance to industry. When our expanding industries are taken into consideration, it is clear that the training of such persons should receive the attention of our universities and higher authorities.
- In a modern state an optical industry is essential. The establishment of such an industry, with the necessary research support, should receive serious consideration from interested organizations and authorities.

The air pollution activities of the National Physical Research Laboratory were reorganized during the year and transferred to the Air Pollution Research Group.

Apparatus

8 kilo-16 bis memory computer—The processing of incoming oceanographic data during the cruises of the "Meiring Naudé" will be accelerated by a small computer, which is to be installed on the vessel.

Acceleration of helium-3 in the cyclotron—The usefulness of the cyclotron was extended considerably by the acceleration of helium-3. A special purification system was built and installed, and this has made it possible to utilize the scarce and expensive helium-3 gas efficiently. External helium-3 beams of 25MeV to 35MeV have been used in experiments.

Pressure range—The maximum pressure obtainable by means of the piston-cylinder high-pressure apparatus was increased by 50% from the earlier 40,000 atmospheres, by means of improved piston design. This increase does not involve any concessions with regard to versatility or accuracy of pressure measurement.

Important research results

Low energy electron diffraction interpretation—This study was motivated by the need for explaining surface phenomena in terms of atomic arrangements. The surface structures of annealed molybdenum (110) before and after ion-bombardment have been determined, in the latter case after carbon monoxide adsorption. These analyses are the first ever done for a re-arranged surface, i.e. one that has been cleaned by ion bombardment and one that is covered by an adsorbed layer.

Volatile rare-earth complexes—Crystallographic studies of two volatile rare-earth chelate complexes of 2,2,6,6-tetramethyl-3, 5-heptanedione have shown that problems which arose overseas in connection with the understanding of the gas-chromatographic behaviour of these materials resulted from complete misinterpretation of their structures. Instead of being normal monomeric octahedral complexes, both Pr and Dy complexes were found to be dimers as a result of seven-fold co-ordination.

Time resolution techniques—Fundamental studies of spark and laser plasmas were continued. Results obtained by means of high speed photography were confirmed by the use of a new electronic-gated integrator device. With this time resolution gated integration system very weak light intensities can be measured. As a result of its wide field of application, industrial and research laboratories have shown much interest in this electronic integration system.

Polymorphism—Except in the simplest cases of elements and alkali halides, polymorphism has always been considered so complex that prediction is precluded. It was found in the NPRL that the polymorphism of a series of compounds can be satisfactorily predicted with the aid of the phase diagram of one member of the series, and simple crystallo-chemical principles.

Speech analysis—For the investigation of those speech properties which are characteristic of individual speakers, spectrograms, although useful, were found to contain insufficient information. Therefore the mutual relationships of the frequency and amplitude of formants, fundamentals and harmonics were systematically investigated. Certain characteristics were discovered which appear to be peculiar to the individual speaker and these properties are now being examined in greater detail.

For the words used during the tests a definite relation was found between the parameters obtained from formants, harmonics and fundamentals on the one hand and the level of the original speech on the other hand. This meant that the loudness at which speech was uttered could be determined from the analysis of a suitable word which had, for instance, been recorded on tape. This result, while still of more academic than practical importance, nevertheless is a definite contribution to the problem of speech analysis. Furthermore, it is a good indication that the present method of digital analysis is a suitable and promising one.

Image-forming properties of spectrographs—In the past the image-forming properties of spectrographs were determined only by the subjective resolution test. However, if the aberration or pupil function of an instrument can be determined, it is also possible to calculate the image-forming characteristics by means of Fourier methods. By making use of shearing interferometry, it has been possible for the first time, to determine quantitatively the pupil function of a plane-grating spectrograph at a number of wavelengths, and from it to calculate the image-forming properties. A paper dealing with the subject was read at the conference of the International Commission of Optics in Reading during July of this year. From the wide interest shown in it and the discussions it evoked, it was obvious that the method was the correct one for studying the shape of spectral lines.

Mechanical properties of metal surfaces—A systematic study of the mechanical properties of metal surfaces showed that the so-called unloading yield point is determined predominantly by the surface. In the course of the investigation it was discovered that the magnitude of the yield point is related to the size of the test sample. This discovery represents the most important evidence concerning the influence of the surface on mechanical properties and is consistent with previous results on mechanical properties of surfaces. It also strengthens arguments which suggest that the surface condition is important in the behaviour of materials in the micro-plastic strain region to which materials and engineering structures are exposed in technology.

Thickness of wool fibres—The existing laboratory methods of measuring the average diameter of a sample of wool fibres are tedious and require expensive apparatus. Preparation of samples requires great care and is also a time consuming operation.

The wool producer judges the fineness (or spinning count) of his clip mainly by visual assessment of fibre crimp. As the Duerden relationship between fibre diameter and the number of crimps per unit length is changing for South African wool, producers will also welcome a new method of establishing fibre fineness.

The NPRL has developed an apparatus which is cheap and sufficiently simple to be used by the wool producer; it can also serve as a useful aid in the laboratory. The principle of optical diffraction is employed in the operation of this instrument and the user can measure the average fibre diameter of a sample of wool fibres to an accuracy of about one micron within a few seconds.

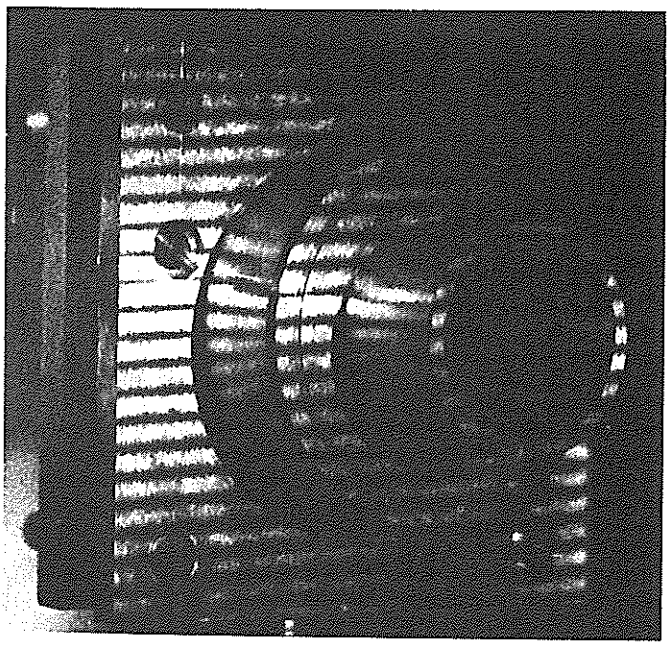
Reference base of the volt changed—The practical unit of electromotive force (emf) or voltage is maintained in South Africa by a reference group of standard cells at the NPRL. Recently a group of four cells was transported in a constant-temperature carrying box, kept in an upright position throughout its journey to Paris where the cells were compared with the standard cells of the Bureau International des Poids et Mesures (BIPM). It was found that the difference between the actual emf of the transported cells and that assigned to them by the BIPM was two microvolts, and when the cells were brought back to Pretoria it was found that their mean value had changed by two tenths of one microvolt. It was thus demonstrated that the national standard of emf was within two microvolts of the true value.

During 1968 the International Committee of Weights and Measures decided in Paris to change the practical unit of emf by a value which would bring it into line with the absolute value of the volt, derived from the basic mechanical units of length (m), mass (kg) and time (sec). In accordance with this decision the national unit of emf at the NPRL was changed by nine microvolts on 1st July, 1969.

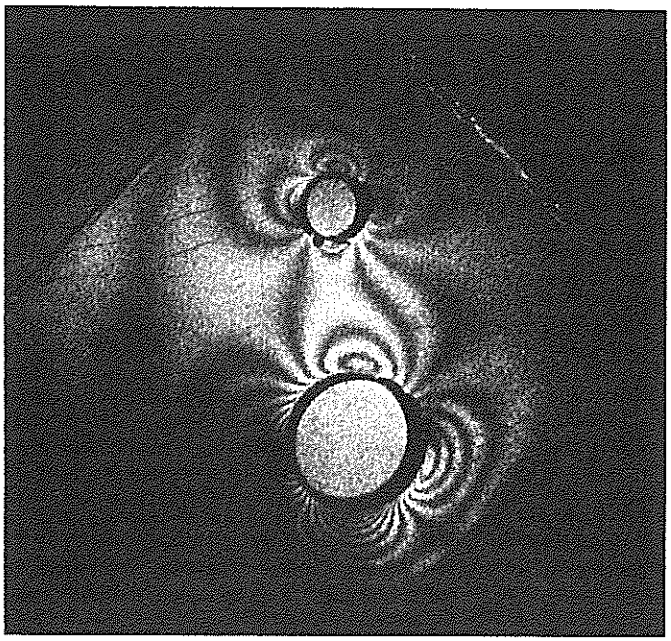
Important developments

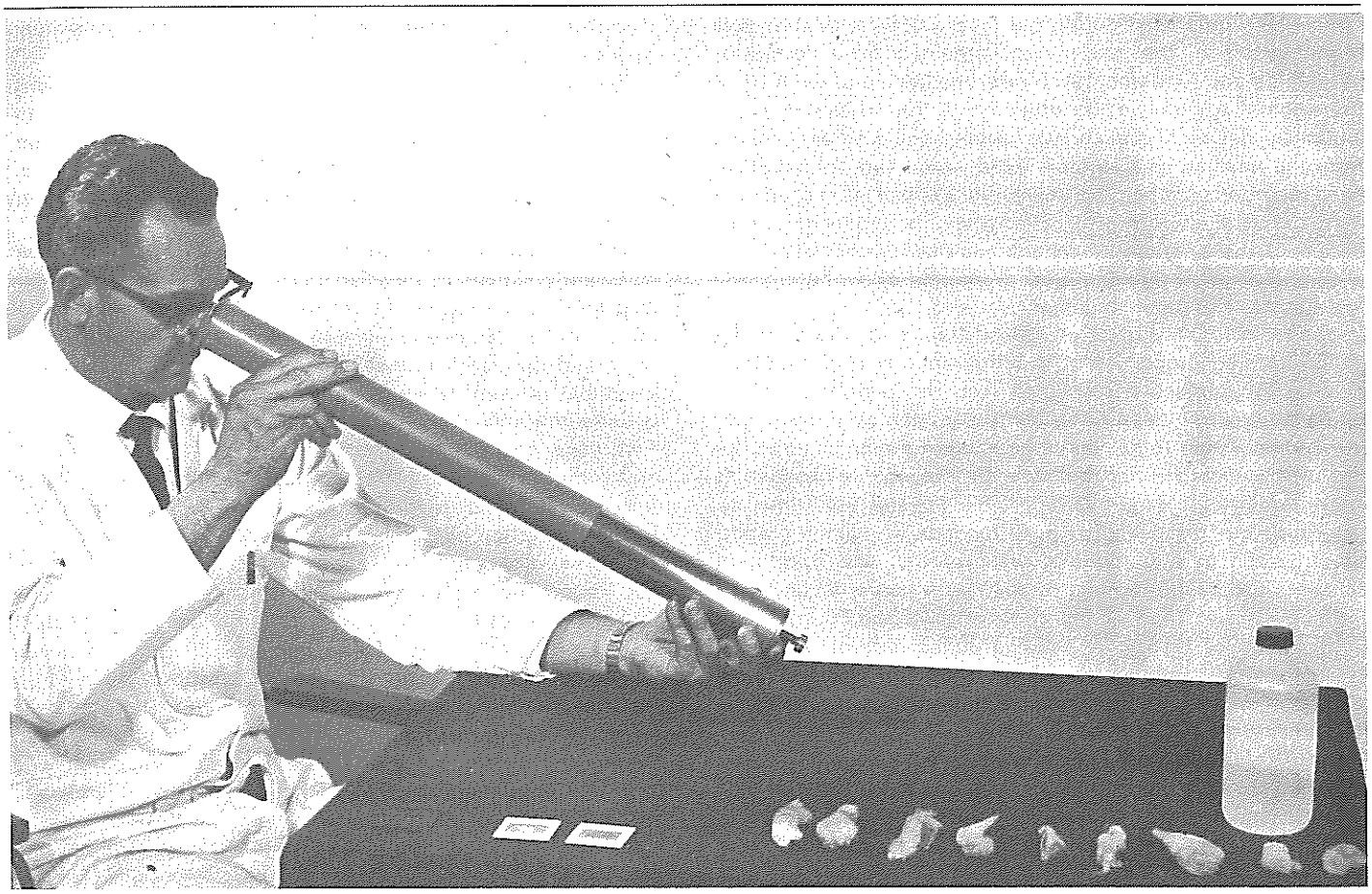
Direct electron excitation X-ray analysis—One of the most important developments in X-ray analytical spectrometry in recent years has been the use of electrons impinging directly onto a sample to excite characteristic X-ray spectra. With

Accuracy control by holographic interferometry. The slightly inclined fringes indicate a very small deviation of the tilting axis from the desired horizontal in an accurate tilting device.



Stress patterns revealed by holographic interferometry. A test piece of Perspex with two holes drilled in it is subjected to mechanical stress (pressure) along one of its diagonals (top to bottom).





A prototype of an instrument for measuring the average diameter of wool fibres.

this technique it is now possible to determine the lighter elements (Z=5 to 15) which have their characteristic spectra in the "soft" or long wavelength regions.

The National Physical Research Laboratory recently acquired a direct electron excitation spectrometer and in the short period that it has been in use, important applied research has been carried out with the instrument.

To avoid the build-up of electric charge in the sample surface, it is necessary that the sample should be conductive. A non-conductive sample must be mixed with a conductive powder, or electrically conductive aluminium or carbon layers must be evaporated onto its surface. However, a unique method was developed, in which nickel grids are placed in contact with the non-conductive sample surface, thus eliminating these time-consuming procedures. A sample prepared for X-ray fluorescence analysis can thus be analysed by direct electron excitation without further preparation.

The technique was applied successfully in the analysis of geological samples and plant material, and a remarkable degree of sensitivity for the light elements as well as freedom from inter-element interference, was obtained. It was also used successfully in the analysis of low alloy steels and cast iron.

Direct electron excitation X-ray spectrometry offers interesting possibilities for basic studies, e.g. line shifts in the region 20Å to 200Å caused by the valency state of the element.

Holography—Holography, or lensless photography, is a laser application which is receiving considerable attention overseas because of its scientific, industrial and military implications. It is a new technique for observing and registering information on the phase and amplitude intensity of the light waves coming from the object being photographed. In this respect it is far superior to conventional photography in which only the amplitude of the light waves is considered. It makes the three dimensional representation of objects and scenes possible and has great potential for application in computer memories. Its principles already find promising application overseas in data processing (e.g. optical processing of seismic data obtained during oil exploration), in pattern recognition (e.g. finger print identification), and in quality control (e.g. in the automobile and aircraft industries).

All indications are that the techniques of holography are destined to become of great technological importance also in South Africa. Activity in this field was initiated at the NPRL during the past year, mainly to acquire the necessary scientific and technical background knowledge. The various holographic recording and reconstruction techniques were investigated and examples of the great variety of possible applications were demonstrated, e.g. the interferometric investigation of vibrating structures, mechanical stress and small displacements. The possibility of studying the recovery of deformed objects by means of this technique was also demonstrated.

Routine services to industry

Acoustic consultation—The more important projects at present being handled by the Acoustics Division are the acoustics designs for the South African Broadcasting Corporation's complex in Johannesburg and for the opera houses in Cape Town, Pretoria and Johannesburg.

Germanium-lithium gamma-ray detectors—Such detectors were constructed in this laboratory during the year. The first 40cc detector manufactured was supplied to the Potchefstroom University.

Chemical analysis—The atomic absorption method was found to be very useful in the analysis of samples received from CSIR institutes as well as from outside organizations.

Magnetic Observatory

Mr A. M. van Wijk, Head of the Magnetic Observatory.

The Hermanus Magnetic Observatory, as this well-established geophysical institution is known to geophysicists throughout the world, was admitted to the ranks of the CSIR in April 1969.
It was founded in 1932 by the late Professor Alexander Ogg and for several years it functioned under the auspices of the University of Cape Town. As the Government recognized the important functions which the small undertaking was fulfilling both in national and international geophysical spheres, it took over the Observatory and incorporated it as a branch of the Trigonometrical Survey Office of the Department of Lands in 1938. This timely action by the Government enabled the Observatory to initiate a much-needed long-term magnetic secular variation programme as early as 1938 and in 1940 the new buildings at Hermanus were ready for occupation. The present Head succeeded Dr Ogg in 1946.
Following the rapid expansion of the Observatory's activities during the two ensuing decades, the question of a suitable "home" for this institution was again raised in 1967. On the recommendation of the Scientific Advisory Council of the Prime Minister, the Cabinet determined in 1968 that the Magnetic Observatory be placed under the jurisdiction of the CSIR.
The functions and current programme of the Observatory include the continuous recording of various geophysical elements, the reduction, analysis and dissemination of the recorded data, the determination of the configuration and variations of the magnetic field in Southern Africa, the maintenance of magnetic standards, and co-operation in both national and international geophysical programmes.
The widespread demand for data recorded at Hermanus is due partly to the strategic location of the Observatory at the southern tip of the continent and partly to the recognized quality of the recorded data. At a recent geophysical congress held in Madrid, the view was again expressed that these data are amongst the most reliable in the world.

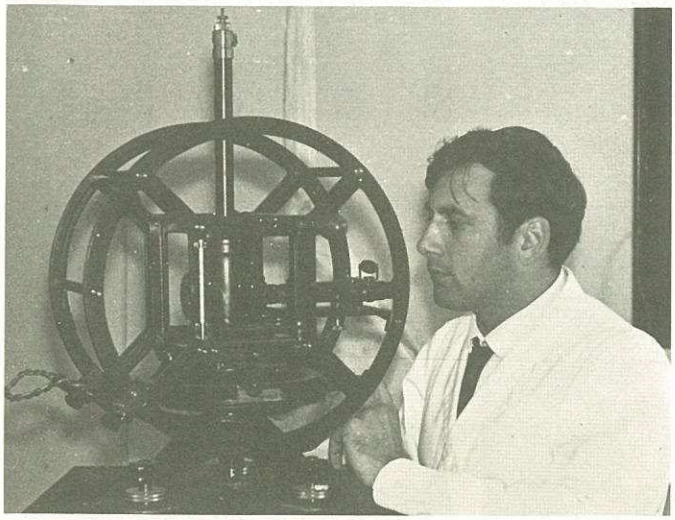
Geomagnetism

In addition to the permanent Magnetic Observatory at Hermanus, a three component magnetic recording station is maintained at Tsumeb in South West Africa. The recording apparatus at Tsumeb is housed on the site of the Ionospheric Research Station of the Max Planck Institut für Aeronomie and in terms of an agreement reached is operated by staff of the Research Station.

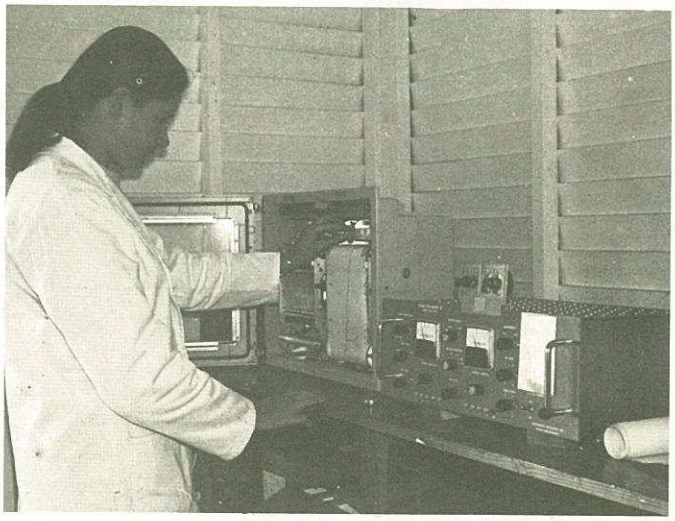
In view of the extensive geographical area served by the Observatory, a third magnetic recording station is definitely needed in the Republic.

The primary object of the magnetic field programme is to determine the absolute values and secular variation of the magnetic elements in Southern Africa. For this purpose, and in collaboration with the Trigonometrical Survey Office, the Observatory maintains a network of primary magnetic field stations ("repeat stations") in the Republic and South-West Africa. The standard magnetic charts issued from time to time by the Hermanus Observatory are based on the data obtained from the periodic observations at these stations.

The Schuster-Smith magnetometer used to determine the absolute intensity of the horizontal component of the earth's magnetic field.



A riometer for measuring the relative ionospheric opacity for cosmic radio noise.



Valuable supplementary information is derived from the compass observations carried out by officers of the Trigonometrical Survey Office in the course of their field duties. In return for these services, the Magnetic Observatory supplies the Trigonometrical Survey Office with standard magnetic data required for all official topographical maps.

During the year a comprehensive study of recent trends in geomagnetic secular variation in the Republic was undertaken.

Cosmic Rays

The cosmic-ray recording programme at Hermanus is conducted in close collaboration with the Cosmic Ray Research Unit of the CSIR, centred at the University of Potchefstroom.

For this purpose a Chalk River type 3-NM-64 neutron monitor is in operation at Hermanus. As from January, 1969 the data are processed by computer in Potchefstroom.

International Co-operation

During the year the Observatory made available laboratory and other facilities to a research group of the Institut de Physique du Globe of the University of Paris. Their project is aimed at studying the morphology of magnetic pulsations at magnetically conjugate stations in South Africa (Hermanus) and France (Hurouqué).

The Observatory is included in the network of 30MHz riometer stations established in 1963 by the Air Force Cambridge Research Laboratories (Bedford, U.S.A.) at certain selected observatories. The continuous records of the intensity of radio cosmic noise provide valuable information on the relative opacity of the ionosphere to radio waves. The data recorded at Hermanus are also of interest to other geophysicists in this country.

The Hermanus Observatory is one of the comparatively small number of magnetic stations whose data have been selected for use in the determination of the planetary indices of magnetic activity, Dst and Ks.

Two members of the Observatory's staff serve on working groups of the International Association of Geomagnetism and Aeronomy (IAGA), and the Head has again been nominated as member of the IAGA/IAMAP Committee for Lunar Variations.

Supplementary activities

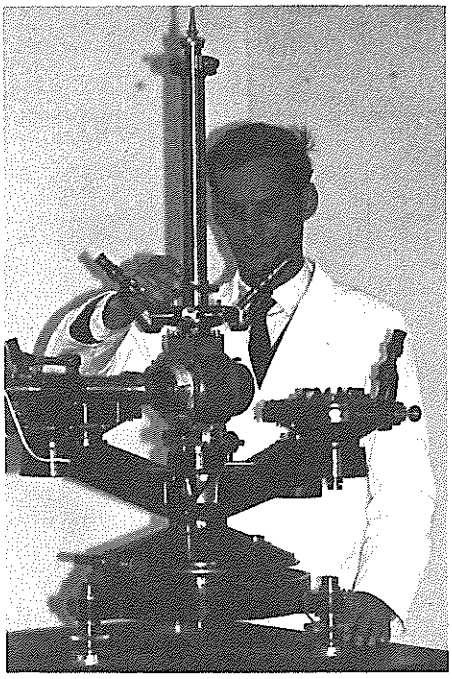
Seismology—Preliminary reports of earthquake phases recorded by the two Milne-Shaw seismographs at Hermanus are supplied on a monthly basis to the seismological centres in Washington, Strasbourg and Edinburgh. The records provided by this "side project" have proved useful for the detection of local earth tremors as well as for distinguishing between pulsations of magnetic and seismic origin.

Meteorology—Becuase some of the geophysical elements recorded at Hermanus are influenced by meteorological factors (e.g. the neutron intensity by the atmospheric pressure and the barometric readings by the wind), a continuous record is kept of certain meteorological elements. The meteorological data collected in this way for purely "domestic" purposes can also be used for research. Thus the solar and lunar barometric tides were successfully computed from the barometric data which were collected at Hermanus for a completely different purpose.

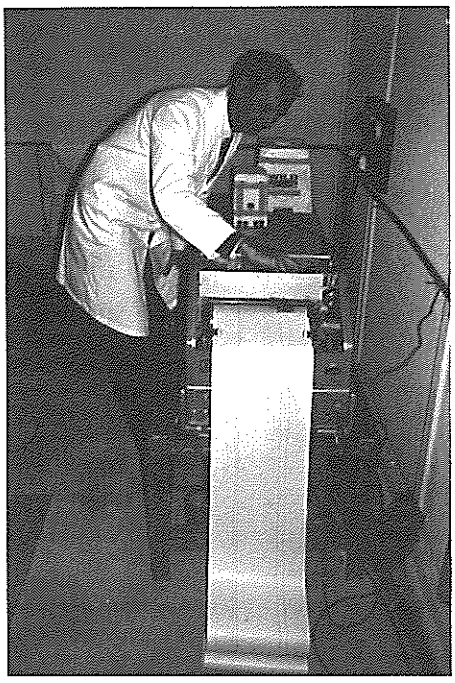
Geophysical alerts—Scientists engaged in geophysical investigations in the Republic and at the South African Antarctic Base, SANAE, are advised of the onset of magnetic and ionospheric disturbances with the minimum of delay. The messages are relayed to the appropriate centres through the communications network of the Weather Bureau.

Antarctic Research—After a nine-year term as co-ordinator of the geomagnetic and auroral programmes of the South African Antarctic Expeditions, the Head of the Observatory has been compelled through shortage of staff to suspend his activities in this field. The geophysicist of the University of Potchefstroom who took over these duties from him in December, 1968 is permanently stationed at Hermanus.

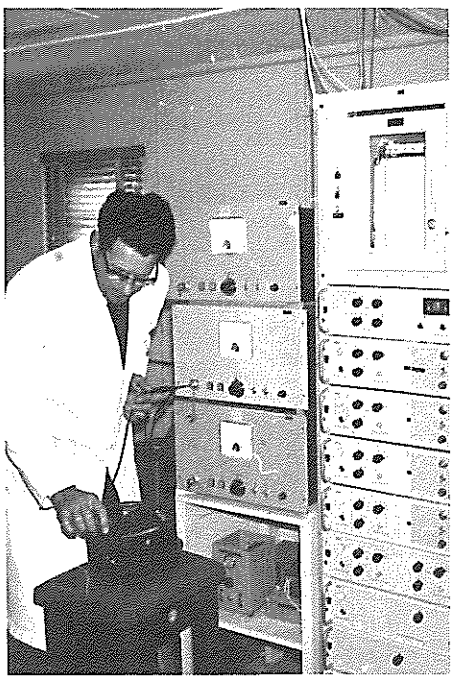
The Schmidt-type magnetometer-theodolite used to measure the magnetic declination to an accuracy of within two seconds of arc.



Very sensitive galvanometers and a photo-dyne recorder used to observe geomagnetic micropulsations



An automatic recording system used to monitor the cosmic ray intensity.



Republic Observatory

Mr J. Hers, Acting Director of the Republic Observatory.

The 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 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.

The Franklin Adams Camera

Towards the end of the last century a wealthy amateur astronomer, John Franklin Adams, commissioned the building of a special 10-inch refracting telescope which was to be used for a photographic survey of the Milky Way. This survey which was subsequently enlarged to cover the whole sky was commenced in Cape Town in 1903 and later it was continued in England. In 1909 the instrument was generously donated to the newly established Transvaal Observatory in Johannesburg where the project was completed three years later.

The telescope was immediately set to work on other programmes as well. In 1910 it was used in photographing Halley's comet and these photographs are still regarded as some of the finest taken of this comet. When the Observatory was asked to assist in the observation of minor planets south of declination $-9°$ shortly afterwards it moved into a new field of activity in which it very soon assumed the leadership. In 1911 a new minor planet, Transvaalia, was discovered. This was the first of nearly 600 minor planets subsequently discovered by the Observatory. Of this number 77 have now been named bearing such typically South African names as Pretoria, Prieska, Umtata, Majuba and Calvinia.

In 1917 a new programme was initiated to re-photograph the whole sky south of $-19°$. The aim was to produce a set of star charts of a larger and more convenient scale than that of the original Franklin Adams Charts. The "Union Observatory Charts" were issued in instalments as supplements to the Observatory "Circulars" and the whole project, comprising 556 charts, was completed in 1936. To the present day this remains the most generally useful star atlas of the Southern Hemisphere and requests from new observatories for copies of the atlas continue to be received regularly.

The development of more sensitive photographic plates should have enabled the telescope to register fainter magnitudes, but this prospect was completely foiled by the increasing light and smoke around Johannesburg. It was therefore decided in 1954 to move the instrument to a better site near the Hartebeespoort Dam, but here too its future is now being threatened by the increasing urban development in the neighbourhood.

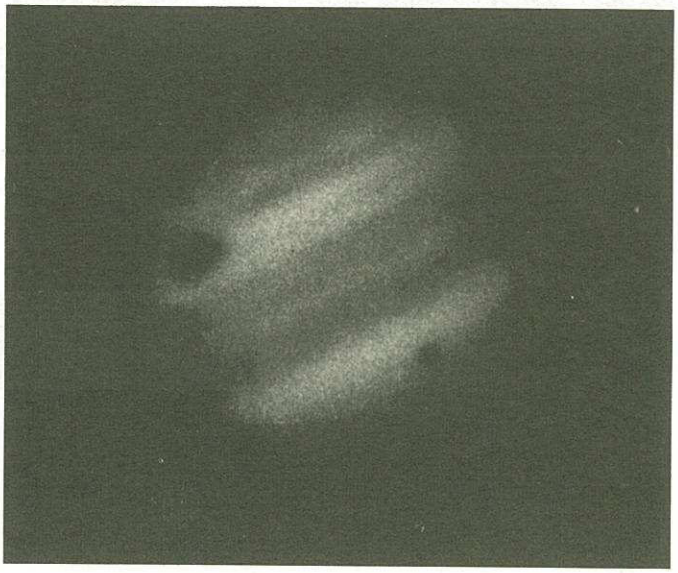
Nevertheless, the Franklin Adams telescope still remains one of the most important instruments in the Southern Hemisphere for the systematic observation of minor planets and comets. As regards minor planets, it is unlikely that many new discoveries will be made, for the many remaining unidentified objects are so small and faint that keeping track of them individually becomes increasingly impractical. Their motion can thus only be studied statistically.

Bright new comets, however, remain an ever-present possibility and it may be that the telescope will again photograph some spectacular objects even before the return of Halley's comet in 1986.

Planetary photography

The orbits of Earth and Mars are at present related in such a way that the latter planet makes its closest approach to the Earth during the southern winter months when it is seen to pass almost directly over Johannesburg. It can therefore be observed more favourably at the Republic Observatory than

Jupiter (1969) with the Red Spot and shadow of a satellite.



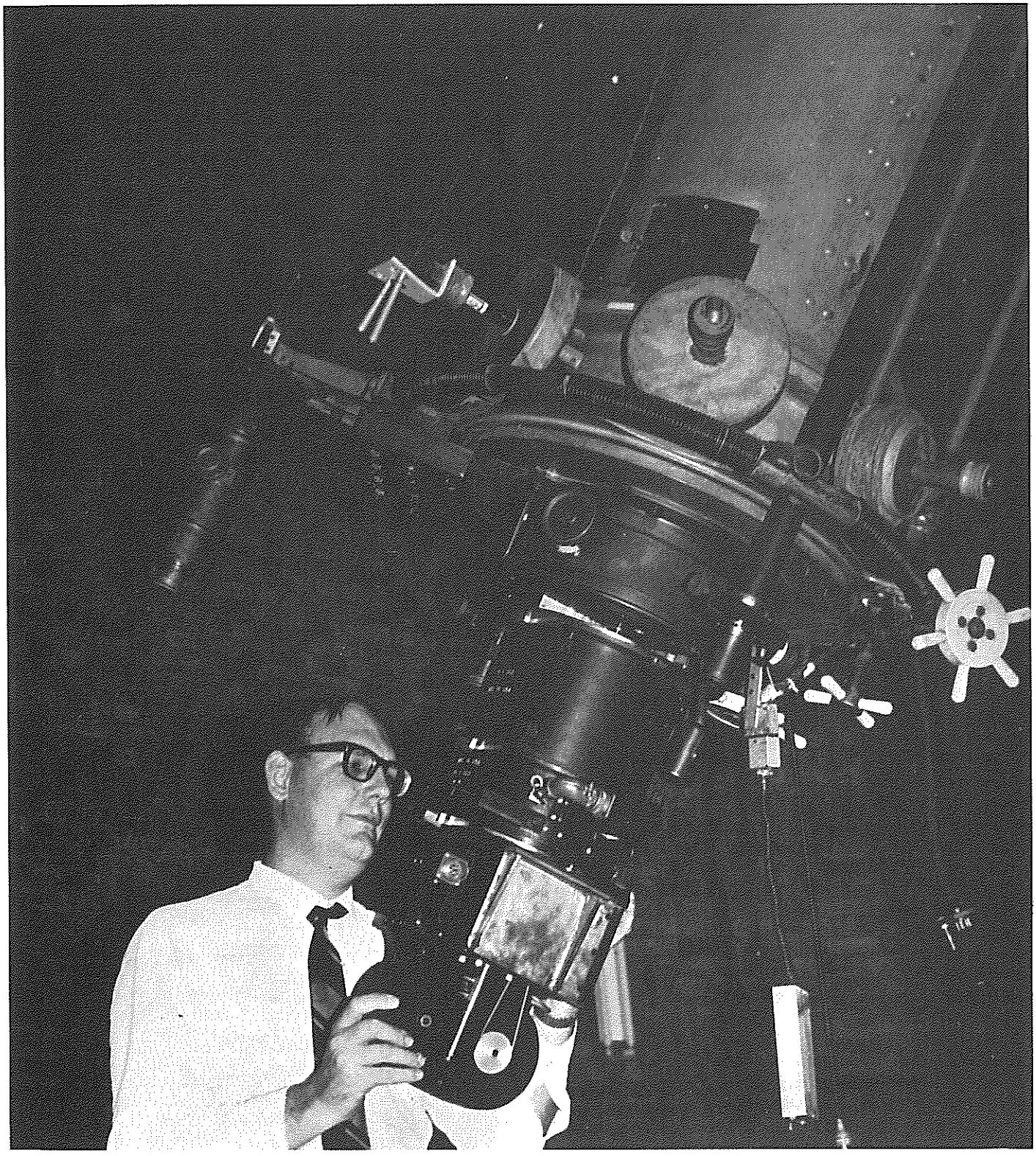
almost anywhere else and some successful attempts at colour photography through the 26½ in. refractor were made as long ago as 1939.

During the subsequent close approaches of 1954 and 1956 a comprehensive photographic programme was initiated and some 60,000 exposures were made on 16mm colour film. Each frame was individually analysed, the best being chosen for making composite colour enlargements. The resulting colour transparencies and prints have probably not been surpassed to the present day.

In 1969 Mars was close to Earth and will again be in 1971 and 1973. During this whole period the Republic Observatory will be participating in a cooperative project which will also include the photography of Jupiter and Venus. The programme is being organized by the Lowell Observatory which has been involved in planetary photography for many years. The actual observations are being made in Johannesburg as well as in Chile, Hawaii, Australia and India. This should make it possible to keep a continuous watch on the planetary surface, and to note any changes in cloud patterns which may occur. These data are today of increasing importance since they are required for selecting sites for observation from orbiting instruments, and eventually for manned landings.

Instead of colour film 35mm monochrome film with red, green and blue filters is being used for the present series of photographs. In 1969, during the first phase of the programme, approximately 43,000 exposures were made of Mars, and 15,000 of Jupiter. First results indicate that the percentage of useful photographs taken at Johannesburg has been higher than at any of the other observing sites.

Planet camera attached to 26in. refractor.



National Research Institute for Mathematical Sciences

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

The National Research Institute for Mathematical Sciences (NRIMS) is concerned with research in the mathematical and electrical engineering sciences. These two disciplines include 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 computation 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 to data processing, analogue computing, the use of ultrasonics for analysis and processing of materials, semiconductor applications, microminiaturization and thin-film technology, and studies of problems peculiar to the Republic in heavy current applications.

MATHEMATICAL SCIENCES RESEARCH DEPARTMENT

Numerical weather prediction

In anticipation of a future denser meteorological observation network over the Southern Hemisphere, further progress has been made with an investigation of the behaviour of the mathematical equations describing large-scale movements of the atmosphere. With the aid of the computer it was possible to confirm an earlier conjecture based on a theoretical analysis, namely that certain obvious simplifications of the equations lead to instability of the computations. These studies are being pursued in close collaboration with the Weather Bureau.

Selection of drill bits

A statistical method was proposed to Soekor (Southern Oil Exploration Corporation) for comparing the efficiency of drill bits and deciding which of various types of such bits would be most economical to use under a given set of circumstances. In this connection Soekor keep a record of data such as the geological formation within which drilling is being carried out, the type of drill bit, depth of the borehole, pressure exerted on the bit and its speed of rotation.

Strength of paper

The NRIMS assisted the Timber Research Unit of the CSIR in making a study of comparable samples of timber with a view to assessing certain qualities—related to the strength of the timber—which are of importance when the timber is to be used for manufacturing paper. Three of the samples were treated with various types of fungicide while a fourth was left untreated as a control sample. The conjecture was that untreated wood is attacked by fungi and this would have an effect on the length of the fibres and, in turn, on the strength of the paper. The experiment was designed in such a way that it was possible to take into account the effect of time and also various methods of beating. Highly significant differences between the treated samples and the control sample could be demonstrated.

Road traffic

The National Institute for Road Research was assisted in determining the minimum number of traffic counts necessary for a national survey of traffic. The digital computer was used to determine the variance in daily spot counts using extensive data collected by the Transvaal Provincial Administration. From the results it was apparent that the variance is very large and that, consequently, a simple sample would also have to be very large to ensure the necessary accuracy. A group of hours during the week was found which exhibits particularly little variance about its annual mean. An attempt to use the corresponding data to estimate the mean daily traffic density during the year turned out to be difficult because it was found that the computed minimum size of the experiment was still unacceptably large.

Treatment of kwashiorkor

Statistical tests were used on behalf of the National Nutrition Research Institute to compare the effectiveness of various dietary treatments of six groups of kwashiorkor patients by evaluating a number of clinical and biochemical observations. It was found that some of the methods of treatment were about equally effective while others were significantly less so.

Diverse statistical applications

- For the Veterinary Research Institute it was determined that there was an upward tendency in the content of glycogen and fatty acids in the livers of sheep placed on a fasting diet.
- In collaboration with the Oceanographic Research Institute in Durban, a new method was developed by which a transition point (sexual maturity) in the development of prawns was determined.
- For the Chemical Engineering Group of the CSIR statistical analyses were carried out to evaluate the use of 22 samples of manganese dioxide in six methods of manufacturing electric dry cells.
- On behalf of the National Building Research Institute statistical methods were applied to evaluate methods by which the percentage composition of the minerals in blast furnace slags is determined.
- For the National Institute for Water Research various methods of determining the phosphate content of water and water grass were compared statistically.

Computer centre

The IBM 360/65 installation mentioned in the previous annual report was put into commission in January, 1969. The graph plotters and the typewriter terminals were added later.

During normal operation the processor simultaneously carries three to four jobs originating from three sources, namely tasks handed in across the counter, tasks from a self-service station where clients operate the card reader and printer themselves, and tasks from various typewriter terminals. Within six months the load already grew to more than a full daily shift of work, with about 150 jobs per day.

As was expected the number of large tasks is increasing. An example is the computation of a crystal structure for the National Physical Research Laboratory which occupied the computer for more than a full day's shift.

Surveying tables

The following example may serve to place in perspective the computing times mentioned above.

At the beginning of this century Oscar Schreiber computed the tables for converting geographical co-ordinates to the South African Gaussian conformal co-ordinates which are the basis of our system of surveying. In the 1920's the tables were re-computed and extended to include tables for adapting various Gaussian co-ordinate systems. Both were enormous computing tasks which have to be measured in man-years.

Recently the same tables were re-computed here with a view to metrication: after about 4 hours of programming, the task required only slightly over 5 minutes' work by the computer, 49 seconds of this being computing time.

Numerical control of machine tools

The computer language for the numerical control of machine tools which was mentioned in the previous annual report has been successfully replaced by a more comprehensive edition. In addition, the post-processing procedure which adapts the results of programs in this language to the automatic milling machine of the CSIR has been considerably improved and abbreviated.

A comprehensive new computer language with which it will be possible to represent in digital form an arbitrary surface defined by projective views has reached an advanced stage of development.

Location of lightning flashes

A set of computer programs has been developed to make possible the accurate location of lightning flashes with the aid of three recording stations. Besides other functions, the program provides for the calibration of the direction-finding equipment with regard to a panoramic camera and the synchronization of the records. This work was done in support of the lightning research which the NRIMS is undertaking in collaboration with other CSIR Institutes.

Civil engineering computations

The comprehensive Integrated Civil Engineering System (ICES) of the Massachusetts Institute of Technology, referred to in the previous annual report, has been implemented and tested on the CSIR's new computer. With a view to adapting the system to South African conditions the Institute, through the South African Institution of Civil Engineers, invited consulting engineers to assist in testing the system by submitting design tasks encountered in their own practice. Experimental tasks, some of which were very extensive, were satisfactorily executed. Recently the largest design analysis to date, namely that of a three-dimensional framed structure with 547 joints and 1035 members, was completed in 37 minutes computing time, total machine time being 90 minutes.

These activities represent part of a long-term project towards more extensive automation of routine engineering computations.

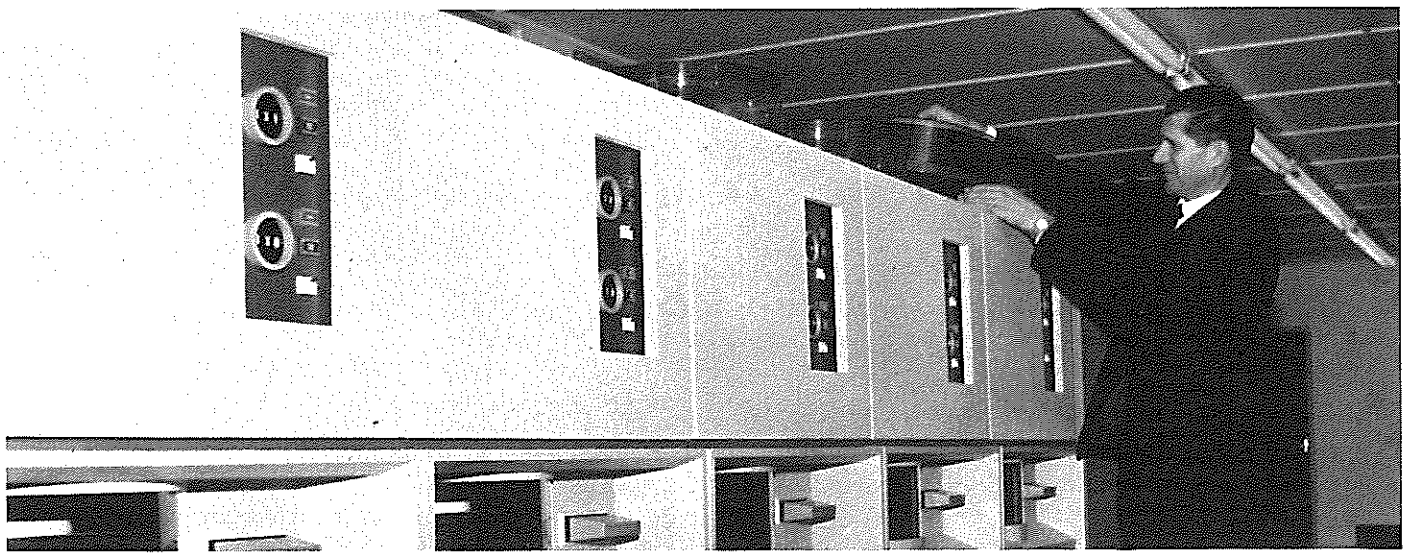
ELECTRICAL ENGINEERING RESEARCH DEPARTMENT

Process control

The object of research in this field is to carry out a fundamental study of process control by means of model simulation on computers and to apply the results of such study to selected industrial processes.

After various possibilities had been considered it was decided to begin by simulating a specific sugar refinery. As is usual in the case of sugar refineries, water is recovered from the extracted cane and the bagasse is used as fuel to generate steam and electricity. This particular refinery is, however, unique in that it is almost entirely dependent on the

The large disk memory of the new computer.



cane for its water and fuel requirements and consequently a delicate balance has to be maintained with regard to the quantities of water and fuel used. It is thus of primary importance that the refinery should be operated within the limits imposed by these water and fuel restrictions, but yet in such a way as to ensure maximum productivity.

An equilibrium model of the refinery is being designed, making use of weekly operating data which are provided by the management of the refinery. Later the model will be expanded so as to simulate also the dynamic aspects of the refinery.

A study has been initiated to become conversant with simulation and system analysis programs which can be used with the IBM 360/65 digital computer. The necessary preliminary work is also being done to enable full use to be made of the envisaged hybrid computing facility when carrying out the project. This computing facility will consist of the EAI 580 analogue computer and a Varian Data 620/i process computer. When the linking of the analogue and process computers has been completed, the Institute will have a powerful hybrid unit with which control studies can be carried out.

Thin-film technology

During the past year much time was spent finalizing the Institute's own manufacturing facilities.

A big problem associated with the manufacture of a fairly large number of circuits is the cleaning of the substrates prior to deposition. Cleaning baths are being constructed in which recirculating deionized water is used. These baths will enable eight substrates to be handled simultaneously.

Very accurate resistive circuits are required in digital-to-analogue converters. To make possible the manufacture of such circuits it was therefore necessary to improve the quality of the photo-masks used for the photolithographic processing steps.

The design of an epoxy bonder used to bond transistor chips to thin-film substrates has been finalized.

Changes have been made to the sputtering unit which can now be used in conjunction with a high vacuum system acquired recently. Experimental capacitors have been manufactured in which the lower electrode consists of an evaporated layer of gold, the dielectric layer of silicon dioxide deposited by radio frequency sputtering, and the upper electrode, deposited without breaking the vacuum, of a layer of aluminium also produced by radio frequency sputtering.

High voltage distribution systems

A recording station is being set up under a 400kV line in collaboration with the University of Pretoria and ESCOM. The aims of this work are twofold: voltage surges will be recorded and analysed, and corona characteristics and radio interference phenomena will be recorded. Digital techniques will be employed as far as possible in the instrumentation and the collection of data will probably be controlled by a process control computer.

As part of the development of suitable measuring equipment the system for the out-of-contact measurement of three-phase voltages and currents is being further developed. In these techniques capacitive and inductive antennas are employed to measure the voltage and current in each of the three phases.

Lightning

In collaboration with the National Physical Research Laboratory three lightning direction-finding stations near Pretoria were operated during the 1968/69 lightning season. Records were obtained of 79 thunderstorms occurring after sunset, but owing to various operating difficulties only 12 storms could be used for three-station triangulation purposes. A large number of individual records obtained during these 12 thunderstorms are, however, available and can be used to determine the effective range of the lightning counters.

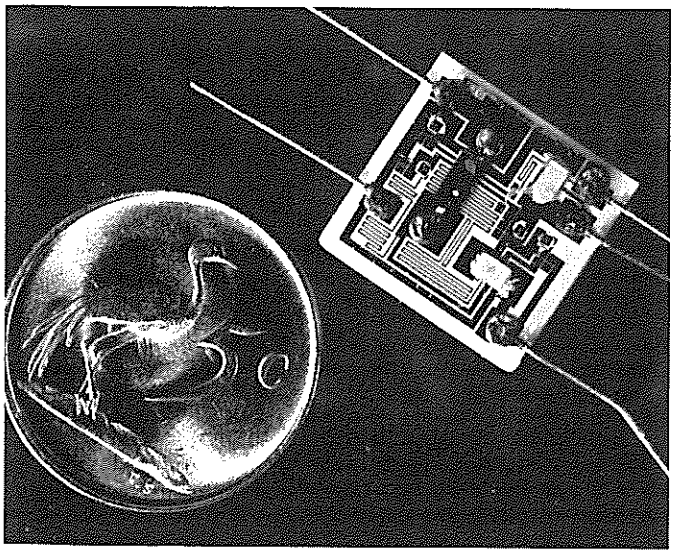
Work is in progress on a special triangulation program for the IBM 360/65 computer with the aid of which it will be possible to calculate the distances from each of the stations to the point where a lightning flash occurred.

A very important aspect of the project is the identification of lightning discharges. For the data on the range of lightning counters to be significant the distinction between intra-cloud and cloud-to-ground flashes is essential. Continued efforts are being made to improve the design of the lightning counters so that they will register only ground flashes.

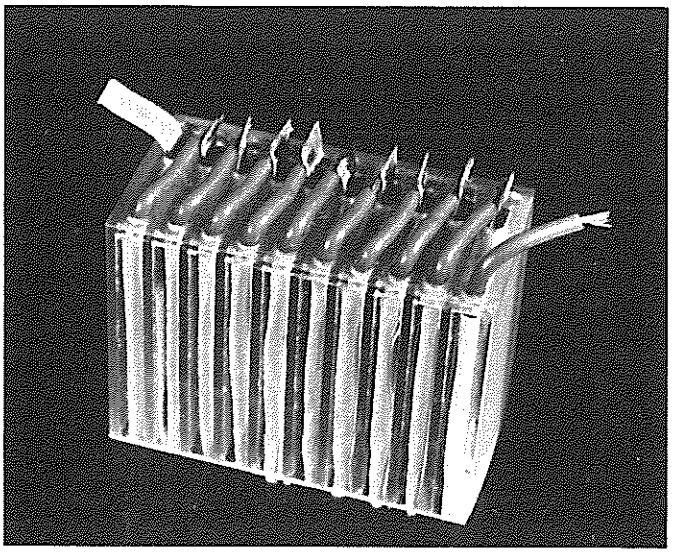
Electrical resistivity and moisture determinations

It is well known that the electrical resistivity of the surface layers of the soil is very high in some parts of the Republic.

A thin-film circuit manufactured by the Institute.



An experimental prototype of a 15-volt seawater battery. Dimensions: 3x1x2cm.



Under these circumstances special measures are required to secure good electrical earths which are necessary for the proper operation of electrical power and distribution systems, and for reasons of safety. The objective of research into this subject is to chart the resistivity conditions in the Republic.

During the past year routine measurements have been continued at two test sites. Methods of measuring the moisture content of the soil, which is one of the most important factors influencing the resistivity, have been further investigated; in particular, attention is being paid to the measurement of the dielectric constant of soil as a means of determining its moisture content. Probes which can be driven into the soil to a depth of about one metre have been designed, and they will be tried out for dielectric constant measurements.

Thermal resistivity

The thermal resistivity of soils is of importance particularly when determining the safe electrical load which can be carried by an underground power cable. A quick and simple method is thus required for ascertaining the thermal conditions of soils along projected cable routes. Work is continuing on the development of a small portable direct-reading resistivity meter.

Insulation

A survey of insulation research requirements in South Africa has revealed considerable interest on the part of manufacturers of electric motors, transformers and cables.

An agreement has been concluded with the Rand Water Board to investigate on a co-operative basis the reasons for the deterioration of insulation in the windings of large 6.6 and 11 kV motors.

Information service on electronic instrumentation

A number of enquiries were received and answered on electronic components and instruments. When information on special equipment was required, this was obtained from various manufacturers; periodicals on electronics are regularly scrutinized with a view to announcements of new instruments and components which could possibly be used to advantage.

Calibration of electronic instruments

The internal calibration service which was inaugurated in 1967/68 could be extended from the beginning of 1969. At first only newly acquired instruments were tested; now a number of pieces of equipment which have already been in use are also being calibrated. A few instruments have been tested for external organizations, as such a service is not yet available elsewhere.

Training of electronics technicians

The students taking the sandwich course during the past year once again maintained a high standard. The success achieved may be attributed in the first place to the thorough and intensive instruction which students received in the laboratories of the Electrical Engineering Research Department during their practical training period.

Attention is also being paid to the development of training aids and the evaluation of existing training equipment and laboratory guides. New lists of suitable handbooks, laboratory guides, demonstration aids and patchboard equipment have been assembled for the Department of Higher Technical Education, based on the subjects of the new syllabus which is at present being drawn up by the Department.

Medical electronics

A useful contribution towards the treatment of certain types of nervous diseases can be made by a procedure which involves stimulation of the brain by means of pulsating electric currents. A small, simple brain stimulator which was developed in the Electrical Engineering Research Department is now being used daily for psychiatric treatment in a Pretoria clinic.

Patients who suffer from angina pectoris, a condition associated with a sporadically accelerated heart beat, are usually treated by being given injections to return the pulse rate to normal. By stimulating the vagus nerves in the neck electrically it is, however, possible to reduce the pulse rate as these nerves are the inhibitors of two sets of nerves controlling the heart beat. At the request of a physician of the H.F. Verwoerd Hospital, and in collaboration with a member of staff of the Atomic Energy Board, an electrical unit for stimulating the vagus nerves was developed. The pulse generator is worn externally, and the electrical pulse, received by a coil implanted under the skin, is transmitted to the stimulating electrodes. Clinical tests have not yet been carried out.

Lightning protection of prestressed concrete water pipes

The water pipelines protected against lightning damage by means of parallel copper conductors according to a technique developed by the Electrical Engineering Research Department continue to operate satisfactorily and the method has been applied to other pipelines in various parts of the Republic. It is expected that the application of the method will be extended further.

Railway electrification

An optical-electrical system for measuring the wear of overhead contact wires was pursued further in collaboration with the National Physical Research Laboratory and the possibility of using a laser beam is also being investigated.

Low level amplifiers

A direct-reading instrument with built-in digital read-out has been completed for the electric thermometer which was mentioned in the previous annual report. This thermometer which operates on the current step principle is now generally employed. Even though the ten transistors which are used were not specially selected they give identical temperature readings to within ± 0.1°C over a range of -80°C to 120°C.

Flash counter

An omnidirectional device has been developed for counting quick flashes such as lightning. More gradual changes in light intensity are not registered.

Sea-water battery

A light, small and yet powerful battery which may be discharged rapidly at a high current has been developed. The electrodes, made of magnesium and silver chloride/carbon, are separated by suitable spacers and the cell remains inactive if stored in an environment with controlled humidity. The battery is activated by sea-water which functions as the electrolyte. The watt-hour capacity per pound of such a cell is 19.4 compared with 2 for the well-known dry cell.

Analogue computer for solving field equations

The analogue computer developed by the Electrical Engineering Research Department is used to solve problems involving potential fields encountered, for example, in electrical engineering and hydrodynamics and heat flow. The differential equations describing such problems can seldom be solved by analytical methods.

In the analogue system the field problem is simulated as an equivalent electrostatic field making use of a conducting graphite paper instead of a conducting fluid. The machine is used to plot automatically the equipotential lines in the simulated field.

National Institute for Telecommunications Research

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

Basically, the work of the National Institute for Telecommunications Research (NITR) embraces the study of natural phenomena and their effects on radio waves as well as the development of radio and radar systems for specialized applications. In addition, the Institute operates the Radio Space Research Station at Hartebeesthoek, near Johannesburg.

Ionospheric research

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 of ionospheric data and predictions of optimum frequencies for use in short wave radio communication.

During the past year research into the various processes controlling ionization in the D- and F-layers of the ionosphere has continued. Several problematic aspects have been elucidated and the results have appeared in a number of publications.

At the request of the United States Jet Propulsion Laboratory measurements of the F-layer critical frequency at Johannesburg were reported hourly, and the total electron content was computed daily, over a period of three weeks at the time when the Mariner spacecraft were approaching and passing the planet Mars. This information was used to refine the accuracy of the deep space tracking network.

Measuring rainfall by radar

Research into the use of radar to study clouds and precipitation has continued. A new radar system was built and in the summer of 1968/69 it was used to measure rainfall over a small test site on which a number of accurate recording rain guages had been placed. Comparison of the two sets of measurements showed a satisfactory measure of agreement. Consideration is now being given to the possibility of extending the system over a sufficiently wide area to provide rainfall data for hydrological studies.

Lightning research

In its programme of research into lightning the Institute has developed a highly accurate system for locating the sources of radio noise associated with lightning. Records of numerous lightning strokes were made in the past summer, and these are now being analysed. It appears that a degree of accuracy to within some 50m in the horizontal plane has been achieved, while vertically the degree of accuracy varies from within 500m near the ground to within some 50m at a height of 4km. It is thus possible not only to locate the position of a lightning stroke, but also to study is fine structure in the context of both space and time.

A highly accurate instrument developed by the NITR for measuring distance by means of a modulated infra-red beam.

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

It is intended to supplement these studies with optical and radar observations, and an X-band radar system is at present being brought into operation.

Accurate distance measurement

An important aspect of the Institute's work is 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 was completed at the end of 1968. Since then the system has been exhaustively tested on a variety of test figures and in practical surveys. Distances up to 1.5km were measured and a degree of accuracy to within 2mm was achieved. At present a South African firm is preparing to produce and market this instrument.

Space research

The Institute has continued to operate the Radio Space Research Station at Hartebeesthoek 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 85ft 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.

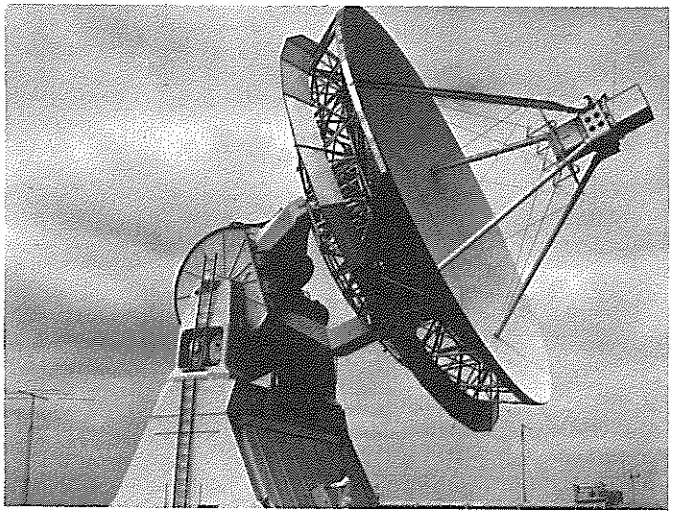
The STADAN is one of a world-wide network of stations established by NASA to track and communicate with scientific earth satelites. This station, one of the busiest in the network, has also proved to be one of the most reliable.

Geodetic survey by satellite

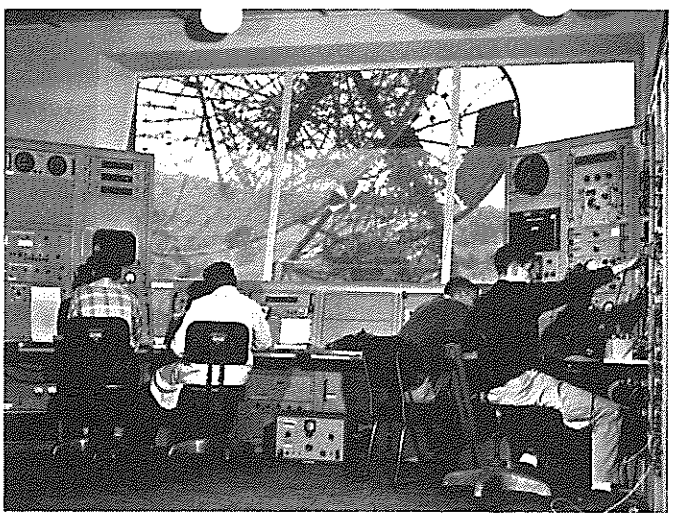
The Institute has continued its participation in the programme of satellite geodesy organized by the United States Coast and Geodetic Survey. An optical tracking station, one of a world-wide network of similar stations, is operated by the Institute at the Radio Space Research Station.

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.

The automatic satellite tracking antenna at the STADAN station, Hartebeesthoek.



Inside the DSIF tracking station at Hartebeesthoek.



National Mechanical Engineering Research Institute

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

The National Mechanical Engineering Research Institute (NMERI) is concerned mainly with the development of new ideas and techniques in mechanical engineering as well as the improvement of machines and materials used in industry. The Institute is also active in fields such as rock mechanics in order to improve efficiency and safety in mining. In addition the Institute has testing equipment and machines, instruments and qualified personnel 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 consists of six research divisions, namely Strength Mechanics, Metal Mechanics, Rock Mechanics, Process Mechanics, Fluid Mechanics and Heat Mechanics as well as three research units, namely the Aeronautics Research Unit, Hydraulics Research Unit and Mine Equipment Research Unit.
The six divisions together with the Aeronautics Research Unit are situated in Pretoria, the Mine Equipment Research Unit in Johannesburg, and the Hydraulics Research Unit is on the campus of the University of Stellenbosch. The three Units are integral parts of the NMERI and are responsible to the Director of the Institute.

METAL MECHANICS

Failures in service

Service to industry in this field consists of investigations into failures of machine and structural metal components. This includes general metallurgical tests to identify specific materials, heat treatment studies, the investigation of corrosion problems and metallurgical tests aimed at pinpointing the cause of failure of metal components.
Thus, for example, the cause of fracture of the intermediate shaft of a marine tanker was investigated. Tests relating to the problem of corrosion of stainless steel food containers were also made. Another typical example of this work is an investigation which was undertaken into the cause of the crash of the South African Airways Boeing 707 near Windhoek.

Ore mill liner materials

A comprehensive investigation into rotary mill liner practice in the South African gold mining industry necessitated the design of a small test mill in which the suitability of any metal for use as liners in ore grinding mills could be assessed within a few hours. Various metals currently being used in the gold mining industry for ore mill liners were tested in this mill with the various ores. The results corresponded to a remarkable degree with those obtained in actual mills during the previous comprehensive investigation which lasted nearly three years.

Foundry research

Investigations on behalf of several foundries and foundry-supply firms were conducted. The properties of different binders and foundry sands were investigated and material tests were carried out on cast irons to determine their mechanical properties, microstructures and chemical compositions. Several investigations were also carried out into the causes of service failures of cast machine and vehicle components.

A one-day sand testing training course for foundry technicians was held for subscribers to the South African Foundry Research Foundation. Thirteen firms sent a total of 26 delegates to this course which was one of the first of this type conducted in the Republic.

A report on the properties of resin bond mould materials was published during the year. The tensile and compressive strength, gas permeability, gas evolution, hot strength, breakdown strength and porosity index of cores produced using the various resin bonding materials were determined. These data facilitate the selection of resin binders for specified purposes.

Research into the production of ferrous castings with high surface quality was given priority in view of the increasing demands for this type of casting in the Republic.

STRENGTH MECHANICS

Stress analysis and material testing

Complete stress analyses of several new railway carriages were undertaken on behalf of the manufacturer of these vehicles. This involved the use of no less than 150 electrical resistance strain gauges on each coach from which strain readings were taken under various loading conditions. An experimental stress analysis of a mine ventilating fan involving dynamic stress measurements was also undertaken.

A wide range of fatigue tests was conducted on railway rolling stock brake components and permanent way equipment.

Strength and stability tests of scaffolding units, props and trench struts as well as tests on joints with high-strength friction-grip bolts and other structural equipment used in the building industry were carried out for manufacturers.

Creep of metals

The instrumentation of a laboratory for conducting creep tests on metals under different temperature conditions was completed. This is the first laboratory of its kind in the Republic.

PROCESS MECHANICS

Heavy machinery testing

A recommendation had been made previously to the councils of the CSIR and the South African Bureau of Standards that Government sponsored central facilities for the testing of heavy rotary machinery, particularly pumps, be established.

Subsequent developments, e.g. the use of much larger turbo-generator units in power stations, necessitated amendments to specifications for test beds recommended at the time.

However, the whole project had to be suspended for the time being as the Government withdrew its previous support.

Phormium tenax processing

The growing and processing of *Phormium tenax* is being encouraged in the Republic to provide an alternative source of vegetable fibre for the manufacture of grain bags, which in the past had been made from imported jute. Difficulties were, however, experienced with the decorticating machinery used to recover the fibre from the plant and the Institute was requested by the Department of Industries to investigate the matter.

Phormium tenax fibre is by nature harsher and coarser than jute. To produce a fibre which can be processed by existing jute machines it is therefore necessary to re-fine the fibre. This can be done either by passing fibre produced by normal decorticating through a subsequent re-fining stage or by using a more intensive decorticating process at the outset.

After experimental work with a conventional carding machine purchased for this purpose the Institute was able to help a producer re-fine the coarse fibre to a degree which made it acceptable to the spinning mills. Another producer's machines of obsolescent design were converted to produce sufficiently fine fibre.

The first performance trials of the prototype of a new small decorticator built by a Natal manufacturer were conducted by the Institute.

ROCK MECHANICS

Services to industry

Various industries both in the Republic and abroad made use of these services which comprise a consultative service, a rock properties testing service and a rock stress measurement service.

An information centre was established during the year to provide a literature retrieval service on rock mechanics publications related to both civil engineering and mining. Specialized equipment was purchased in order to mechanize the procedures.

Large-scale testing of rock and coal in situ

This project which is fully sponsored by the Coal Mining Research Controlling Council is aimed at determining the complete load deformation characteristics of coal once pronounced fracturing had taken place. During the year underground tests on large coal specimens were conducted under conditions of controlled end constraint simulating the action of roof and floor on coal pillars. The knowledge gained by these tests will throw light on the strength of pillars beyond their normal strength failure loads and could result in higher percentage extractions without imperilling safety in the mine.

Stress in rock

The CSIR 'doorstopper' strain cell equipment and the CSIR 'triaxial' cell equipment for measuring stress in rock have been developed to such perfection that they are now both commercially manufactured in the Republic. This equipment has aroused considerable interest overseas and is now being used throughout the world. Very satisfactory results have been obtained using the 'doorstopper' equipment for measuring pillar loads in a colliery, despite the inhomogeneous nature of the coal.

Fracture mechanism of rock

The Institute's publications on rock fracture have received world-wide acclaim. Research was concentrated on the behaviour of fractured rock and particularly its stability as a function of structure configuration, state of multiaxial stress, and time.

Stability of rock slopes

Research into rock slope stability is particularly important in the Republic at the present time in view of the latest trend to mine deposits by open pit methods such as are used at Phalaborwa.

As a result of a critical literature survey on rock slope stability, research is now concentrated on the application of the finite element method of determining stress distributions in rock slopes. Computer programmes have been developed for both two- and three-dimensional treatment.

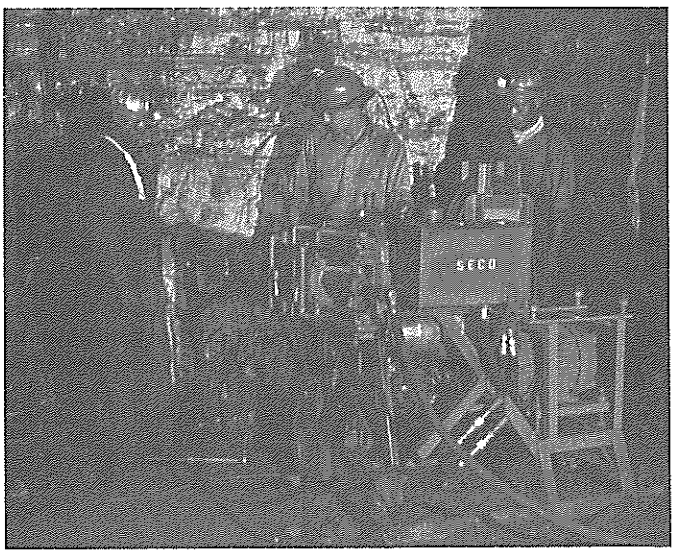
FLUID MECHANICS

Natural aerodynamics

A dynamic model constructed for tests in the wind tunnel was successfully used to establish the fact that wind-excited roof oscillations of a large liquid storage tank could be effectively reduced by erecting a wire mesh screen around the perimeter of the tank. An optimum screen configuration was also recommended.

The surface tension of liquid iron being measured.

Measuring the stress in a coal pillar underground using CSIR "doorstopper" rock stress measuring equipment.



Hydraulic transportation of solid materials

For the manufacture of cement limestone is often transported over long distances in the form of a slurry in a pipeline.

The results obtained from an investigation into slurries which have different water concentrations and particle size distributions enabled the Institute to calculate the capacity of the pumping plant required by a factory which, for instance, would have to pump through an 8-inch pipeline over a distance of 100 miles.

Hydraulic hoisting

As the mining industry is interested in the possibility of pumping rock out of the mines with water passing through steel pipes, a prototype hydraulic hoisting plant was erected at the Mine Equipment Research Unit. This plant is capable of lifting lumps of rock approximately 1.5 inches in diameter vertically up a pipe at a rate of about 3.5 tons per minute. This corresponds roughly to a mine shaft with a capacity of 100,000 tons per month.

Research is being done using this plant to determine the optimum design parameters of such a system. If the system works satisfactorily, capital and operating costs could be about one half of those of conventional hoisting.

HEAT MECHANICS

Air conditioning and refrigeration

The growth rate in the application of air-conditioning equipment is at present estimated at 15 per cent per annum for the Republic. Considerable capital expenditure is involved in industrial refrigeration plants which are currently being planned and in the next few years the estimated expenditure in the abattoir field alone will approach R5 million. Consequently there is an ever increasing demand for technical assistance in the planning of air-conditioning and refrigeration facilities.

As a result of certain basic investigations into the chilling of meat, the Institute published the results obtained in the form of basic design data which will enable consultants to design certain components of abattoir refrigeration systems on a sound economic basis.

Advice was given on the basic design of comfort air-conditioning systems and temperature and humidity control equipment in a variety of applications such as surface acclimatization chambers in the mining industry, plant growth rooms for horticultural research, and textile factories.

The latter included investigations into the problem of moisture condensation in roof structures during the winter months. Basic research relating to the influence of temperature and relative humidity on the electrical resistance of certain natural and synthetic yarns and their consequent tendency to generate static electricity, was also done.

Climatological design data for air-conditioning equipment

In order to provide winter design data on which the capacity of the heating equipment for air-conditioning systems can be based, an analysis of the daily minimum dry-bulb temperatures occurring just before sunrise was carried out for most weather observation posts in the Republic of South Africa, South-West Africa, Rhodesia, Botswana, Lesotho and Swaziland.

Workers at the Institute also calculated design values based on the highest dew point temperature that occurred during the summer as well as the lowest dew point temperature that occurred during the winter months and early spring. Suggested design values were presented graphically on maps of Southern Africa and numerous requests for this published information were received from consultants and other interested bodies.

MINE EQUIPMENT

Statutory wire rope testing

The Mine Equipment Research Unit is responsible to the Department of Mines for testing every winding rope used in the Republic. By law a length of every such rope has to be tested to destruction every six months to ensure that its condition is such that it may continue to be used safely.

Apart from ropes for the mining industry in South Africa, ropes from South-West Africa, Rhodesia and Zambia are also tested. During the twelve month period ending 30th September, 1969, about 5,200 ropes were tested. Of these approximately one half were over 1.25 inch nominal diameter.

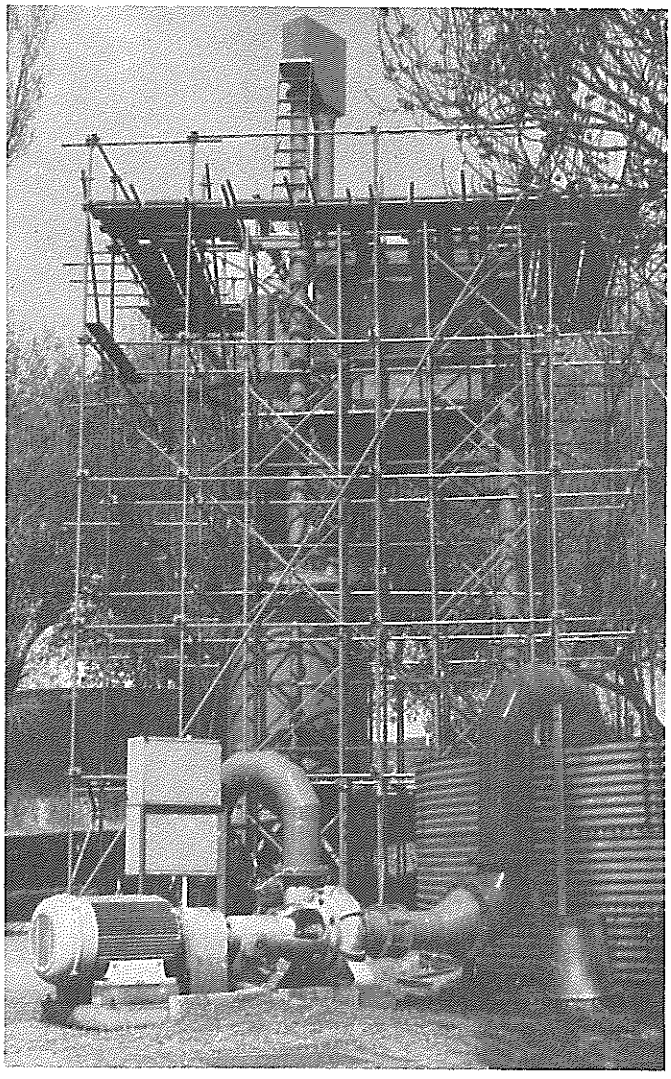
Non-statutory testing of components

The facilities at the Unit are extensively used by the Chamber of Mines, the South African Railways, Iscor, and industry in general for all types of non-statutory work such as the testing of lifting tackle and crane hooks to ensure that they comply with certain strength requirements. A new 1,000 metric ton tensile testing machine will be commissioned in 1971 and will greatly improve and increase the capacity of the existing test facilities.

Fatigue of winding ropes

A unique machine for fatigue tests on wire ropes was successfully operated for the first time at the Mine Equipment Research Unit. This universal fatigue testing machine which was designed by the Institute can be programmed to apply any desired sequence of bending, torsional and tension stresses to simulate the actual service life of a mine winding rope. Results which should throw considerable light on the service behaviour of winding ropes are expected.

Pilot plant for research on the hydraulic hoisting of ore out of a mine.



HYDRAULICS

Sediment movement in the sea

Previous surveys of various Natal rivers in flood indicated that the silt laden river water spread out over the surface of the heavier sea water. In the first part of this programme a survey was made of suspended solids discharged into the sea opposite the Umgeni River mouth during the 1967/68 flood season. In the second part of the programme, a survey will be made of sand drift along the entire Natal coast. The main areas of study will be the mouths of the Isipingo, Umkomaas, Tugela and Umzimkulu Rivers.

Disposal of effluents

A study in a hydraulic model to investigate the discharge of nitrogenous liquid effluent from a chemical plant into Table Bay was successfully completed. The movement and dilution of effluent was determined in the vicinity of a proposed harbour at Rietvlei and it was shown that there is no danger of an undue increase in effluent concentration in the harbour under the various conditions tested.

Ocean wave research

Ocean wave data which cover the whole of the South African and South-West African coasts are being collected, analysed and correlated with a view to forecasting wave conditions.

Wave clinometers are in operation at St. Lucia, Richards Bay, Port St. Johns, East London, Cape St. Francis, Mossel Bay, Buchu Bay and Walvis Bay. Inverted echo-sounder recorders have been installed at Richards Bay and Durban and, in addition, data are available from ship-borne recorders on the research vessels Africana II, Thomas B. Davie, Meiring Naude, SAS Natal and Benguela. The aim is to have all the records analysed by computer, whenever possible.

Reports published to date include wave and wind data for the Natal and western Cape and for the Cape St. Francis and Mossel Bay coastal areas. A manual for wave predictions was prepared and efforts were made to set up international standards for wave recording and analysis.

Coastal design problems

A large number of enquiries were received, including one in connection with a small craft harbour at Umzimkulu, a proposed tidal pool at Kelso Beach, protection of beaches in the vicinity of George, a small craft harbour at the Tongaat River mouth, the formation of beaches at Swakopmund and a harbour investigation at Lamberts Bay.

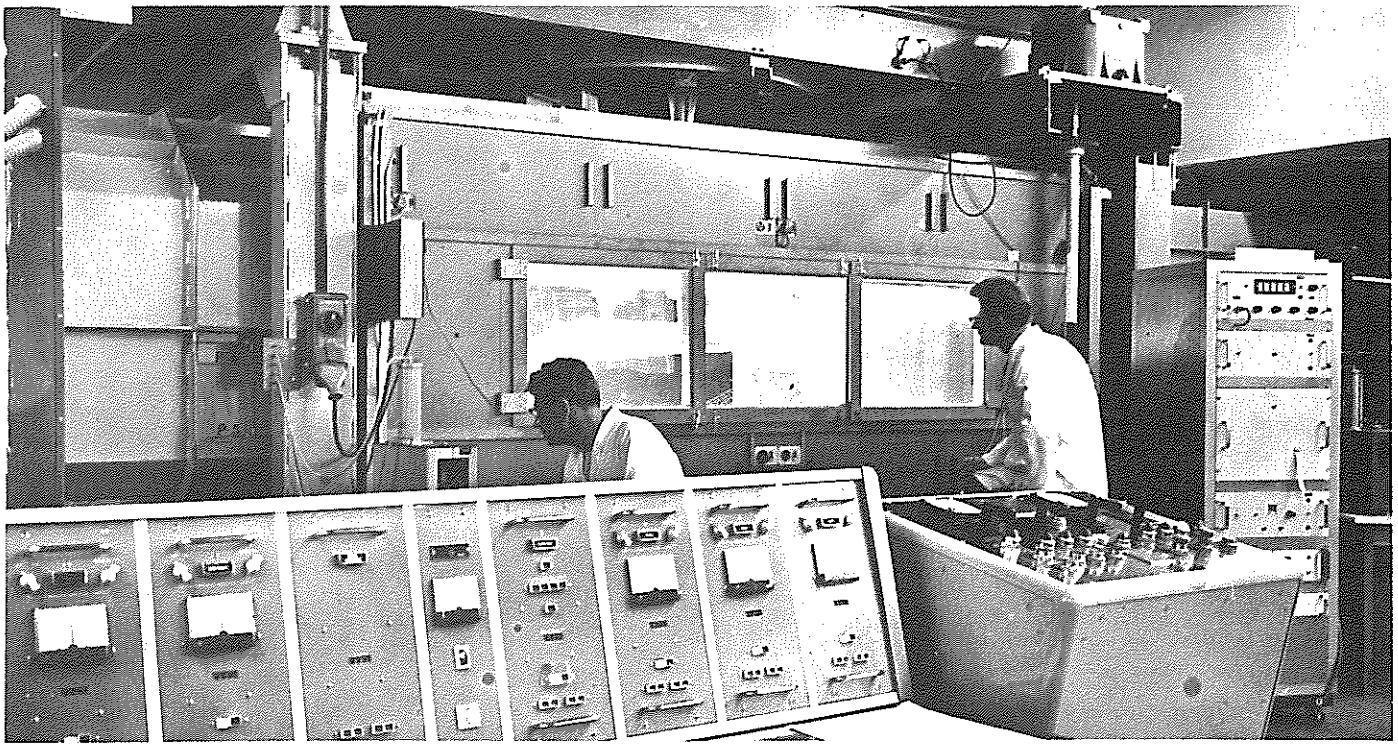
The problem of protecting the new breakwaters at the entrance to the harbour at Gansbaai has been solved by the use of a dolos-protected rubble breakwater. This provides a very good mooring area during storm conditions, and boats can be navigated without difficulty into the new mooring area except during extreme westerly storm conditions.

Harbour siltation and beach erosion

The Durban underwater mound, a sand ridge of about 61m (200ft) wide at the crest and reaching to about 7.3m (24ft) below low water is being constructed to run parallel to the shore, some 2,100m (4,000ft) offshore. Large waves break on this mound which thus effectively protects the beaches against storm damage.

In June, 1966, a start was made with the actual construction of the mound and although no sand was dumped during

The working section of the 7ft x 5ft subsonic wind tunnel.



1968, the volume of the sand in the mound already exceeds 3 million m^3. A total of about 10 million m^3 of sand is required to complete the mound and sand is now being made available from maintenance dredgings of the harbour entrance by the South African Railways and Harbours.

Records of the year during which no dumping was done show that the mound remains stable. The beaches in the lee of the mound show improvements and there was no damage to the fully protected beaches during a storm in mid-November, 1968.

Harbour development at Richards Bay

The Richards Bay field team is still engaged on collecting data. Current measurements in the breaker zone, sand tracer tests, surveys of the beaches and offshore bottom surveys, aerial photographs and depth charts of the estuary are made at intervals of three months. Winds, offshore currents, waves and tides, as well as salinity at various points in the bay, are continuously recorded.

Most of the data obtained so far have been analysed and the results used to design the first movable-bed harbour model, due to be completed early in 1970.

A larger scale fixed-bed model is being designed for a more detailed study of the entrance to the harbour, including its navigability.

Shore erosion at Port Elizabeth

Field observations on the shore erosion at Port Elizabeth were completed. Beach profiles measured at intervals of three months indicated that further erosion predicted north of the dolos protection is in fact taking place. It is also evident that the rubble protection to the north of the dolosse will eventually need additional reinforcement or protection.

Recommendations for further studies were made to the authorities in order to find means of preventing the erosion from progressing further north and proposals for the re-establishment of the lost beaches were submitted.

Stability of estuaries and river mouths

A sub-committee for the preservation of river mouths, lagoons and lakes visited all the most important river mouths between Gouritz River mouth and Kowie River mouth (Port Alfred). Problems relating to hydraulics were encountered at various river mouths such as Kowie River, Swartkops River and Keurbooms River. These problems may well lead to a future enquiry and, possibly, a model investigation.

Staff members served on the technical sub-committee which advises the St. Lucia Scientific Advisory Council on the necessary measures to be taken to safeguard the St. Lucia Lake system.

Sand dams in South-West Africa

Intensive surveys of water quality, water table fluctuations and sediment and flow characteristics in the Ondekaremba, Neudamm and Otjozondu sand storage dams have been made over the past two rainy seasons. As the floods were negligibly small during this period the field survey is being extended for another rainy season.

Topographical features both in and surrounding the Ondekaremba sand storage dam were recorded to enable verification of the hydraulic scale model which is to be made. This model study is aimed at investigating various schemes to improve the yield of water from the sand storage dam. A start has been made with the construction of a movable-bed model of the Ondekaremba Dam.

AERONAUTICS

Low-speed wind tunnel

The 7ft x 5ft wind tunnel which was put into commission during 1968 was used almost continuously for sponsored *ad hoc* investigations during 1969. In fact, the demand for tests in this tunnel was so great that the final calibration of the tunnel had to be postponed. The scheduled testing programme already extends to the middle of 1970.

High-speed wind tunnel

As a result of preliminary tests in the new trisonic wind tunnel it was decided to redesign the flexible nozzle plates in the tunnel to improve flow conditions in the test section. The modification became necessary to ensure that this wind tunnel, the only one of its size and shape in the Republic, would be as perfect as possible.

Considerable difficulty was experienced in obtaining suitable material for the new nozzle plates and in getting the plates machined to the required degree of flatness. Special steel was eventually imported from overseas and will be machined in the Republic. Various other improvements, mainly in the electrical and hydraulic systems of the tunnel, have also been made.

Stability and control of missiles and high-speed aircraft

The development of a free-flight testing technique was completed and a number of experimental cone models were designed and manufactured for free-flight stability testing in the trisonic wind tunnel. Special manufacturing techniques had to be developed to make these models.

Aircraft noise

Work aimed at refining a method for assessing aircraft noise disturbance in areas surrounding airports still further was continued in collaboration with the South African Bureau of Standards (SABS). Application of the method could eliminate the problem of aircraft noise by suitable zoning of residential areas or by revising operational procedures at particular airports.

The method has already been approved by the Inter-Departmental Committee on Aircraft Noise, adopted by the SABS as the basis for a Draft SABS Recommendation, and published in an overseas journal. The principles of the method were presented before a committee of the International Organisation for Standardisation (ISO), and before a special meeting of the International Civil Aviation Organisation. At the ISO meeting, held in Italy, the South African delegation succeeded in obtaining overwhelming support for a proposed revision of the ISO method evolved over the past ten years.

Gust loading effects and aircraft fatigue

Some ten years ago this Institute, together with the National Physical Research Laboratory, was briefly involved in the initial stages of a research project concerned with the effects of atmospheric turbulence on aircraft fatigue. Attention was confined to the accumulation of gust data over South African air routes. The limited and somewhat superficial data obtained suggested that conditions could be much more severe in South Africa than in other parts of the world, and that the safe life of aircraft operating in this country might therefore be substantially reduced.

The project had to be shelved owing to staff shortage, but recently it was resumed. Work was started on the preparation of in-flight recording systems. A new instrument had to be designed for counting stress levels or vertical accelerations experienced over predetermined ranges of altitude.

Aircraft propulsion

Consideration was given to the possibility of developing an aerothermodynamic resonator, evolved earlier by the Institute, into a valveless pulse jet engine. It was decided to evaluate this possibility by testing a small experimental unit in a special air duct facility.

National Institute for Water Research

Dr G. J. Stander, Director of the National Institute for Water Research.

As 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.

Anaerobic digestion of waste matter

Anaerobic digestion of organic material is a process widely applied in the treatment of organically polluted effluents. In practice, however, imbalances that cannot easily be explained often occur in the process which is very complicated and is influenced by a whole range of variables. Consequently much attention is given to basic research into the process. It is hoped that the information gained will, in practice, contribute towards anaerobic digesters being operated on a more reliable basis.

Anaerobic digestion of wine distillery wastes

Full-scale anaerobic digesters for the treatment of wine distillery wastes, based on research carried out by the NIWR, are already being operated in the western Cape. Research on this project was resumed in 1969 when experiments were conducted with a full-scale digester to determine whether the capacity of the digester could be extended by externally increasing the concentration of sludge and feeding it back into the digester. At the same time studies were conducted with twelve laboratory-scale digesters to investigate factors such as the effect of sustained feeding with wine distillery waste only, the reactivation of digesters which have become less active, and the effect of sludge density on the maximum permissible loading of a digester.

Anaerobic digestion of raw sewage

In collaboration with the Durban Municipality the possibility of anaerobic treatment of sewage without any pre-settling was investigated. The investigation was conducted by means of a pilot plant and the results were very encouraging.

The digester tank can reduce the organic load by 80 per cent or more within 12 hours and yields an effluent which is particularly suitable for water reclamation. Even in cases where water reclamation is not practised, this process probably has advantages over the conventional sewage purification process: primary settling is eliminated while the organic load on the secondary aerobic treatment units is considerably lower. Investigation of this process is being continued in Pretoria.

Guides on water and effluent management in industry

As all industrial effluents have to conform to certain quality requirements laid down by the Water Act, industries are compelled to pay attention to the management of water and effluents. Very often industries do not possess the technical knowledge necessary to meet these requirements, in which case they approach the NIWR to assist them in solving their problems. In an effort to augment the limited knowledge of industrialists on subjects such as the economic use of water, water re-use and effluent treatment, the NIWR initiated the publication of a number of guides on these subjects. In addition to a general guide describing principles which may be applied irrespective of the nature of the specific industry, guides have already been completed for the textile, abattoir and dairy industries. These manuals were specifically compiled to satisfy South African needs and were therefore submitted to panels of experts in the various fields for their recommendations. A guide on water treatment for boilers is at present being prepared.

Disposal of effluents into the sea

At a one-day symposium and conference held in Durban, April, 1969, the Natal Town and Regional Planning Commission in collaboration with the CSIR, released a report entitled *The disposal of effluents into the sea off the Natal coast.* In essence this report covers ten years of research conducted by the CSIR on the disposal of effluents into the sea along the Natal coast, and can serve as a guide to local authorities and industries dealing with the problem of the marine disposal of effluents.

On account of the flourishing tourist trade, sea pollution cannot be tolerated along the Natal coast. In fact, as far back as 1959, the Natal Provincial Administration had approached the CSIR to conduct a comprehensive survey on all aspects of the marine disposal of effluents. The objective of this survey was to establish parameters for natural conditions along the coast, to determine the chemical and physical factors involved in the assimilation of effluents in the sea, and to develop design criteria for marine disposal systems. This entailed extensive research involving the chemical, physical, biological and engineering sciences and eventually not only the NIWR but also the National Institute for Physical Research and the National Mechanical Engineering Research Institute participated in the investigation.

Whereas research conducted on behalf of the Provincial Administration covered the marine disposal of effluents in general, research on specific disposal systems was conducted on behalf of the Durban Municipality and several large industries.

The objectives have been realized to a great extent and three large pipelines leading into the sea are already in opera-

tion while a fourth will be completed shortly. However, research in connection with these pipelines will have to continue to establish to what extent the actual dispersal and mixing of effluents are in accordance with conditions predicted on the basis of research results.

Reclamation of water for domestic purposes from purified sewage

An important milestone in the research programme of the NIWR was reached in January, 1969 when the Prime Minister inaugurated the Windhoek plant for the reclamation of water from purified sewage effluent. This is the first plant in the world which reclaims water from purified sewage for domestic purposes on a large scale and on a permanent basis.

The plant which yields approximately 30 per cent of the city's water is based on a pilot plant which was developed during the period 1962 to 1965 by the joint research efforts of the NIWR and the Municipality of Windhoek. The research was initiated when it was realized that, considering the ever-growing need for water, the available water resources in Windhoek would be inadequate towards the late sixties. Water reclamation was the cheapest proposition as the cost of building new dams far from the city and then pumping the water over long distances was prohibitive.

In addition to the technical problems which had to be solved, public prejudice had to be overcome. This particular problem was satisfactorily solved by keeping the public fully informed on every aspect of the research. Demonstrations for the press and other interested parties were arranged from time to time at the pilot plant. This approach proved so successful that there was no sign of public prejudice when the reclamation plant was finally commissioned.

The importance which the Government attaches to this development is evident from the fact that the Prime Minister, when opening the plant, declared that subsidies to local authorities for the construction of water reclamation schemes may well prove more economical in future than the construction of dams from which water would have to be pumped over long distances.

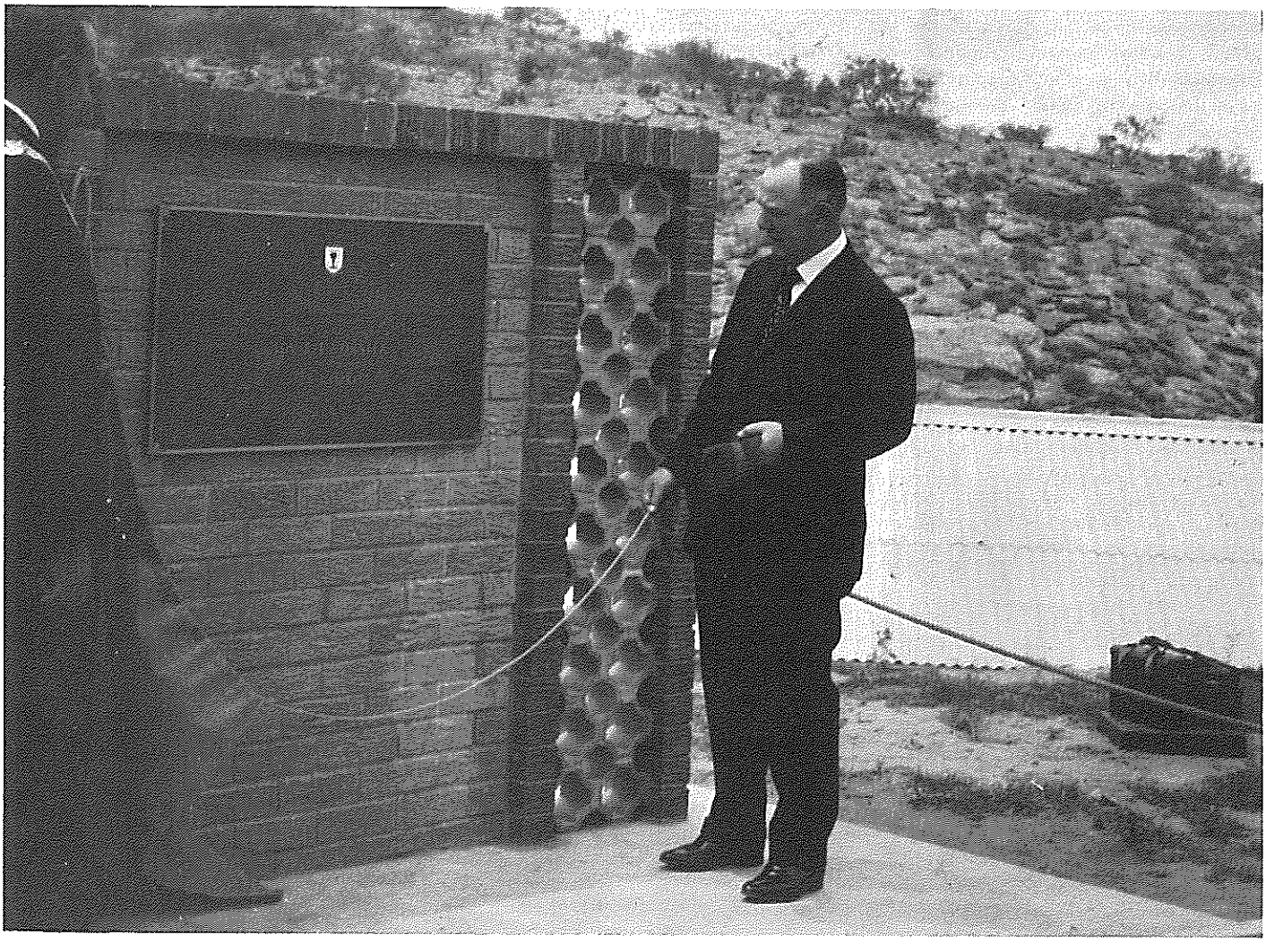
Pilot plant and demonstration plant for water reclamation in Pretoria

Since the completion of the Windhoek project, the NIWR continued its research to refine the process of water reclamation. The investigation was conducted by means of a pilot plant at the Pretoria sewage works. The process has been improved and refined to such an extent that the present process resembles the process in Windhoek in very few respects. The NIWR considers the subject of water reclamation to be of cardinal importance and consequently devotes a great deal of its research effort to it.

A feature of the reclamation process in its present form is that there is no necessity for initial biological purification. Whereas the Windhoek plant uses maturation pond effluent as raw water feed, raw sewage which has undergone only primary settling may be used in the present process. The process is of a physico-chemical nature and as such may be more readily controlled than a system including biological purification.

It is expected that a demonstration unit with a capacity of 1 million gallons per day will be completed by the end of 1969. Its inauguration will probably coincide with the beginning of the Water Year. The plant will serve as a working model in planning large-scale reclamation schemes in the

The Honourable the Prime Minister, Mr B. J. Vorster, unveiling the memorial plaque at the opening of the Windhoek water reclamation plant.



Republic; at the same time it will be used as a display window for the general public in order to propagate the concept of water reclamation.

Use of natural sandbeds in water reclamation

The natural sandbeds of the Cape Flats could possibly be used for the reclamation of water from purified sewage and for storage of storm water.

The NIWR in collaboration with Geological Survey has completed a geophysical survey of the area to determine the underground contours of impermeable layers and sand formations. Promising results have been obtained by means of a gravimeter, an instrument which measures the gravity of the earth very accurately. The instrument is sensitive to variations in the specific gravity of underground formations and can therefore give an approximate indication of the depth of sand layers and solid formations. By means of this technique it will be possible to identify gullies and basins in the underground formation which may be used for the reclamation and storage of water.

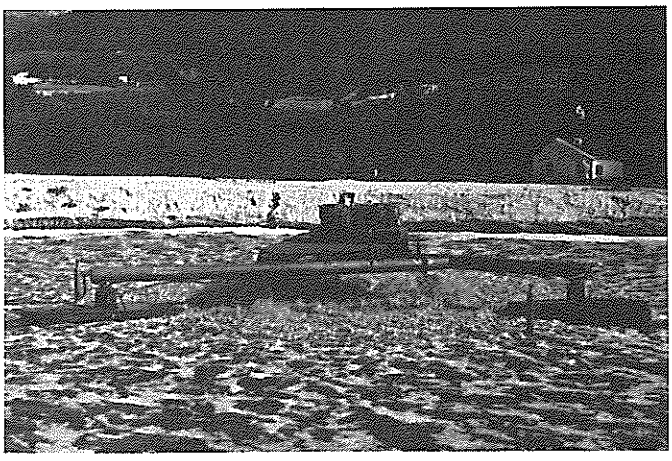
Data collected to date indicate that the bed of the Kuils River was originally far below the present sea level and that through the ages it gradually silted up with sand. The geological structure of the Cape Flats may probably also be utilized in draining storm water. The increasing development of the urban areas of Bellville and Kuils River causes a rapid increase in the flow of storm water which in future may create serious problems with regard to the flooding of the Kuils River. If suitable subterranean drainage to a reclamation area could be found, flooding could possibly be obviated.

Disposal of mineralized effluent

Mineralized effluents emanating from factories cause a number of problems as these effluents, before being discharged into water courses, have to conform to specific quality standards laid down by the Water Act. Mineral pollution of water constitutes a far more serious problem than organic pollution, as organic material may be effectively broken down to simple compounds such as water, carbon dioxide and methane by biological processes. The accumulation of salts in water causes serious problems in the utilization of this water and, moreover, the cost of demineralization is still very high.

The NIWR is at present investigating the possibility of disposing of the mineralized effluent from a pulp and paper factory by irrigation. On test sites experiments are conducted in order to determine the reaction of various plants to mineralized water and also to determine the effect of irrigation on the soil structure over a long period. Parallel tests are also being conducted in lysimeters filled with representative soil samples to study especially the drainage of soils under controlled conditions.

Organisms responsible for the purification of wineries effluent need an adequate supply of oxygen for efficent performance. This is one of the aeration mechanisms being tested by the NIWR.



It is a well-known fact that the use of mineralized effluent is detrimental to the structure of certain types of soil and consequently also their crop potential. At the same time, experiments are therefore being conducted to determine the efficacy of certain types of soil amendment for counteracting the mineralization of soil under irrigation.

The hydrobiology of inland waters

Over the past ten years the NIWR has conducted chemical and hydro-biological surveys of all the economically important rivers in South Africa (with the exception of the Orange River, in which case a survey has only recently been started). Through these surveys permanent records have been built up which may serve as parameters against which future changes in the quality of the river water may be measured.

At the same time research has been carried out on the taxonomy of freshwater diatoms and insects affected by changes in the water quality and samples of the fauna collected have been regularly sent to overseas specialists for identification and description. The mass of data collected over the years will now be consolidated into a number of textbooks on South African hydrobiology.

Fisheries research

The Transvaal Provincial Administration is at present engaged in investigating fish farming as a source of protein food for the Bantu in the northern Transvaal. In order to effect the most profitable conversion of foodstuffs into protein, knowledge must be gained on aspects such as food chains in dams where the fish are bred and on the feeding habits and rate of growth of the fish. The NIWR is studying these aspects at the request of the Administration.

The NIWR has continued its research on the toxicity of dieldrin to fish life. This project has been carried out with the collaboration of the Department of Agricultural Technical Services to whom this information will be of importance, should dieldrin be used on a large scale for pest control.

Pathogenic bacteria, viruses and parasites in water

The NIWR is at present engaged in studies on the incidence of pathogenic bacteria, viruses and parasites in the effluents from hospitals, in raw sewage, in purified effluents and in other water environments. Until now no intensive research has been conducted on these aspects and a great deal of attention has to be paid to the development and improvement of tracer techniques.

Services rendered to Provincial Administrations, State Departments and local authorities

In addition to the fact that the NIWR is engaged in research on behalf of the Provincial Administrations of Natal, the Orange Free State and South-West Africa on a long-term contract basis, the Institute is also often approached by provincial and local authorities as well as by state departments to solve *ad hoc* problems in connection with sanitation, water supply and effluent control.

River research

The flow in the majority of South African rivers is either weak or intermittent and constant vigilance against pollution is necessary since dilution cannot be relied upon to reduce the degree of pollution. It is therefore desirable that intensive chemical and biological surveys of the most important rivers in the Republic should be undertaken as soon as possible in order to establish a point of reference against which the extent of future pollution can be measured. The NIWR has already made surveys of all the economically important rivers in the country with the exception of the Caledon, the Orange and the Fish Rivers. Surveys of these rivers as well as of the rivers in north Zululand, the Berg River, Eerste River, Bree River and Diep River in the western Cape are now under way.

National Nutrition Research Institute

Dr J. J. Theron, Director of the National Nutrition Research Institute until 31st July 1969.

The National Nutrition Research Institute (NNRI) was concerned mainly with improving the nutritional status of all sections of the South African population and determining the influence of various aspects of nutrition on the health of the nation. Over the years the Institute acquired research functions covering a very wide spectrum of scientific endeavour ranging from clinical research to the study of industrial problems in food processing. Following the establishment of the South African Medical Research Council it was decided to transfer to that body those divisions of the NNRI whose functions were considered to fall within the field of medical research. The remaining functions of the former NNRI—research into food processing, food chemistry and the nutritional evaluation of foods—have been retained by the CSIR, but because of the change of emphasis in the activities the Institute has been re-named the National Food Research Institute as from 1st November, 1969. This annual report of the CSIR will consequently be the last to cover the activities of the National Nutrition Research Institute.

NUTRITION RESEARCH DEPARTMENT

Food supplement

The development of a food supplement designed to rectify the deficiencies of a predominantly cereal diet was completed with the addition of an essential quantity of vitamin E after detailed knowledge of its preparation and keeping properties had been obtained. The work done on dietary supplementation has shown once again that, when the level of some nutrients in the diet is raised, this can result in a deficiency of other nutrients which were adequately supplied before the diet had been supplemented. Experimental animals fed for protracted periods on diets supplemented with the NNRI food mixture developed myocardial hyalin degeneration in the absence of added vitamin E. This emphasizes the importance of investigating the adequacy of every nutrient when supplementation studies are carried out.

Biological evaluation of proteins

The economics and efficiency of the biological evaluation of proteins are greatly affected by the uniformity of the experimental animals used and the design of the cages used to accommodate them during the test period. Investigation of the three strains of rats bred at the NNRI has shown that the two strains developed from many generations of scientifically-controlled inbreeding are superior to the random-bred strain. The experience of many years of work in this field has led to the development of a new design of metabolic cage and mechanical cage-washing device. Prototypes have been made and have proved very successful when tested.

The role of methionine in protein depletion was investigated. Urinary nitrogen excretion showed a marked increase during the initial stages of protein depletion, indicating increased loss of non-fatty body-tissues. This increase could be prevented by inclusion in the diet of small proportions of egg protein or L-methionine.

The results of work carried out in recent years on the digestibility of the protein component of a large variety of foods, mainly of South African origin, have been collated and published.

Dietary causes of nephrocalcinosis

The incidence of nephrocalcinosis (formation of kidney stones) in experimental animals fed on diets previously shown to be nephrocalcinogenic was considerably reduced by increasing the magnesium content of the diet.

International Biological Programme

Under the auspices of the International Biological Programme, the Division of Field Studies has been mainly engaged in the coding, analysis, interpretation and reporting of the two surveys carried out in 1968 on rural and urban Venda. Reports on the clinical, somatometric and haematological observations have been completed and those dealing with the socio-economic and dietary aspects are in the final stages of preparation.

The statistical analyses were aimed at studying the effects of age on the variables measured as well as investigating differences between the rural and urban Venda populations. The somatometric and clinical observations indicate that, in general, the nutrition status of the urban Venda is significantly higher than that of the rural members of the tribe and that for both groups nutrition status deteriorates with increase in age.

Nutrition status survey of a Bantu township

At the request of the Department of Health the NNRI has undertaken to investigate the nutrition status of the inhabitants of a Bantu township. The proposed survey will include an assessment of the nutrition status of the population and an investigation into the relationship between socio-economic and nutrition and health status.

Survival

A manual on survival techniques is being prepared in collaboration with the Department of Defence. For this purpose a pilot study was carried out on army personnel to determine the minimum knowledge required to identify edible wild plants.

Cancer incidence

The Institute has taken over from the National Cancer Institute (National Institutes of Health, USA) the task of providing statistical guidance to the Transkei Bantu Cancer Registry. It has also assumed responsibility for the coding, analysis and statistical interpretation of the results obtained by this Registry.

The main purpose of this work is to identify factors which may be associated with the extremely high incidence of oesophageal cancer which is found in certain areas of the Transkei. The incidence of cancer in all parts of the body is also being studied.

Mycotoxins and liver cancer

Thorough toxicological evaluation of the major toxic metabolites of fungi isolated from foods was undertaken as part of an investigation into the possible relationship between mycotoxins and liver cancer.

Aflatoxin has received attention on a world-wide scale due to its potent carcinogenicity to a wide variety of species. A study was made of its effects on certain constituents of the cell nucleus and it was found that aflatoxin combines physico-chemically with nucleic acids and enzymes controlling nucleic acid metabolism. This interaction with genetic material may account for the carcinogenic activity of the toxin.

Sterigmatocystin, the major toxic metabolite of three fungi *(Aspergillus versicolor, A. nidulans* and *Bipolaris sp.),* was studied for toxicity in rats and monkeys. It was found to be less toxic and carcinogenic than aflatoxin. Studies of the changes produced in the liver of rats on a diet containing sterigmatocystin revealed that only the liver cells were affected and that, unlike aflatoxin, sterigmatocystin had had no apparent effect on bile-duct cells. These changes are morphologically similar to changes observed in Bantu patients from a "liver-cancer area".

Other toxins such as ochratoxin and cyclopiazonic acid have been tested for carcinogenicity in rats with negative results.

Analytical techniques for the determination of these toxins have been developed so that surveys of their occurrence in foods could be undertaken. A procedure has been developed for the assay of aflatoxin, sterigmatocystin and ochratoxin in the same extract.

The possibility has also been investigated of collaborating with scientists in Mozambique on this problem. A collaborative team has been organized and the procedures for the study drawn up. At present samples are being collected for laboratory tests from the highest-incidence area.

Kwashiorkor and pellagra

The nutrition status of a selected group of Bantu children at Hammanskraal was investigated and the effects of nicotinic acid and riboflavin supplementation on this group were determined.

In addition the Institute has undertaken a complementary study of the amino-acid patterns of the serum and urinary proteins and of the vitamin and general nutrition status of a group of kwashiorkor and pellagra patients. Except for the amino-acid analyses the investigation has been completed.

The glucose and lactose tolerances and the disaccharidase activity in the small-intestine epithelium of a group of pellagra and kwashiorkor patients have been determined. The results are being prepared for publication.

The liver function and the total body-potassium-contents of kwashiorkor patients were investigated in collaboration with the Life Sciences Division of the Atomic Energy Board. Intravenous radio-active material was used to determine the rate of absorption and excretion of the isotope by the liver.

A study of the composition of milk from Bantu and White women has been completed and the results are being prepared for publication.

Iron metabolism

Following the finding that bile contains appreciable quantities of iron, a study of the absorption of bile iron was initiated.

Millions of people throughout the world are in need of iron therapy. It has been found, however, that current procedures

Mr J. P. de Wit, Acting Director of the National Nutrition Research Institute from 1st August to 31st October 1969, and Director of the National Food Research Institute as from 1st November 1969.

do not always ensure adequate iron absorption. It is possible that the use of bile iron may provide a solution to the problem.

For this purpose ^{59}Fe was injected intravenously into patients who required external drains from the common bile duct after gall-bladder operations. The radio-activity of bile collected for 6 hours after the iron injection was determined, and the bile was administered to a healthy person through an intraduodenal tube. The absorption of bile iron was measured by determining the radio-activity of the whole body and by measuring the excretion in the stools. The results obtained from two test subjects showed that the radio-activity in the bile administered was too low to permit accurate estimation of the iron absorption.

Further investigations are envisaged.

Gastroscopy and oesophagoscopy

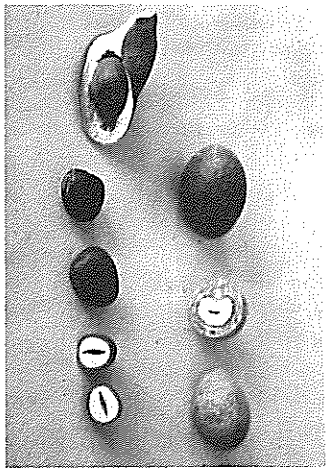
More than 400 gastroscopies and 100 oesophagoscopies were carried out and two papers dealing with the techniques developed were presented at the 47th South African Medical Congress. The use of the oesophagoscope and the gastroscope has been greatly stimulated by the work done by the NNRI clinic at the H.F. Verwoerd Hospital and the application of these instruments has proved so successful that it is now a routine procedure in the hospital.

By using the gastroscope it has been established that, although the incidence of gastric ulcer and cancer among the Bantu population is still low, these diseases are not entirely absent, as was once thought. As it seems possible that the frequency of incidence may be influenced by changing food habits resulting from the adaptation and development of the Bantu population, a long-term survey is planned.

Oesophageal cancer is the most common form of cancer among Bantu males in Pretoria, as it is in the Transkei. However, there is a great difference in the ratio of incidence among males and females in the two areas, namely 15 to 1 in Pretoria and only 2 to 1 in the Transkei. This great difference is at present still unexplained.

Infective hepatitis and cirrhosis of the liver

Information obtained so far in the long-term study of former sufferers from infective hepatitis indicates that this disease is not the main cause of the high incidence of liver cirrhosis among the Bantu population.



(Right) Mangetti fruit.
(Left) *Bauhinia esculenta* seed.

Tuber of *Bauhinia esculenta.*

Atherosclerosis and coronary heart-disease

The Division of Physiological Chemistry previously concerned itself mainly with the biochemical recognition of metabolic disorders which may lead to the development of atherosclerosis. Appropriate dietary regimens have been compiled for the three basic types of metabolic disturbance found to be associated with coronary heart-disease. For patients with an inhibition of carbohydrate metabolism a dietary regimen limiting caloric intake and providing the majority of calories from unrefined carbohydrate is used. For those patients with a primary defect of the lipid metabolism a diet is prescribed which limits the total caloric intake and decreases the fat intake as far as is permitted by the essential fatty-acid requirements of the body. In cases of over-active carbohydrate and fat metabolism, patients are required to consume a number of small meals during the course of the day, instead of the customary three large meals, in an effort to counteract the prolonged hypoglycaemia which is commonly found in this group.

The results of the surveys on Pretoria school children revealed that the blood serum of the White children contained appreciably more cholesterol than did that of the non-White groups. Intercorrelation of the biochemical and dietary parameters showed a significant positive relationship between the intake of fat and animal protein and increased serum-cholesterol concentrations. It is thus evident that if it is possible to decrease the incidence of coronary heart-disease in a population by decreasing serum-cholesterol content, it will be necessary to introduce dietary changes at a very early age—preferably in infancy. The importance of such a procedure is accentuated by the fact that there is a pronounced tendency for habits acquired in youth to be retained throughout the entire life span.

Since it is impossible, for ethical and practical reasons, to conduct research on atherosclerosis on a molecular-biochemical level using human subjects, it is necessary to use experimental animals. Previous experiments using rabbits had to be curtailed owing to recurring infections, especially of *Pasteurella*. It was therefore decided to use primates (baboons) as experimental animals, as they are not only much less susceptible to infections than rabbits but their physiology resembles that of man much more closely. The animal experiments conducted in this context are intended primarily to determine the basic cause of atherosclerotic-lesion development.

Thus attempts are being made to develop techniques which could be used to measure changes occurring in the arterial walls, liver, heart muscle and blood of the experimental animals in order to assess the basic causes of the derangement of metabolic processes which lead to atherosclerosis. For this purpose enzymatic and pathological examinations of these tissues, glucose-tolerance tests, and lipid and hormone analyses of the blood serum are being carried out.

FOOD SCIENCE AND TECHNOLOGY RESEARCH DEPARTMENT

Composition of South African foods

The Division of Food Chemistry continued its investigation of various edible wild fruits and also determined the composition of the oil contained by some of them.

The mangetti fruit *(Ricinodendron rautanenii)* is an important item of the diet of some Bushmen and Bantu tribes in Southern Africa, both the fruit and the kernels being eaten. It is classified as a primary food of the !Kung Bushmen of the Dobe area in Botswana.

The kernel of the fruit contains about 50 per cent of oil which is rich in linoleic acid, one of the essential fatty acids, as well as about 20 per cent of two unidentified fatty acids. Attempts are being made to separate and identify these two acids, which are probably isomeric.

The seed of *Bauhinia esculenta* is another important food of certain Bushman and Bantu tribes.

Rancidity of fats and oils

Some Bantu tribes have traditionally used the root of witgatwortel *(Boscia albitrunca)* to keep milk and butter fresh. This phenomenon was investigated and the claims made regarding the preservative properties of the root were substantiated; milk stored at 30°C remained fresh for 24 instead of 12 hours, when only 0.5 per cent of the powdered freeze-dried root was added. The treatment also prevented the development of mould growth, which occurred in the control sample. In addition, unsalted butter prepared from cream similarly treated remained in good condition for 27 days when stored at 30°C, although a slight, but not unpleasant, foreign flavour was imparted to the butter.

Experiments are being conducted to attempt the isolation and identification of the active principle (or principles) in the root with a view to possible industrial application.

Mealies

The acid-hydrolysis process normally used for the production of glucose syrups and dextrose requires virtually pure starch as basic raw material. The present large-scale commercial production of standardized starch-splitting enzymes has suggested that a process based on enzyme hydrolysis using dry-degermed maize grits may be economically preferable. Preliminary investigation has shown that good yields of dextrose can be obtained by such a process.

In storage studies on maize meal it was found that cotton fabric was a more satisfactory packing material than polyethylene film for storage in conditions of low or moderate relative humidity, but at relative humidities exceeding 75 per cent polyethylene was preferable. The development of rancidity in maize meal is dependent on the grade, and thus on the fat content. It was found that this relationship is particularly noticeable during storage under high humidity. Investigation of the sorption characteristics of maize meal showed that the differences between equilibrium moisture contents for the three grades were approximately inversely proportional to the fat contents for all relative humidities.

The effects of different cooking and pre-cooking procedures on the physical, chemical and nutritive properties of maize meal are at present also being studied.

Flavour chemistry

The isolation and investigation of the substances which collectively constitute the flavour of roast groundnuts when freshly roasted and during storage was continued. Valuable information regarding the polycyclic aromatic components of the flavour has been obtained.

Powdered-fat products

The work on the preparation of powdered fats intended primarily as ingredients of commercial "convenience mixes" was concluded with the completion of storage tests.

Mixing or blending techniques

The mixing or blending of granulated or powdered solids is a fundamental operation in many processes used in the food and other industries. The degree of homogeneity obtained in such processes is greatly affected by many factors, such as the relative particle-size, specific gravity and shapes of the individual components being mixed, the design of the apparatus used, the time of mixing and the quantities of ingredients.

A mixing problem was encountered in the manufacture of the NNRI food supplement and the investigation that followed was extended to determine the most economical and effective procedure for enriching mealie meal with micro-proportions of vitamins and to obtain information on general mixing problems that would be of value to industrialists.

Air Pollution Research Group

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.

Air pollution from automobiles

For periods of several weeks measurements were taken, in the streets of Pretoria, Johannesburg and Durban, of the pollutants associated with automobile engines, viz. carbon monoxide, hydrocarbon vapour and oxidants. The concentrations found were not high enough to indicate that immediate control of motor-car exhausts is necessary.

Metallic and other fumes

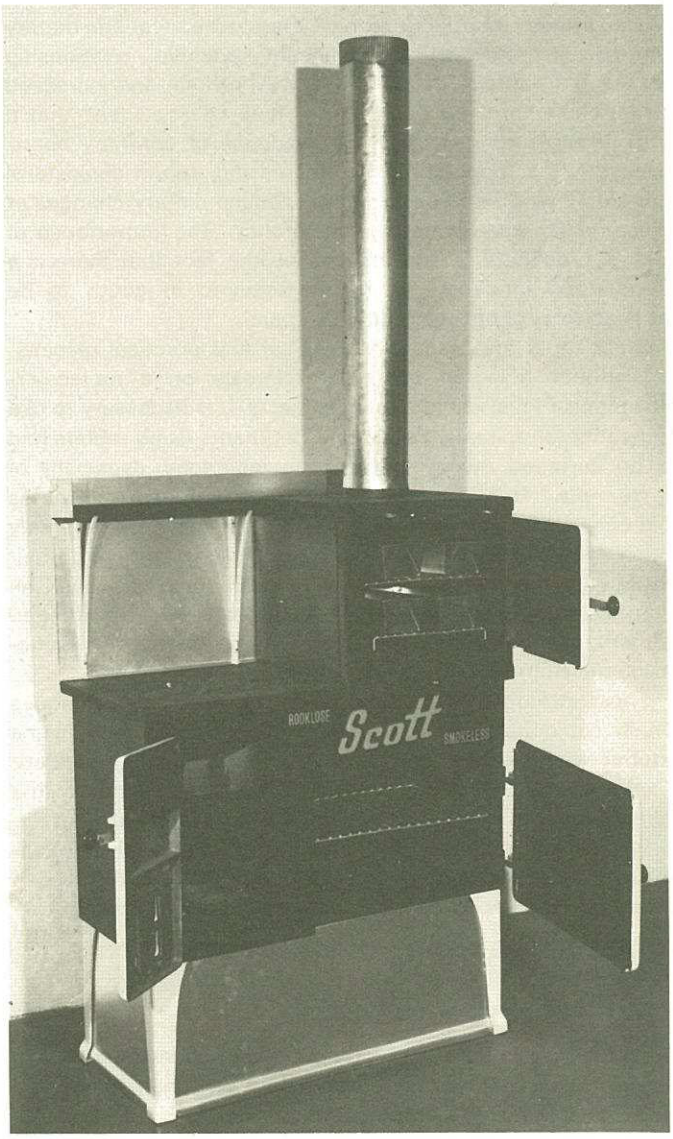
A programme has been started in which large volumes of air are aspirated through special filters and the metallic and other fumes thus captured are submitted to spectrochemical analysis. In this way information will be obtained on the substances which occur in the air of the major cities of South Africa. Substances which have been found, and which were expected, are iron, lead and aluminium. Others found, to mention two, are barium and titanium, which were not expected.

Visibility at airports

Measurements were made at two South African airports to determine the extent to which smoke is causing reduced visibility for pilots making landings. By correlating smokiness with wind direction, information was obtained about the urban communities from which the smoke was drifting onto the airports.

Siting of industries

Because the Nelspruit area is being planned for industrial expansion, the National Air Pollution Advisory Committee requested that a study be made of the local atmospheric circulation in the neighbourhood of Nelspruit. Measurements of wind speed and direction are being made at a number of points over a six month period and temperature gradients, atmospheric stability, and wind directions are being measured at heights of up to eight hundred feet above the ground. With the aid of these measurements, the probable effects of the establishment of industries at a number of possible industrial sites around the town will be studied.



The Scott Stove which was evaluated for performance and acceptability by the Air Pollution Research Group. It is smokeless when burning anthracite and is one of a number of household devices which will eventually ensure clean air in the Bantu townships.

National Institute for Personnel Research

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

The optimum utilization of labour resources is of the utmost importance in South Africa with its acute manpower shortage, especially in respect of skilled labour. 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 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 maladjustment to work, e.g. absenteeism, accidents, occupational disorders and group conflicts.**

Trends in personnel research at the NIPR

The NIPR's work is hampered by a progressively more acute shortage of experienced and highly qualified senior staff.

The topics of research projects show a notable shift in emphasis from applied projects aiming at the selection of manifest abilities and skills towards more basic research projects concerning aspects of the development and training of skills.

About one quarter of the research projects completed or under way involve problems of development, learning and training. Ten out of 60 projects deal primarily with learning and/or training. They range from experimental investigations on the effects of verbal versus practical training on conceptual reasoning, and the effects of acculturation and education on the structure of mental abilities to training manuals for front-line supervisors.

One third of the enquiries and requests for assistance directed to the NIPR still concerns selection problems or the installation of selection test batteries and more than half of these enquiries are related to Bantu labour. Usually "operational surveys" involving, among other things, job analyses, job descriptions and classifications have to be undertaken prior to the introduction of selection procedures. In some cases it has been possible to train staff members of the sponsoring organizations to conduct the necessary analyses themselves. This together with a "manual for job analysts" which is nearly completed, not only frees the staff of the divisions involved for other research activities, but also helps the organizations concerned to obtain a clearer insight into their own personnel and management problems than they would have been able to do before having prepared some of the material on which the operational survey is based.

The design of programmes for programmed instruction has become a very urgent need. In response to one specific request a training course in programming techniques was held for programme writers outside the NIPR. This may well prove the solution for meeting the growing demands for programme writing in future. By training outsiders to do essential preparatory work research projects which would otherwise have to be postponed or abandoned can be completed.

In basic psychological research, the methodological "new look"—into the processes that lead to responses rather than the mere analysis of the responses themselves—can be applied most fruitfully. Basic research projects, apparently theoretical in nature, have provided insight into important developmental factors which are of practical use. For example, recent evidence has shown that intellectual functioning at the conceptual level will be inadequate in adult life, if certain experiences during the pre-school and primary school years have been lacking. From the completed first phase of the NIPR's contribution to the investigations into human adaptability which form part of the International Biological Programme (IBP) it also appears that the change from a tribal-rural to an urban-industrial environment has relatively less influence on the structure and level of primary mental abilities than the massive effects of school education. This means that the adaptation from a rural environment to an industrial way of life can be quite satisfactorily effected, provided an adequate school education is available.

One of the problems contributing to occupational mobility and labour turnover is the widespread lack of "competition" for the White worker seeking employment in the Republic. Such a situation is unhealthy and is bound to lower the standard of work and work morale. It is not known to what extent this could influence the productivity of the White worker, nor would a ready solution be available if a negative effect on work behaviour were found. Several measuring instruments are at present under construction at the NIPR which will make feasible studies of work morale and motivation under varying conditions.

RECENTLY COMPLETED RESEARCH

Aircraft noise

A sociological survey with the aim of assisting in establishing a norm for aircraft noise annoyance in the vicinity of airports was carried out on behalf of an auxiliary committee of the Department of Planning. The survey was done in collaboration with the Aeronautics Research Unit of the CSIR National

Mechanical Engineering Research Institute. A distinct relationship was shown to exist between the noise intensity index, as established by the Aeronautics Research Unit, and its sociological effects as revealed in personal interviews with residents. It was also shown that positive identification with a residential area can compensate for aircraft noise annoyance. Some residents did, however, express the opinion that aircraft noise could become a serious problem in the future.

Training for the building trade

A study of employers' attitudes to the recruitment and training of building trade apprentices was completed and reported at the Conference of the Federation of Building Trade Employers. It was recommended that the skilled building artisan should function at a higher level with added supervisory responsibilities while the more routine aspects of his task should be taken over by semi-skilled Non-White labourers. A further recommendation was that apprentices for the building industry should be trained at special training centres.

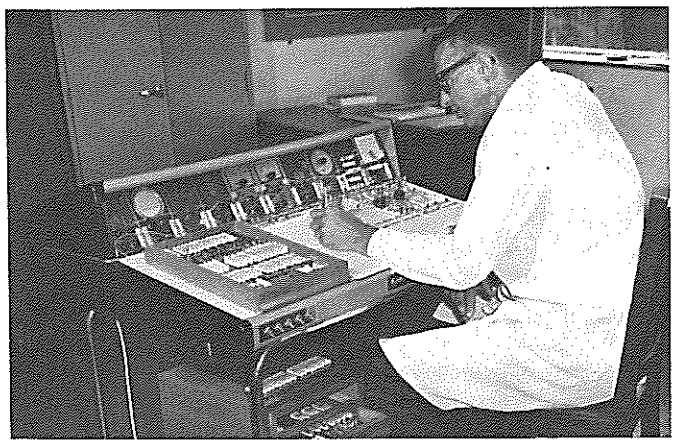
The Bantu in secondary industry

An investigation into the job expectations, job attitudes and work motivation of Bantu workers in secondary industry was sponsored by the Bantu Wage and Productivity Association. Apart from good wages the importance of security of employment and opportunities to acquire useful skills were especially stressed in the findings. It was also found that the Bantu in the industries studied do not yet think in terms of a career, but are inclined to take the first job they can get. Little evidence was found of positive work motivation which would result only from an identification with one's job. The recommendations therefore stressed the importance of training managerial and supervisory personnel in dealing with Bantu industrial workers in the transitional phase.

Road safety

A series of investigations on human factors in road safety and the effectiveness of the communication system through road signs and markings was undertaken on behalf of the National Institute for Road Research. Reports were submitted on the different phases of the study. There are grounds for hoping that the recommendations may contribute towards more effective implementation and maintenance of communication between road authorities and road users by means of signs and markings. In general, the main hypothesis of the study was confirmed, viz. 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 act on them in preference to the signs.

The Gajon Electronics Teaching Desk being used in the application of programmed instruction.



Programmed training

An investigation into the role of personality factors in programmed instruction led to the conclusion that programmed instruction not only eliminates the influences of individual differences in learning techniques or strategies, but also appears to eliminate to a considerable extent the effects of personality factors. There is, however, an indication that differences on the extroversion-introversion scale are related to conceptual learning by programmed instruction as extroverts tend to do better.

Psychological dimensions

A study relating to the evaluation of existing techniques and the development of new techniques for studying psychological dimensions was completed. A report on this research has appeared as an Educational Testing Service Research Bulletin since parts of the investigation were carried out while the project leader was studying at this centre in Princeton, USA.

CURRENT RESEARCH

Staff selection and training

In collaboration with the South African Computer Society a project has been initiated to design a selection system for personnel in the field of electronic data processing. The project can be seen as a model in scientific personnel selection since it started with careful job analyses of computer operators, programmers and system analysts, followed by the design of an appropriate selection procedure, a detailed criterion study and the development of a criterion schedule for the appraisal of performance.

Human adaptability

Practical problems relating to the selection and training of Bantu industrial workers have underlined the necessity of studying the organization of mental abilities of a labour force in transition towards urbanization and industrialization. Such a project forms part of the International Biological Programme. Its first phase, that is an analysis of aspects of the mental ability structure of urban and rural Venda, is nearing completion. 'Acculturation' in the sense of the adoption of an urban rather than rural way of life raises the level of intellectual performances, but does not significantly change the structure of interrelated abilities. Formal school education has an even stronger effect on the level of performance and tends to lead to a change in the interrelation of abilities.

Electronic equipment

A project designed to develop a training procedure for front-line supervisors has been undertaken in a factory which lends itself well to the assessment of production performance as it produces electronic equipment. The training system utilizes programmed instruction and the preliminary results obtained with three training manuals are promising. If successful this scheme can prove very valuable in the vitally important field of supervisory training.

Enquiries

A steady stream of requests for information and/or research assistance in the field of personnel work has reached the NIPR and has been dealt with. Enquiries from African states were fewer than usual. Three enquiries were received from Malawi concerning selection of Bantu workers, and seven from Rhodesia; five of the latter concerned selection of Bantu, the other two selection of Whites.

A considerable number of enquiries on programmed instruction and learning programmes has been dealt with—eleven of these in connection with Whites, and four in connection with Bantu pupils.

About one fifth of the enquiries received during the year came from outside the Republic.

National Institute for Road Research

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

The 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 is affiliated to the Institute and also makes an annual contribution to research costs.

Highway planning

In fulfilling the primary function of providing roads for the safe and economic transport of persons and goods under all weather conditions road authorities are confronted with the problem of advance planning in order to anticipate and determine the demand for highway facilities.

The Economics Group of the NIRR has undertaken a study of various methods used for long-term planning and suggested a method of predicting the expected future date at which the level of service on any particular route would no longer be satisfactory. Use is made of concepts developed in the *U.S. Highway Capacity Manual* and the proposed method consists of specifying a terminal level of service, calculating the service traffic volume at this level, and estimating the number of years likely to elapse before existing traffic will reach this critical volume.

The traffic volume of the terminal level of service is calculated by multiplying the maximum number of vehicles per hour a road can accommodate under ideal conditions by several adjustment factors to take account of lane and shoulder widths, lateral clearances, the amount of heavy truck traffic in the traffic stream, passing sight distances and road speeds on each highway route under consideration. The number of years before the critical service volume on each route is likely to be reached is then estimated by making use of the compound interest law.

By this method, which is simple to use in practice, information is obtained on when and where improvements are required. Since definite predetermined service standards are used, it also ensures that only worthwhile projects are considered. By stating the nature of the required improvements an indication of the financial requirements in each time interval over the planning horizon is obtained. Furthermore, due to the simplicity of the method the plan may be revised at any stage to take account of changes in circumstances and conditions.

Calcretes for roadbuilding

Research on calcretes which was undertaken by the Institute as part of a special contract investigation for the South West Africa Administration some years ago, was recently concluded.

Calcretes are common features of semi-arid lands everywhere but as they are normally of little economic importance they have not been well studied. In 1963, however, they assumed new significance in South West Africa where the Administration was faced with the task of building good all-weather gravel and black-top roads through the vast sand-covered areas of Ovamboland, the Okavango, Bushmanland and the South-west Kalahari. The only road-building materials known to be present were wind-blown sands and calcretes and the road-making properties of both these materials were little known and somewhat suspect. In addition, calcretes are often covered by many feet of sand and are, consequently, difficult to locate.

One of the general conclusions drawn from this study of calcretes over the Republic as well as South West Africa is that they represent the second most important group of road materials in the Republic, and probably the most important in Southern Africa. Some of the important achievements in this work have been the classification of calcretes into six basic types and the gaining of considerable knowledge of the composition of calcretes and of how they were formed. They are basically of two types: those which form by precipitation above a shallow water table and those which form through the downward leaching of calcareous parent materials by infiltrating rainwater. They form a definite sequence and this has simplified their classification. A new theory of calcification based on changes in soil suction has also been developed.

Furthermore, useful methods for prospecting for calcretes have been devised and a combination of air-photo interpretation, topographic setting, vegetation indicators and the use of a simple probing device is recommended. The engineering properties of the six basic calcrete types are now reasonably well defined.

Calcretes appear to self-stabilize in some roads and this has now been proved to occur in the laboratory. The strength properties of lime-stabilized calcretes are controlled by the amount of micro-fossils present. Some calcretes yield higher strengths when stabilized with lime than with cement. Because of their unique properties as road-making materials, the normal specifications do not properly apply and revised specifications for using calcretes have been drawn up.

Heavy traffic and damage to roads

The damaging effect of heavy truck traffic on roads has been clearly established by road experiments overseas, including the AASHO Road Test in the USA. This test revealed that a single vehicle with axles overloaded by 8,000 lb will cause as much damage to a road foundation and surface as five trucks with axles loaded only to the legal limit of 18,000 lb or as much damage as 25,000 large passenger cars.

In order to protect the existing road system in South Africa—in which an estimated R1,800 million has now been invested—it is essential that the axle loads of present traffic be measured, and the porportion of overloaded axles be determined. This will assist authorities in taking action against the owners of vehicles which cause such disproportionately severe damage. In addition, for purposes of designing new roads the axle loads of vehicles using the existing system must be determined and those of vehicles which may use the road over a 20 to 30 year design life be predicted.

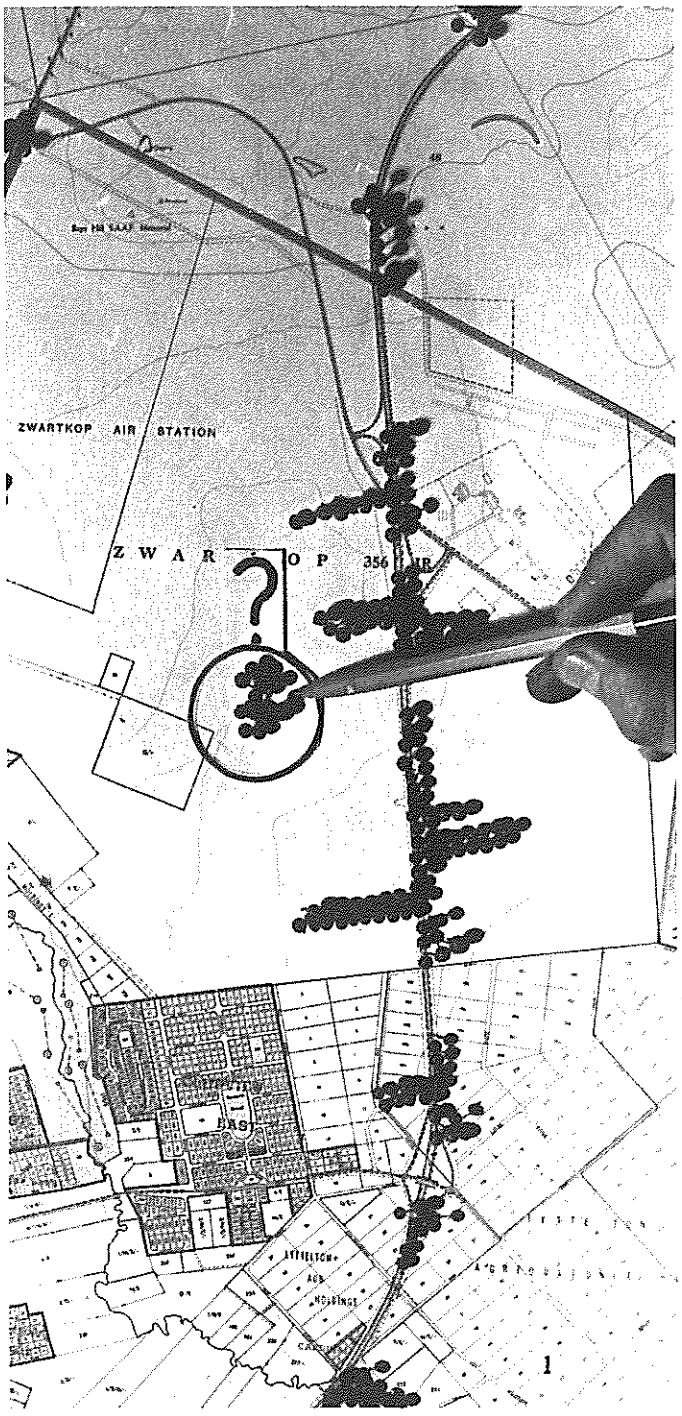
Up to the present time there have been no simple methods of obtaining this information and the very few axle load surveys that have been conducted have required a major effort involving a large team of technicians. This has also caused considerable delays to traffic as only stationary loads could be measured. A portable axle load distribution meter being developed by the Institute overcomes many of these problems as it can be operated by a team of two and causes no congestion as the loads are recorded while the flow of traffic continues. This instrument in essence consists of a quarter-inch-thick rubber pad which is laid on the road surface and an analyser which classifies passing axles into 4,000 lb weight groups and then counts them.

The previous static weighing procedures were generally only conducted over an 8-hour daylight period on a single day, but the automatic nature of the new instrument permits it to be used continuously over a longer period, and a week has been found convenient. This has the advantage that the mean distribution over a longer period is determined and also that measurements are obtained around the clock and not only during normal working hours.

Results given by the Institute's instrument on some roads have in fact revealed that a greater number of overloaded vehicles operate at night than during daylight. Typical results for one road carrying heavy traffic reveal that on this particular road an alarming proportion of the vehicle axles exceeded the legal limit. These results show that some 80 per cent of the damage to the foundations of this road is being caused by the 16 per cent of axles that exceed the legal limit.

Milestone with route number indicated. If all roads were marked in this manner, police authorities could easily identify accident localities.

Spot map showing locality of accidents on certain roads. If the locality of the accidents pointed at were also known it would be easier to determine which road improvements were necessary.



Reference system for roads

Planned road improvements and law enforcement to reduce accidents appreciably are based on the study of a limited number of hazardous locations selected from accident records. This basis is founded on two general research findings, viz. that an appreciable proportion of the accidents on the road network occur on a relatively small part of it and also that the accident distribution pattern is very consistent from year to year. The NIRR has been closely associated over a number of years with improving the way in which accident records are kept so that they may better serve as a foundation for planning. Improved methods have been evolved for processing accident reports and for analysing, presenting and interpreting accident data.

A prerequisite for such records is accurate pin-pointing of accident sites on the road network, especially in rural areas where cross-roads and other landmarks are far apart. Inaccurate designation of accident sites on rural roads has always been a serious problem and has prevented suitable summaries being prepared for use by road engineers and law enforcement officers.

In an effort to improve the precision with which accident locations are recorded on police record forms the Institute has provided maps to some selected police stations. Very little improvement, however, could be detected as accident reports continued to be returned for analysis without a proper identification of the accident location.

From this experience, and also from a study of how this problem of location identification is handled in other countries, it may be concluded that no significant improvement is possible until an adequate identification system is provided for the whole of our road system, both urban and rural.

Within built-up urban areas accident localities are usually and most accurately described in terms of the 'street grid system, but in semi-rural and rural areas the name of the road or its reference number and the actual position on the road in relation to a permanent identifiable feature, such as a mileage figure from a known datum, are often difficult to identify. Even if a milestone giving a figure to a tenth of a mile can be found it is seldom possible, without further additional investigation, to identify the official designation of the road.

Evidently, a system of markers at 0.1 mile intervals on all roads showing not only a distance but also the official designation of the road would be the most satisfactory method of ensuring accurate recording of accident locations.

This Institute has made representations to the road authorities, through the Metrication Department of the South African Bureau of Standards not only to take special care that no additional confusion of accident recording is caused when existing milestones are replaced by 'kilostones' but to take advantage of the opportunity to establish a uniform system of roadside marking throughout the country. Police authorities will have to be kept closely informed of whatever action the various road authorities take in this matter if continuity of recording is to be preserved.

Metrication

With the impending change to the metric system of weights and measures in South Africa the Institute decided to make an early start with studying the new system and its implications for laboratory work and research reporting. A committee set up at this Institute was eventually joined by representatives of the Department of Transport and the Metrication Department of the South African Bureau of Standards to serve as a sub-committee to study and recommend suitable SI units (metric) to replace the multiplicity of Imperial and other units used in present day road engineering practice. A document incorporating these recommendations is now available to all engineers.

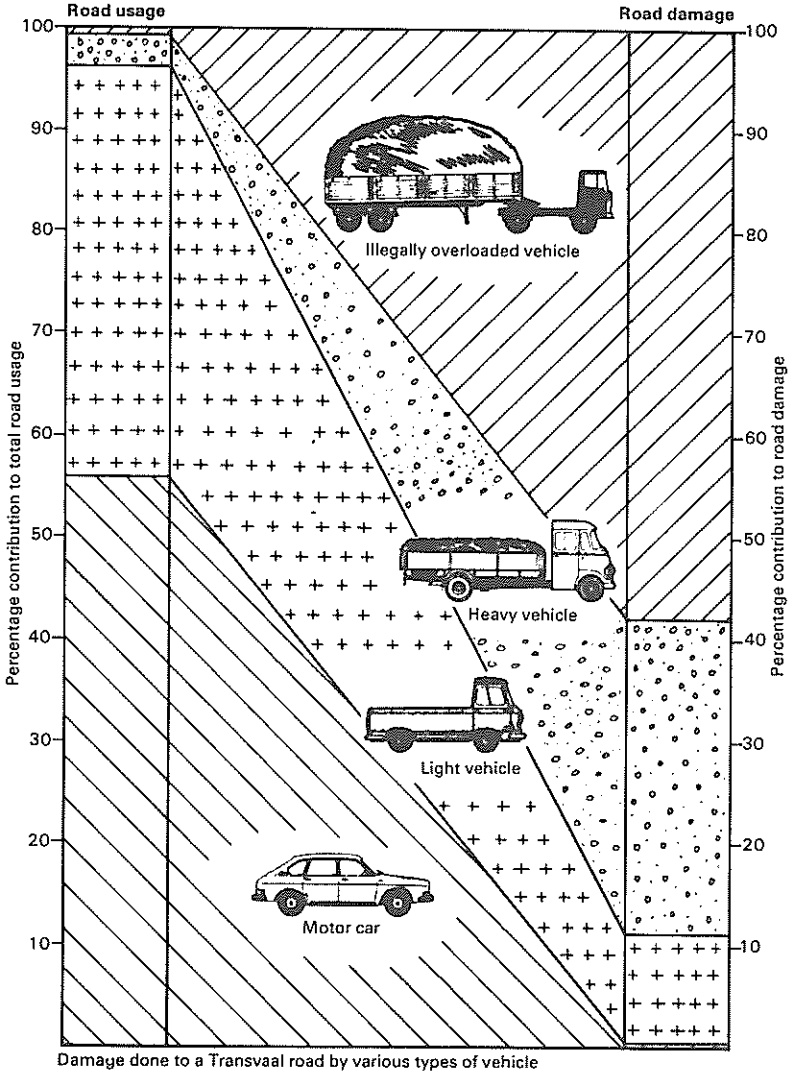
Information centre

The world wide 'information explosion' has also influenced the road industry. While those actually engaged in designing, building and maintaining roads might only be vaguely aware of the vast mass of technical literature written on all aspects or subjects which affect them the research engineers and scientists have an obligation to keep themselves informed of the latest available knowledge.

To illustrate the formidable task which would confront anyone attempting to keep abreast of all aspects of research on roads one has only to cite the latest issue of *Highway Research in Progress* which lists 5,000 items of information on active road research throughout the world. There is, of course, an equally voluminous output of technical information describing completed research and techniques in a wide field ranging from practical road building to the subtleties of human behaviour related to traffic accident involvement.

During the year an information centre has been established at the Institute to receive and process literature and assist the Institute's own research staff in keeping abreast of the latest developments in all subjects relevant to this Institute's work. Apart from this 'current awareness' activity the Information Centre is able at this stage to assist in a limited way in making literature searches on particular topics.

All literature produced by the Institute is also disseminated through the Centre. While the immediate objective is to meet the needs of the Institute's own research programmes adequately, the longer-term objective is to act as a clearing house for information for the whole road industry of Southern Africa.



Damage done to a Transvaal road by various types of vehicle

National Building Research Institute

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

In South Africa about 1,000 million rand is spent annually on building and construction (excluding roads). The purpose and function of the National Building Research Institute (NBRI) is to serve the industry and professions behind this multi-million rand investment.

In order to achieve its goals the NBRI maintains close and effective contact with the building and construction industry, related professions, public bodies, property developers and financing organizations as well as the building public as a whole. The NBRI is in essence an organization for applied research with the aim of obtaining, processing and disseminating information directed towards improving building design and services, structural and foundation engineering, building materials, lighting, ventilation, building economics and other aspects of building.

Its research has been instrumental in improving the performance of a wide range of building materials and the environment prevailing within a building. In this a better understanding of the effect of climate and weather plays an important part.

Special service is rendered to the community through research into the planning of hospital facilities, schools and housing for all population groups. Investigations are also being undertaken in the fields of management, organization and industrialization in the building industry.

The Institute and its regional offices in Cape Town, Durban and Windhoek pursue an active policy in disseminating research information by means of research publications, films, lectures, symposia and by replying to about 20,000 enquiries per year.

The NBRI obtains about a third of its income through grants-in-aid and earnings from a considerable number of contract investigations. Financial sponsorship by the private sector has increased considerably in recent years. Substantial grants-in-aid have been made by both private and public bodies.

The steadily growing demand for research from all sectors of the building and construction industry and the building public at large, whilst being in itself most gratifying and indicating the need and usefulness of building research, is a matter of some concern. It is in the national interest that services should be promptly and effectively rendered, but long-term research into problems of general national importance should also be given due consideration. With the present critical shortage of qualified manpower and funds and a growing demand for its services it is becoming increasingly more difficult for the Institute to maintain a healthy balance between these two demands.

Building and Construction Advisory Council

The Institute has been closely associated with the Building and Construction Advisory Council and its work, particularly on metrication, modular co-ordination, statistics, the rational use of computers in the industry and the development of a formal procedure for the evaluation of new techniques of construction, materials and components.

Agrément Board

As a result of the Building and Construction Advisory Council's energetic efforts and acting on its recommendation the Honourable the Minister for Community Development and Public Works has recently established the Agrément Board of South Africa. This Board has its Secretariat in the NBRI and performs functions similar to those of Agrément organizations in Great Britain and Europe. In collaboration with the appropriate bodies the NBRI will test novel and unorthodox building systems and new materials, after which the Board will issue certificates of approval for these systems and materials. These certificates should be of great value to central, provincial and local government agencies, both as clients and as building control bodies, as well as to the professions and to industrialists offering such techniques and products. It is expected that this Board will give impetus to the design and rational use of industrialized building methods in this country, leading to increased productivity and more effective utilization of manpower.

New NBRI divisions

Recently the Institute has established an Evaluations and Performance Criteria Division and the Civil Engineering Division has been split into the Fire, Drainage and Concrete Engineering Division and the Structural Engineering Division.

Regional offices

The regional offices in Cape Town, Windhoek and Durban have continued to provide spesialized services related to local problems for which there is a growing demand.

Committees and congresses

During the past year staff members participated in the work of over 100 committees serving the interests of different facets of the building and construction industry.

The Second South African Building Research Congress was held in Johannesburg during the period 5th to 8th May, 1969 and was attended by approximately 400 delegates, ten of whom were from neighbouring countries. Altogether thirty papers were read including the Congress keynote address on the building industry in South Africa, and seven papers presented by leading overseas authorities on the world building scene.

Films

A Film entitled *The buildings in your life,* which illustrates the role played by building research in industry and the community, was produced by the Information and Research

Services in collaboration with the NBRI and had its première during the Second South African Building Research Congress.

Operational research

A survey was carried out to determine the potential role of the NBRI in propagating operational research in the building industry. Based on experience in operational research both at the Institute and in industry, and the trends of research activities overseas, it was concluded that the NBRI would, initially at least, have to carry out operational research projects rather than study the techniques.

In order to obtain first-hand experience of the problems involved in the more general application of critical path analysis this technique was used in the construction of a new building.

Computers in building

Some work was done on adapting a package computer programme to suit the special needs of building projects. At present the NBRI is collaborating with planning consultants and the Department of Public Works on the planning of two large construction projects.

A survey of the present and potential use of computers to improve efficiency in the building and construction industry, indicated that the greatest need at this stage is for co-ordination on a national basis. It has therefore been proposed to the Building and Construction Advisory Council that a standing committee on computer application be formed for this purpose. The proposal has been very well received and is being implemented.

Architectural planning

In present architectural planning research the emphasis tends inevitably to fall on the development of working demonstrations together with the transfer of technical know-how, design and architectural management planning to those who will implement the recommendations or new techniques that emerge from the research.

Current projects are concerned with new audio-visual educational techniques and equipment, housing in hot, dry climates, the hospital sterile operating enclosure, and pre-cooked frozen food service systems for hospitals. A new project concerns briefing methods and procedures for large, continuing building programmes.

Building and the sun

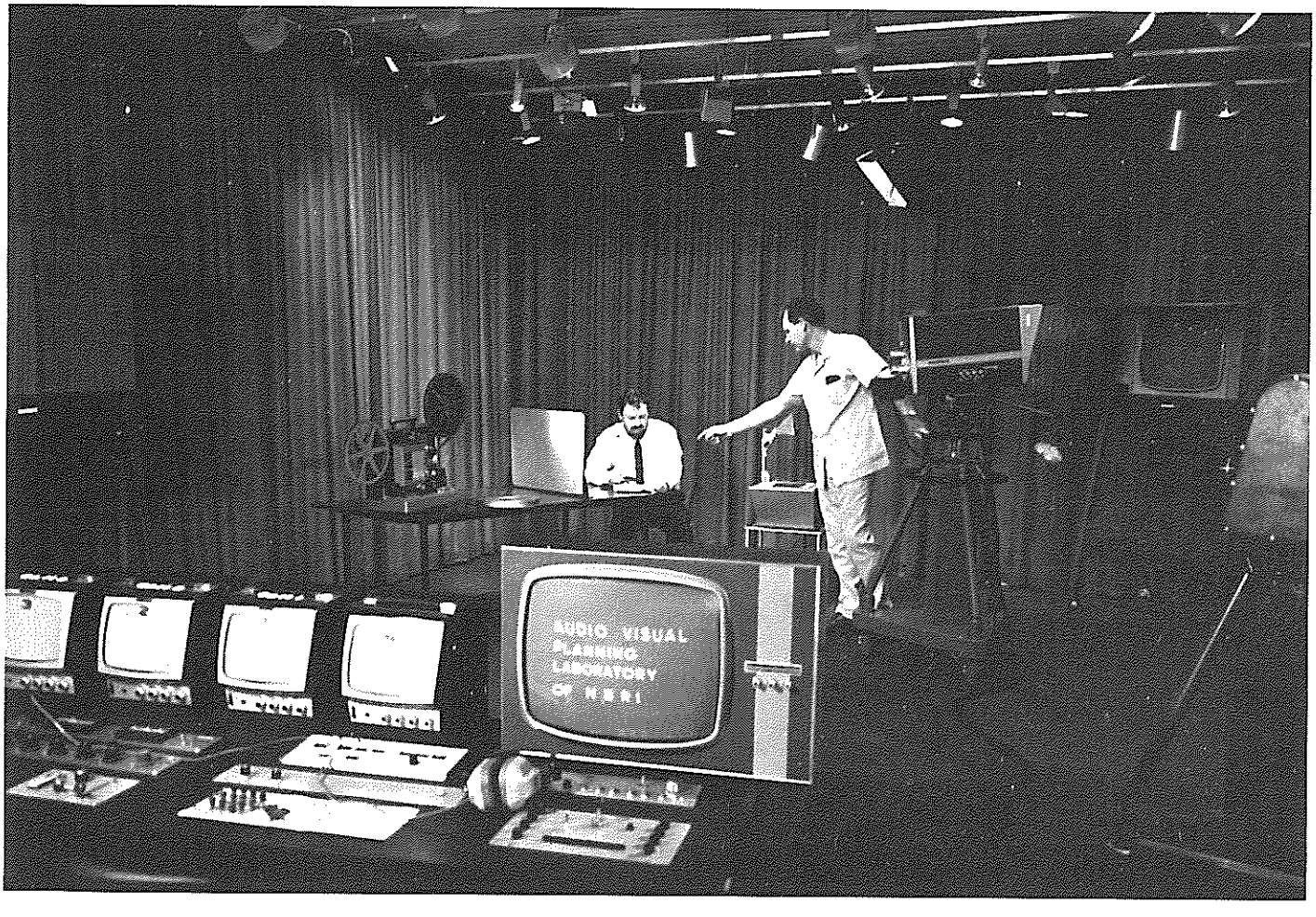
Architects and planners are becoming increasingly aware of the influence of solar radiation on the performance and durability of buildings. To simplify the design procedure and its application a relatively simple instrument, the solar shadowscope, has been developed.

The solar shadowscope permits the convenient visual observation of sun and shade patterns in and around a building for any given place, time and day of the year. With a scale model of the building or part of it, an adjustable table on which both the model and the instrument can be mounted, and a source of light, a good deal of design information can be obtained. The device has been considerably improved and the new modified instrument promises to be a most useful design tool.

Air and moisture penetration through windows

As a result of the ever increasing height of modern buildings and a consequent increase in wind pressure the air and moisture penetration characteristics of windows are becoming more and more important. Designers in general are aware of some of the problems but there is virtually a total lack of valid performance criteria for local conditions. This gives rise to demands that are completely unrealistic in practice. Moreover, they are often either excessively costly or unsatisfactory.

Planning for the use of audio-visual teaching aids.



One of the biggest problems in determining design criteria is the shortage of information regarding the occurrence of wind-driven rain. Moreover, on the basis of experience and understanding of the principles involved, provisional criteria have been prepared for high buildings in Cape Town and Durban.

Inorganic materials

Increased activity in the building industry and the concomitant shortage of bricks, building blocks and other building units have stimulated interest in the manufacture of alternative masonry materials. Recently numerous enquiries have been received. Assistance has been given and investigations have been conducted into raw materials and the manufacture of burnt clay bricks, concrete blocks and bricks, and sand lime bricks. The latter are of particular importance in those parts of the Republic and South-West Africa where clay deposits are scarce and face bricks very expensive or where there is a shortage of bricks.

Industrialized building, especially those systems in which large concrete prefabricated units are used, has stimulated interest in the use of light-weight aggregate as a replacement for ordinary sand and stone. By adopting special firing techniques certain shales, clays and waste products, such as coal ash, may be processed into light-weight aggregates. The results of a number of investigations in this connection are very promising.

Considerable progress has been made in the investigation of ceramic raw materials found in Southern Africa. Data sheets on the occurrence, mineralogy and characteristics of roughly forty raw materials have been published. These data sheets have been very well received by the industry and are considered by manufacturers of ceramic products to be of exceptional importance to this rapidly developing industry.

Ceramic colours based on local zirconium dioxide have already been successfully developed. Further progress has also been made in the rapid firing of bricks, and in the manufacture of tiles and the glazing of fired clay products.

The durability of building materials is of considerable importance as maintenance is expensive and more often than not such work must draw labour from the ranks of those who could be used to advantage on new building projects. Research in this field has the dual purpose of improving the durability of building materials and developing methods whereby durability can be predicted or assessed. Many failures involving materials have been investigated to determine the reason for the failure, to make recommendations as to how and what repairs can best be effected, and to gather information on techniques which can be devised to improve the quality of building materials. One such problem is that in some parts of the country, notably the North-Western Cape, the Karroo and South West Africa brackish water quite often causes deterioration and disintegration of concrete structures such as storage dams.

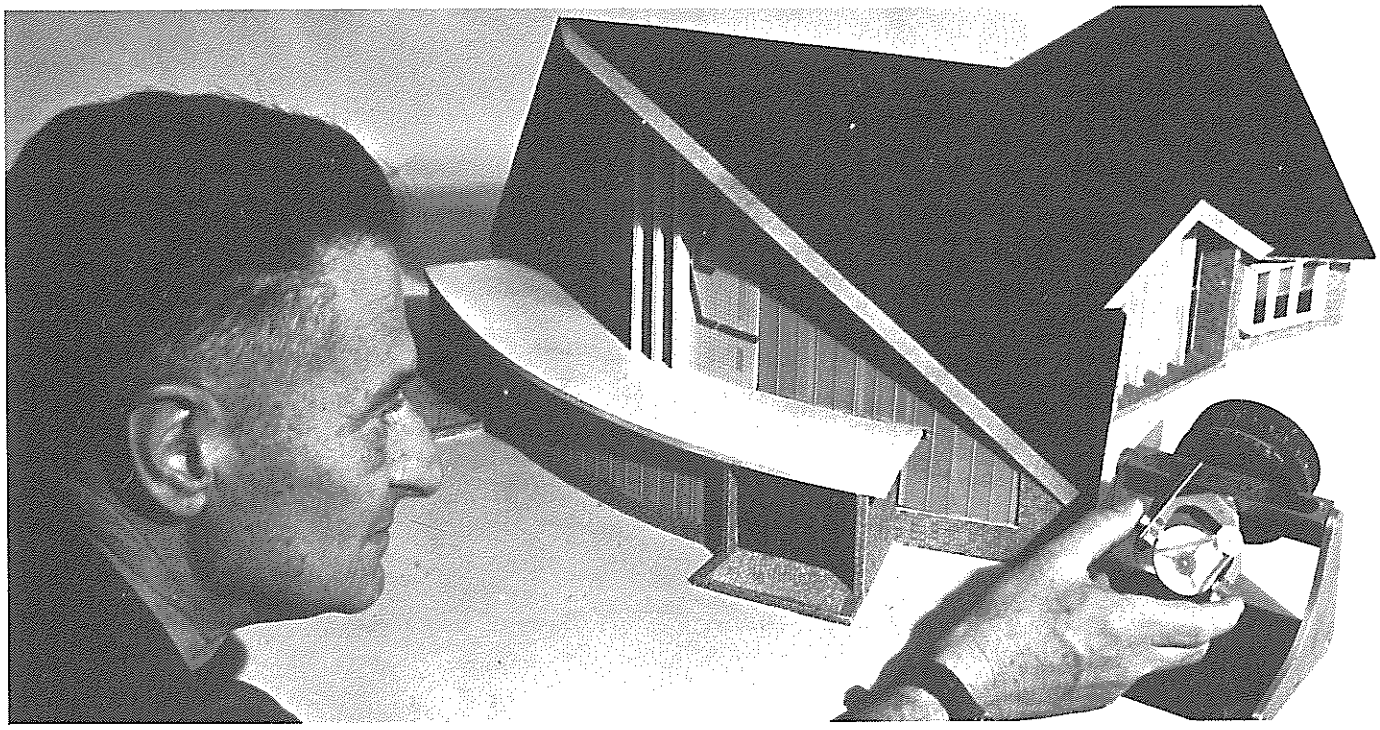
Organic materials

Two diametrically opposed attitudes are prevalent with regard to the application of organic materials in the building industry. The one considers plastic materials to be the panacea of building problems while the other regards these materials as the cause of all problems. Much of the NBRI's work in this field involves reconciling these divergent attitudes and inducing a realistic approach to the use of organic materials in the building industry in South Africa, as well as improving their quality.

Organic materials have poor resistance to outdoor weathering when compared with traditional inorganic building materials, particularly on the South African highveld. Investigations into the durability of these materials under outdoor exposure are therefore being continued. The correlation between accelerated and natural weathering is known to be poor but it is hoped that certain accelerated test procedures which will reproduce in a relatively short time those types of failure encountered in practice will be developed so that unsatisfactory materials can be avoided or improved.

The increasing use of foamed plastic materials (mainly polystyrenes and polyurethanes) as insulating materials in places where there is a fire hazard, is becoming a cause for concern as the products formed when they burn may be poisonous. A project is therefore being undertaken to investigate the products of thermal decomposition of these materials. The toxicity and amount of vapours produced and the temperatures at which the materials decompose are being studied.

The solar shadowscope being used to obtain design data.



Epoxide resins remain of interest and the effects of repeated cycles of wetting and drying on the bond between epoxide resins and concrete are being investigated.

The results of the long-term assessment of paint systems for hot-rolled structural steel have been correlated and analysed. Of the 900 systems originally exposed, only 30 systems of two or more coats provided protection for 6 years. With the conclusion of this investigation more basic work has been undertaken in the field of pigment-binder ratios for emulsion paints.

An investigation into the performance of water-repellent stains for externally exposed timber has shown that these stains can only be expected to last for about as long as clear varnish but that the stains have a distinct advantage in that they may be easily and cheaply re-applied to the timber.

More attention is now being paid to the use of elastomers in building and equipment is available for the compounding of certain of these materials. The possibility of producing building material from locally produced raw materials, particularly styrene-butadiene rubber, is being investigated.

Prefabricated brick building panels

The common brick is now finding application in the construction of walls by the most modern techniques of industrialized building.

Brick masonry panels, prefabricated in a factory by semi-mechanized techniques and suitably joined together on the building site to form walls of houses and other buildings are already in use in Europe. Research in the Institute and collaborative development work in industry, have shown that the manufacturing process for such panels can be considerably accelerated by the use of special techniques which achieve rapid consolidation of the mortar. This newly developed process has now been patented. Apart from the proved durability and aesthetic appeal of bricks this system promises savings in labour and the possibility of industrialization at a low cost.

This work has been undertaken on behalf of the South African Brick Association and a major brick manufacturer is now actively developing the process for commercial exploitation.

Fires in high buildings

Recent investigations have indicated that insufficient precautions are apparently being taken in South Africa to prevent the start and spread of fires in high buildings. Furthermore, fire escape routes are often not properly designed.

Major faults that have been encountered are, amongst others, large, undivided floor areas combined with combustible ceilings, spaces between ceilings and the underside of the floor above inadequately fire-stopped to prevent fires spreading in them, air-conditioning ducts without automatic cut-offs, vertical shafts without adequate fire-stopping measures, and stairways without suitable means to control smoke hazards.

In view of the increasing number of high buildings now being erected it is of great importance that steps be taken to rectify this situation and the Institute is studying both how this can best be done and how the results can be applied in practice.

Jointing of sewer pipes

Underground sewer pipelines are subject to a variety of influences which tend to cause failure of the joints between pipes and consequent loss of watertightness. Particularly difficult to combat, especially in the case of salt-glazed earthenware pipes, are the lateral and longitudinal forces associated with movements of the surrounding soil.

Research of the latest overseas developments in sewer-pipe jointing, coupled with laboratory tests on locally available joints of various types enabled workers at the Institute to evaluate the performance of joints for a wide variety of pipe materials under simulated field conditions.

Foundations on expansive soils

Over the years the Institute has devoted a considerable amount of research effort to the behaviour of foundations on expansive soils. Comprehensive and detailed data on building movements resulting from foundation movements that are caused by expansive soils have been collected. Methods of predicting movements have also been devised.

The Institute has therefore concentrated on movements as such. In other countries where expansive soil conditions are found very little attention has been paid to actual movements and instead the swelling pressure has been considered as a major criterion of expansiveness of the soil. Soil densities are therefore taken into account whereas in the observation of movement the focus is on moisture changes. In order to assess the influence of the various factors involved, a programme has been initiated to investigate the interrelationship of moisture conditions, density swelling-pressure and the amount of swell.

It is hoped that this comprehensive research approach will lead to more accurate methods of prediction and may also indicate measures to reduce the influence of these heaving soils on the foundation of buildings and the resultant serious damage to the structure.

Urban Bantu housing

On behalf of the NBRI the Institute for Social Research of the University of Natal has investigated the prevailing socio-economic position of the urban Bantu. This study forms part of the total research project aimed at reappraising urban Bantu housing and has been designed in such a way as to satisfy requirements set by the planners who will eventually interpret and translate the data into performance criteria for the specific dwelling units and urban planning.

International activities

The NBRI has continued its membership of a number of working groups of both the International Council for Building Research, Studies and Documentation (CIB) and RILEM and considerable benefits are derived from this participation. The Director of the Institute, who was elected a member of the CIB's executive in October last year, attended two committee meetings and several other meetings of this body during the year. As a member of Council of the International Confederation of Thermal Analysis, he also had discussions with this body.

In recognition of the role the Institute has played in the field of soil mechanics, a representative of the NBRI was invited to serve on the discussion panel dealing with expansive soils at the 7th International Conference on Soil Mechanics and Foundation Engineering in Mexico City in August, 1969.

On the occasion of the Second South African Building Research Congress, leading members of the building and construction industry and the NBRI had the opportunity of discussing problems and matters of mutual interest with leading authorities in the field of building research from America, Australia, Canada, France, New Zealand, Portugal and the United Kingdom. There was a steady demand from overseas for the Institute's publications and films. Increasing international recognition of the Institute is a highly gratifying development. In collaboration with the French building research organization a comparative study was undertaken into the effects of South African climatic conditions on a range of French plastic materials. Such close association with other building research organizations, particularly when it permits personal contact, is vitally important in that the cross-fertilization of ideas and knowledge resulting from such contact is of inestimable value. This is particularly true today with the rapid advancements and changes in building technology.

Timber Research Unit

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

The Timber Research Unit (TRU) offers a wide variety of specialized research and technical services to both producers and consumers of forest products. The main purpose of the Unit is to further timber technology, through research and development, for the benefit of the forest products industry. More specifically the aims of the Unit are:

- **to promote effective utilization of South African timber resources**
- **to assist in developing satisfactory products**
- **to assist in developing and improving manufacturing processes**
- **to promote effective use of timber products**

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

WOOD PROCESSING

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

Seasoning

The recently proclaimed regulations, which now govern the compulsory grading and marketing of sawn and processed structural timber grown in the Republic and certain neighbouring countries, have served to emphasize the importance of seasoning and the need for improving present-day kiln drying practice.

Research is being done on those factors in the drying process that affect the quality and serviceability of South African timbers, and on ways and means of either eliminating or reducing seasoning degrade. The programme involves studies of dimensional changes in timbers, stacking methods, seasoning treatments, and the effect of inherent defects on seasoned timber.

Timber drying efficiency

Research aimed at developing both a suitable method for evaluating the efficiency of timber-drying processes and a kiln suitable for South African conditions, was undertaken in collaboration with the Techno-economic Division.

In preliminary work on this project, timber-drying efficiency was defined, the cost of drying soft-wood timber in compartment and progressive kilns was determined, and progress was made with the development of quality standards for the input and output timber. This information will provide a basis for further work to promote drying efficiency by reducing costs or increasing revenue either by improving present methods and practices or by developing new techniques and apparatus.

A kiln performance standard was compiled and, in collaboration with the Department of Forestry and the South African Bureau of Standards, a code of practice for timber seasoning in South Africa, which will incorporate such a standard, is being prepared.

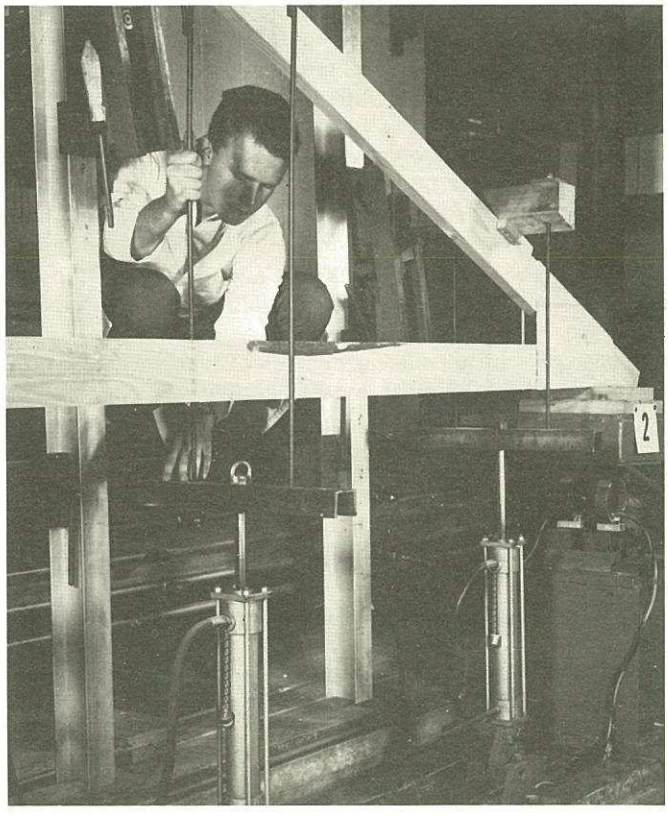
Board products

Chipboards made with an adhesive derived from wattle bark extract were found to be as good as or better than boards made with the synthetic resin adhesives that are normally used.

TIMBER ENGINEERING

The Timber Engineering Division has continued with its three main projects which it hopes will culminate in the production of economical standard roof designs.

A prototype roof truss with plywood joints being prepared for testing in the TRU test rig.



Stress-grading

Satisfactory progress is being made with development of the mechanical stress-grading method for application in the local timber industry. Structural timber will be classified into grades, each having safe, reliable and realistic design stresses assigned to it in order to utilize the full strength-potential of the available material. All preparatory work has been completed, and the main research programme is currently under way. Early indications are that machine stress-grading of South African pine timber will be very much better than current visual grading practices. A prototype Selectometer, a machine to grade timber with respect to moisture content, twist and dimensional tolerances, is being designed and manufactured by a private firm on behalf of the Unit.

All the information needed to enable industry to grade scaffold boards of three species of structural softwoods by machine, has been published in a comprehensive CSIR Research Report. Practical application of the new grading method to structural timber in the Transvaal is foreseen for 1971.

Joints

Work is in progress to develop specifications for nailed plywood joints for roof trusses, using local materials. A pilot study on non-proprietary, nailed metal gusset plates is also being made. The intention is to provide the building industry with more efficient truss joints which can be made on site.

Roof trusses

Progress is being made with a programme to develop sound, economical, standard designs for roof structures in South African timber that can be fabricated on site or by industrialized methods. It is expected that the first designs will be available early in 1971.

As a result of considerable expansion in the market for factory-produced roof trusses, attention is being given to the development of a standard procedure for the prototype testing of timber trusses in South Africa. A paper on this subject was read at an international meeting in London.

FIBRE AND CHEMICAL RESEARCH

Preservation of paper

The mechanism of paper deterioration during aging was elucidated and the parts played by various aging factors were indicated qualitatively. This work is being continued in order to establish the quantitative effects of these factors. The findings so far have made it possible to give preliminary recommendations for the restoration and preservation of archival documents.

Requirements for pulpwood

The relationship between pulp quality and the properties of pulpwood are being determined in order to establish criteria for the best types of tree for pulping. Wood fibre morphology is one of the most important factors that influence pulp quality; the measurement of fibres in length and cross-section therefore plays an important part in the investigation. Statistical analysis of the results will produce regressions which will eventually be used in the breeding of improved trees.

TECHNO-ECONOMIC STUDIES

The main purpose of the Techno-economic Division is to provide an economic background against which research projects can be identified and evaluated and guided. The Division now has the following three main functions:

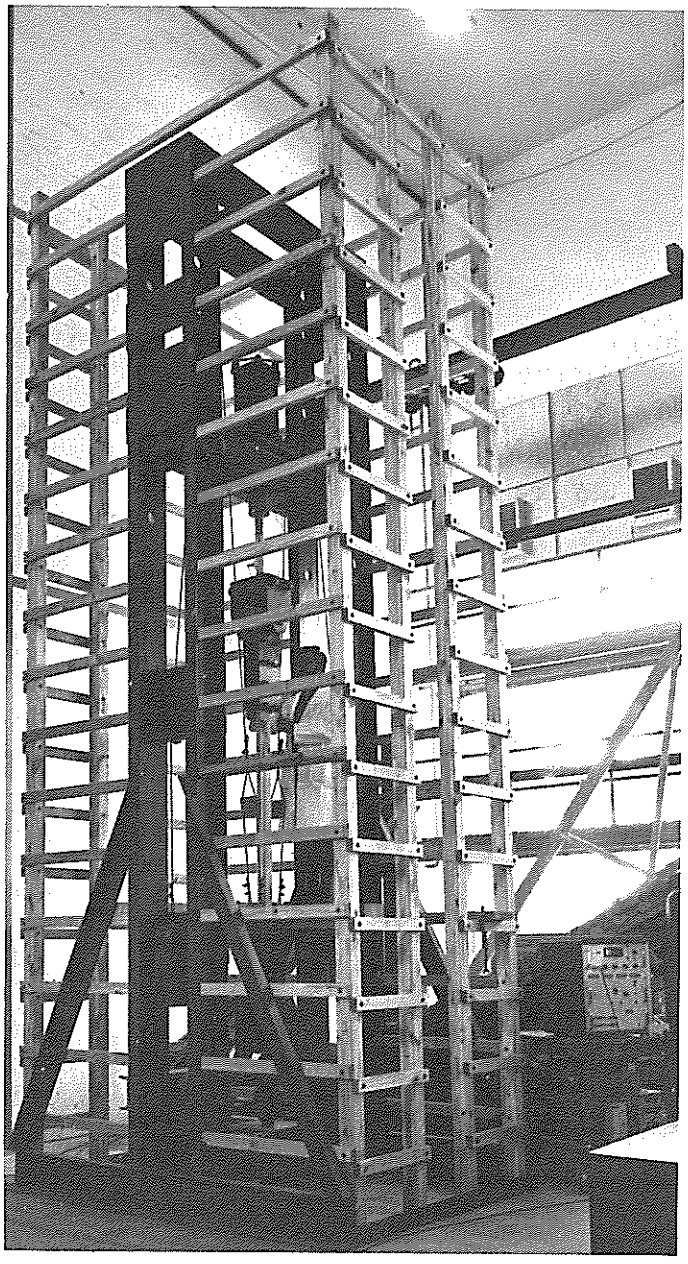
- to undertake techno-economic studies which will assist in defining the research objectives of the Timber Research Unit
- to study the economic aspects of technical projects
- to conduct industrial engineering investigations by applying modern management techniques and operations research, with the ultimate objective of increasing the efficiency of research projects as well as that of processes in the timber industry.

During the past year an analysis of timber consumption trends in South Africa revealed not an oversupply but a situation of rather serious undersupply of timber.

A cost study of the manufacturing of roof trusses in South Africa was made in order that any new types of trusses that are developed will be economically competitive with traditional trusses.

A long-term project to determine and improve the efficiency of seasoning timber which will result in a cost reduction or increase in revenue was initiated. A next stage in this project will be to improve drying practices at sawmills in South Africa.

An apparatus developed by the TRU for testing full-sized structural timber in tension parallel to the grain.



South African Wool Textile Research Institute

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

Although 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.

During the year the Institute once again proved that it can make a major contribution to international wool and mohair research, fundamental as well as applied. Particularly good progress has been made with the conversion of mohair into end-commodities and with a study of the dimensional stability of knitted fabrics.

As a result of the progress made in the latter field, the local industry and also, significantly, the Product Development Laboratories of the Internatonal Wool Secretariat (IWS), have sought closer collaboration with the Institute. In order to share the Institute's advanced knowledge of the dimensional stability of knitted fabrics with other interested parties an international symposium on knitting was organized at the University of Port Elizabeth. Papers were read by SAWTRI's staff members and also by prominent textile scientists from overseas.

The Research and Development Committee of the IWS is due to meet for the first time in South Africa during April, 1970. To coincide with this important meeting the Institute is already making arrangements for an international symposium on dyeing and finishing.

The following paragraphs reflect some of the Institute's most important achievements over the past year.

Fundamental wool protein research

Following upon its achievement in isolating the first pure wool protein fraction and determining its complete amino-acid residue sequence, as reported in the previous annual report, the Fundamental Wool Protein Research Group in Pretoria has established the following properties of this fraction (SCMKB-IIIB2):

- the molecule can be divided into a high-sulphur and a low-sulphur region
- the amino-terminal peptide, acetyl-Ala-Cys-Cys, and the carboxy-terminal residue, cysteine, correspond to similar groups in another much larger protein isolated from SCMKB by Australian workers

Fibre entanglement in scouring

It has been established that the fleece breaker, hitherto widely used to open wool before scouring, causes excessive fibre breakage. The use of this machine is therefore to be avoided wherever possible.

Optimum speeds have been determined for the harrows and for the squeeze rollers of the Petrie and McNaught pilot-scale scouring train. While a reduction in the normal speed of the auxiliary harrows is feasible, complete synchronization with the major harrows is not advisable.

The felting caused when wool tumbles down the incline of the spill-over to the squeeze rollers can be prevented by increasing the capacity of the liquor circulation pump so that the wool floats right into the nip of the rollers.

Hopper feeding of wet wool into the dryer causes a great deal of fibre entanglement. This can be prevented by replacing the hopper with a conveyor belt. Adjustments to the rate of feeding to ensure a steady ribbon of wool through the machine improve the openness of the scoured wool. The increased feed thus required necessitates in turn settling tanks of greater capacity for the larger amounts of matter removed from the wool during scouring and also to provide the correct wool to liquor ratio.

Circle temperature and combing performance

It was shown that the "withdrawal force" of the ingoing slivers is of overwhelming importance in the production of minimum noil and is also the deciding factor in the selection of the correct temperature to be used at any given setting. The temperature pattern changes and eventually reverses when more open settings of the outside drawing-off rollers are used.

When the amount of ether-extractable matter was over 2.4 per cent it seemed to have an effect similar to that of a wool with a higher withdrawal force. Below 2.4 per cent the pattern was not affected. When the withdrawal force was low a minimum percentage of noil was obtained from a given wool, whether combing for the first time or recombing, when the outside drawing-off roller setting was close, the ether-extractable matter low, the large circle cold and the small circle hot. In no instance could heating of the circles be dispensed with altogether but judicious selection of the temperatures used did produce significant improvements in the percentage noil level. Heated circles were necessary when the withdrawal force was high.

The results of this work may be of immediate economic importance to the combing industry, as its implementation would lead to lower noil production during combing and thus effect a reduction in the conversion cost of the top.

The combing of mohair on the French comb

Combing trials were carried out on BSFH mohair (37 microns) employing a St. Andrea Novara rectilinear comb.

The percentage of noil produced during rectilinear combing was linearly related to the gauge setting of the comb but decreased with increasing gill feed at a constant gauge setting. The mean fibre length in the top and the noil decreased

somewhat when the gauge setting was increased slightly but increased again at still higher gauge settings, indicating that higher fibre breakage took place at increasing gauge settings.

The mohair fibres in the top were significantly longer than the kemp fibres left behind in the top, while the lengths of the two types of fibres in the noil were about the same. In Noble combing, however, the kemp fibres in the noil had a significantly greater mean fibre length than the mohair fibres.

The kemp content of the different components was not significantly affected by varying the settings of the rectilinear comb although there was a tendency to remove more kemp at higher gauge settings. However, as the percentage of kemp in the noil was much lower in rectilinear combing than in Noble combing, tops obtained in the latter process contained less kemp than French-combed tops.

The percentage fibre breakage increased significantly with an increase in gauge setting but then decreased rapidly at the very wide setting of 32mm. More fibre breakage occurred at medium gill feed settings and the best combing performance was obtained at high settings.

Spinning of mohair

Influence of additives—The spinning performance of BSFH mohair (37 microns) on the Continental system improved markedly when as little as 10 per cent of a coarse wool (26 or 30 microns) had been mixed with the mohair.

Antistatic additives, which also increase interfibre friction and sliver cohesion, gave the best results as regards the spinnability of mohair. An indication of the performance to be expected during spinning can be obtained by measuring the withdrawal forces of the slivers.

A new processing system—For many years the processing of mohair was restricted largely to the Yorkshire area where the Bradford system, incorporating the draft-against-twist principle, was found to be ideally suited to the processing of long fibres such as mohair.

When mohair was spun at SAWTRI on the Bradford (cap, ring or flyer) system or on a combined Bradford/French system, it was found that yarns from relatively fine mohair fibres were stronger, more regular, and could be spun to finer counts than yarns from coarser mohair. Yarn strength also increased with fibre length. Cap-spun yarns were more hairy, stronger, and could be spun into finer yarns than ring or flyer yarns. Yarns of good regularity were spun from low-twist Bradford rovings on a double-apron French-type ring spinner. Yarn hairiness was influenced by fibre fineness and length, roving and yarn twist, spinning mode and spinning speed and the use of balloon separators.

Double jersey fabrics

Over the past few years a detailed study has been made of the geometry of double-knit jersey structures and their dimensional stability (ability to retain size and shape). SAWTRI is well in the forefront of knowledge in this particular field; for this reason the Ilkley laboratory of the IWS is collaborating very closely with the Institute in order to put the research results into practice.

SAWTRI's first task was to define the *fully-relaxed state, relaxation shrinkage,* and *felting shrinkage.* The fully-relaxed state of a knitted fabric or garment is achieved when the knitted loop has taken up its most stable configuration or, to use more scientific language, its state of minimal energy. Relaxation shrinkage involves a change in knitted loop configuration only, whereas felting shrinkage involves a change in knitted loop length only.

A whole range of the most popular double-jersey fabrics (Swiss double piqué, French double piqué, Punto-di-Roma, Milano-rib, interlock, etc.) were knitted, and from the fully-relaxed dimensions the four main characteristics, the K-values, were calculated. (These values are mathematical constants employed in calculation to predict the behaviour of the fabric). The most significant aspect of SAWTRI's findings was that each structure can be characterized by the four K-values. In other words, once these four constants are known, one can calculate for a particular machine gauge and yarn count, even before knitting, the most important properties such as weight, width, shrinkage, etc. of a particular structure.

A grant from the Mohair Board made it possible for SAWTRI to purchase and install a machine for the production of dimensionally stable fabrics by a technique known as "Co-we-nit" which, as the name implies, is a combination of weaving and knitting.

With this machine it is now possible, for the first time in warp knitting, to lay a weft in front of and behind the warp threads—thus simulating a typical woven structure with an accompanying dimensional stability hitherto not attained in normal knitted structures. The fact that the fabric so produced has such marked dimensional stability when compared with weft-knitted fabrics, more than makes up for the loss in elasticity derived from conventional weft knitting. The "Co-we-nit" production rate is much higher than that in weaving and, because of the novel machine design, it is possible to produce a wide range of fabric designs suitable for furnishing materials and sunfilter curtaining.

Weft skewing

Further investigations into the effects of various factors on the weftwise skewing of wool worsted woven fabrics, indicated that the width at which a fabric is woven is of importance. Furthermore, cloth width affects finishing and making-up and as a consequence has a bearing on the cost of reprocessing. It was found that, with changes in fabric width, 2/2 and 4/4 twill fabrics react differently as regards skewing; this is also the case with changes in sett.

Differences between looms and in yarn tension similarly give rise to variations in cloth skewness. Increased weaving tension also leads to increased fabric contraction and the amount of contraction of a fabric in loom state bears some relation to the amount of skewing.

Domestic machine washing of wool

Four different types of domestic washing machines, viz. rotating drum, impeller, agitator and dunker, were employed in an investigation of the relationship between the rate of felting and the rate of soil removal when wool fabrics were washed in these machines under various conditions of mechanical agitation, load and foaming. For any particular detergent a direct relationship was established which applied to all the machines. Although with greater machine loads and with increased foaming there was a retardation in the rate of felting and of desoiling, the direct relationship was maintained.

The results have also shown that a machine of less energetic action may take a little longer to provide the required degree of cleanness, but the ultimate amount of felting when the fabric is just clean will be the same for all four types of machines.

It was also found that a slightly alkaline detergent, rather than a neutral or acidic one, is to be recommended for domestic washing of wool fabrics.

Dyeing of shrinkproofed wool

Wool shrinkproofed with dichloro-isocyanuric acid (DCCA) may suffer a greater loss in weight than untreated wool when subsequently dyed. This loss in weight is dependent on the dyestuffs used as well as on other factors. Variations of between 1.5 and 7 per cent have been recorded for shrinkproofed fibres (4.5 per cent DCCA) dyed at the boil for various

periods. This loss in weight during dyeing can be reduced considerably by treating the wool in the same bath after dechlorination with bisulphite by one of the following reagents:

- formaldehyde
- formaldehyde plus an alkyl polyamine
- a polyvinylsulphonium compound

The first two treatments appear to be the more promising in terms of cost and availability of the reagents. Of these, the mixture of formaldehyde and the polyamine gives superior protection to that by formaldehyde alone, but whether this is justified in terms of the additional cost has not as yet been determined.

Bright pastel shades

The dyeing, bleaching with sulphur-containing reducing agents, and the application of certain fluorescent brightening agents to wool have been combined into a single process.

Several bleaching agents were investigated in combination with one fluorescent brightening agent and a suitable dyestuff. The selected dyestuff had previously been shown to possess a high resistance to bleaching agents and to yield pastel pink dyeings of reasonable wash-fastness.

The dyed fabrics were fast to washing but varied in brightness. Their light-fastness values were generally 2-3.

Pigment bleeding from karakul hair

The precise chemical structure of melanin, the pigment responsible for colour in animal fibres and skins, is not known. However, it has been established that it contains a certain amount of carboxyl groups. Melanin is quite insoluble in neutral solutions or in acids, but because of saponification of the carboxyl groups it is partly soluble in alkalis. It follows that some loss of the pigment (bleeding) occurs when pigmented fibres such as karakul fibres are scoured in alkaline solutions.

Solvent-scoured karakul wool samples were treated at 40°C in solutions of various alkalinity and ionic strength. The least bleeding occurred in an acid solution; salt solution (Glauber's salt) showed slightly increased bleeding while relatively severe bleeding occurred in alkaline solutions. A direct relationship was observed between the rate of bleeding and the concentration of alkali. The slight increase in bleeding experienced with an increase in salt concentration was so small that its practical significance is doubtful.

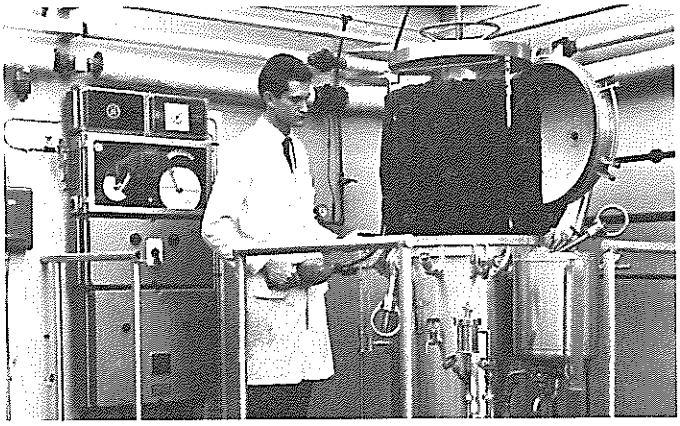
It was further found that the presence of melanin salts formed during alkaline treatment as a result of the reaction between the carboxyl groups and the alkali, facilitated further bleeding during subsequent wet processes. This was the case when solutions of a nonionic detergent or soap were used in the presence of soda. As soap is alkaline, the likelihood of bleeding even in samples treated with soap solutions containing no soda also increased substantially, but the addition of sodium sulphate to soap solutions reduced pigment bleeding. Treatment of karakul hair with a pure nonionic detergent actually decreased the extent of melanin bleeding slightly. Increasing the temperature during these treatments caused a general increase in the subsequent melanin bleeding of the fibres.

In view of subsequent dyeing and other wet processes it is, therefore, desirable that the use of alkaline media be avoided in the processing of pigmented fibres if bleeding of melanin at later stages is to be prevented. If processing under alkaline conditions is unavoidable, neutralization of the processed wool becomes advisable. An efficient and inexpensive way of achieving this is to terminate the concluding wet process by brief treatment in dilute acetic acid.

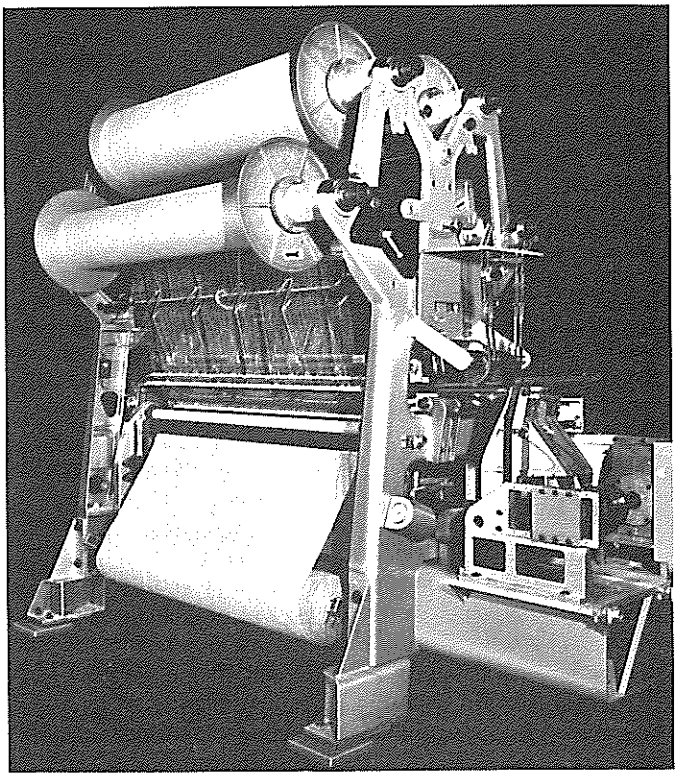
Textile training

With 28 students enrolled since the introduction in 1967 of the degree course in Textile Science at the University of Port Elizabeth, the venture has proved to be a very successful one. It is to be expected that the number of students will increase steadily as the course becomes more widely known.

The Vald Hendriksen high temperature dyer for loose wool, tops, cheeses, hanks and cones.



A machine for the production of dimensionally stable fabrics by a technique known as 'Co-we-nit'.



Leather Industries Research Institute

Dr S. G. Shuttleworth, Director of the Leather Industries Research Institute.

The Leather Industries Research Institute (LIRI) had its origin in research grants made in 1936 by the hides and skins and the 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.
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 Leather Industries Research Institute is nearing the end of its fifth five-year grant cycle, and negotiations with the four main industrial partners for the sixth cycle of guarantees are nearing completion. The hides and skins, wattle, and footwear industries have undertaken to increase their grants substantially by from 25% to 33%, while the tanning industry will consider the matter early in 1970. In general it may be said that the increased grants reflect the satisfaction of these industries with the role played by LIRI since its inception in 1936 and its organization into a joint research venture in 1941.

The industrial subscribers appreciate the fact that, while LIRI has established an international reputation in various fields of fundamental research, thereby earning free exchange of confidential research publications with its overseas counterparts, the technological problems of the factory floor are equally well catered for and include frequent factory visits. Moreover, many members of the technical and managerial staffs of these industrial subscribers have been trained by the Institute, a situation which facilitates teamwork between science and industry, particularly when these ex-students gain senior positions.

The valuable role which can be played by industrial research associations in technological training is well established in Europe and has also proved itself in South Africa. The LIRI training system takes several forms: firstly, there are correspondence courses for over 300 students, conducted by factory staff course leaders; secondly, operative training schools are set up within factories, and the school supervisors are trained; thirdly, short intensive courses are held at LIRI; and fourthly, experts are brought out from overseas to give lectures and to operate training seminars.

The training industry and its suppliers of raw materials, the hides and skins and wattle industries, are alerted to the increasing impact of substitutes for leather evolved by the enormous research and development facilities of the world's giant chemical combines. They are well aware that their survival depends on maintaining technical initiative and on using science to the utmost to improve and elaborate their products and to seek additional outlets.

The footwear industry is being flooded by a bewildering variety of new products and manufacturing techniques, which have changed it from a craft to a modern mass-production industry. Problems relating to the assembly and preformance of footwear are multiplied hereby, and can prove very costly in shoe returns if these stages are not under the control of trained scientists. Thus LIRI is in constant demand to evaluate new materials and adhesives and to advise on new processes. Shoemaking is a labour-intensive industry and LIRI is maintaining a programme of research into personnel problems and productivity.

Preservation of hides and skins

Numerous large-scale curing trials have been carried out to study the influence of various factors on leather quality. These trials have given rise to a wider realization of the losses due to faulty preservation of hides and skins and many of the larger curers are revising and improving their methods.

A bacteriological laboratory has been set up, in which very interesting results are being obtained on bacterial counts and types in relation to ultimate leather quality. The area beneath the grain of the leather is particularly prone to bacterial attack, which gives rise to loose leather. To control some of these bacteria, known as halophilic or salt-loving bacteria, it is necessary for bactericides to be blended with the salt in curing. These bactericides must be effective in saturated salt solutions, must be stable during the brine purification process, and must not interfere with the subsequent tanning process. Large-scale curing and tanning experiments, accompanied by bacteriological studies, are necessary for practical evaluation.

Fundamental research on proteins

LIRI publications in prominent overseas biochemical journals are attracting increasing attention, particularly in the medical field—as indicated by the large number of enquiries for reprints and requests for review articles in overseas books and journals related to skin diseases.

This fundamental protein research is primarily intended to form a sound basis for alternative uses of such parts of hides and skins as are not required for leather.

Chipboard and plywood adhesives

The wattle industry has asked LIRI to investigate non-leather outlets for wattle extract, to offset the fall in demand due to the increasing use of substitutes for leather. One of the most promising bulk outlets is in the field of waterproof chipboard and plywood adhesives. After large-scale trials and modifica-

tions of adhesive wattle derivatives it has become apparent that, although wattle has great potential, these products require further modification to fit in with modern large-scale production techniques which have been specially designed to suit alternative adhesive systems. In order to give the maximum impetus to this urgent work, a glue spreader and an R8,000 hydraulic press have been installed to produce 2 ft. x 2 ft. plywood and chipboards from local veneers and wood chips.

Wattle derivatives for oil-well drilling

A second major use for wattle extract is in oil-well drilling. A specially tailored drilling mud thinner and water-loss inhibitor, Kr6D, developed last year by LIRI, is now in large-scale use. This will operate satisfactorily at depths where temperatures are below 200°F. However, at greater depths higher temperatures are experienced, and further work has evolved modified mud thinners based on wattle extract which are stable at temperatures of up to 300°F.

Ground wattle bark to control trace-element deficiencies

Experiments carried out overseas have indicated a potential use for ground wattle bark to overcome trace-element deficiencies in trees and plants. On alkaline soils in particular, plants and trees suffer from iron and other trace-element deficiencies—which can be overcome by using costly chemicals known as chelating agents. Fundamental investigations into the chelating effect of wattle extracts and field trials using ground wattle bark to overcome trace-element deficiencies are in progress in collaboration with the Citrus Control Board and the Western Province Fruit Research Station.

New tanning process

Following a lead from fundamental research on the mechanism of vegetable tannage, LIRI scientists have developed a method for doubling the rate of penetration of wattle extract through hide. This method appears to be very promising for the purpose of speeding up vegetable tannage and extending the range of application of vegetable tannage in leather manufacture.

Scuff resistance

In the competition of leather with synthetics, factors of scuff resistance and resistance of finish to wet and dry rub have acquired increased significance. LIRI staff are therefore investigating these properties in both leather and synthetics, and co-operating with the tanning industry in order to improve these aspects of leather quality.

Metric sizes and fittings

The South African footwear industry has accepted the new proposals for an international shoe-sizing and fitting system, and LIRI has developed a measuring device which will enable shoe factories throughout the Republic to remark their lasts and shoes. The new system will be known as Mondopoint. It is based on the foot length in millimetres and the joint girth or fitting as a percentage of the foot length. The present system originated from the length of a barleycorn, which is approximately one third of an inch. Much confusion is caused by the sizes of lasts imported from different countries—a confusion made worse by changing toe shapes.

Adhesives for footwear manufacture

In recent years, adhesives have played an increasing role in shoe construction, and a large proportion of shoe soles are now joined by stick-on processes to their uppers. The increasing variety of shoe upper and soling materials and the development of new types of adhesives can lead to major losses if the shoes are unsatisfactory and have to be returned. An important role for LIRI is therefore the evaluation of adhesives.

Synthetic upper materials and easy-care leathers

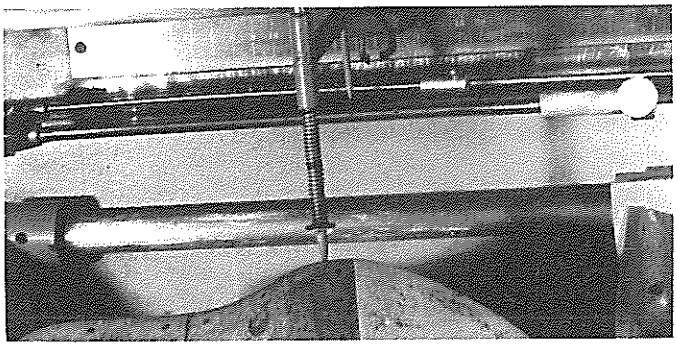
The footwear industry is being offered an increasing range of synthetic upper materials; approximately 30 of these leather substitutes are now being marketed by the major chemical companies. LIRI has published several research reports on the physical properties and shape retention of some of these new materials in comparison with leather. In general it has been shown that although some of these new materials are porous, their ability to absorb perspiration is not equal to that of leather. Nor do they retain the true shape in manufacture and adapt to the shape of the foot—the property which is so important in making leather comfortable to wear. The main advantage of the new materials lies in "easy-care" characteristics due to the impervious "plastic" outer surfaces.

In view of the claims that synthetic upper-leather substitutes eliminate the need for finishing in the shoe factory and for polishing during subsequent use, LIRI scientists are assisting the tanning industry to develop finishes which will have similar easy-care properties without detracting from the natural beauty and handle of leather. In order to facilitate this work a pilot-scale curtain-coating machine has been installed. This machine applies finishes by passing the leather on a moving belt through a continuous falling curtain of finish.

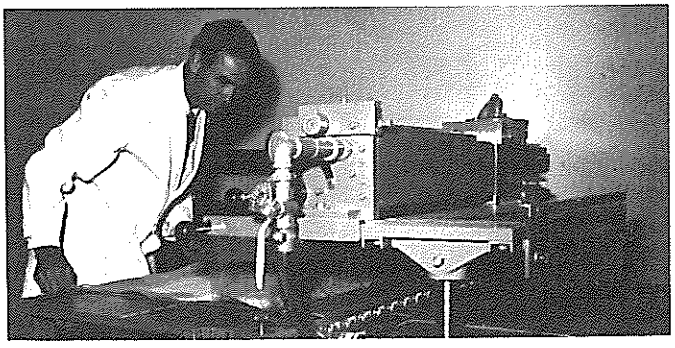
Labour-turnover research

A project which is nearing completion is a comparative study of labour turnover in the South African footwear industry, which includes a careful analysis of the causes of high labour turnover in some factories. A new set of measures has been applied to the data which will be of wide theoretical and practical interest. The results of this work have already alerted factories to the important cost factor in high labour turnover.

The LIRI last measuring device for converting sizes to the metric Mondopoint system.



A pilot-scale curtain coating machine for impregnating and finishing leather.



Fishing Industry Research Institute

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

The Fishing Industry Research Institute (FIRI) is affiliated to the University of Cape Town and has its main laboratory on the University campus; a second laboratory is situated 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 R227,000.

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 of commercial fishing 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 examinations 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

In relation to the more intensive exploitation of the stocks of Cape hake, as reported before, further attention was given to the various aspects of handling, preparation and quality control of hake products.

Tests carried out at sea once more confirmed the importance of good working of the fish and of avoiding delays at deck temperature, in order to obtain satisfactory storage life and texture of fillets. Since a small drop in temperature below 0°C delays bacterial spoilage to a marked extent, experiments were carried out to compare the effects of traditional icing with that of storage in chilled sea water, or in chilled mixtures of sea water and fresh water which were kept at temperatures just above their freezing points.

Dipping the fish in polyphosphate solution prior to freezing was shown to reduce drip and to improve the texture of fillets after subsequent thawing.

Experiments on the draining of fried hake showed that the fat content of the final product can be reduced by 10% or more by draining at elevated temperatures.

Considerable attention was also given to improving the method of sampling frozen fish finger blocks for bacteriological examination. In the conventional method the blocks are partly thawed and representative pieces from a block are used. It was found that the bacterial loads in blocks of frozen fish show a rather even distribution, and that it suffices to take only small core samples or even surface pieces. A method for rapid screening in order to detect blocks with high bacterial counts was developed by making use of the agaroid sausage technique. Large numbers of blocks can thus be tested in a short time without causing any damage to them.

Smoking

Since smoked foodstuffs may be contaminated with carcinogens (polycyclic hydrocarbons, e.g. 3, 4-benzpyrene and 1,2,-5,6,-dibenzanthracene) the removal of these substances from the smoke by means of the FIRI smoke washer was investigated. For this purpose a method for quantitative determination of 3,4-benzpyrene in smoke condensate was developed. The results indicated that even mild scrubbing of the smoke leads to removal of most of the 3,4-benzpyrene. Washing of the smoke also resulted in a similar reduction in smoked fish; the deposit in the wash water reservoir was shown to contain this compound at the 500ppm level.

Fish meal

The low porosity of cooked and pressed fish is an important impediment to efficient removal of oil. As a result two different lines of approach were followed, namely pressing by means of a series of small presses, instead of one large press, and de-oiling by centrifugation. Both methods showed promising results.

Lantern fish *(Lampanyctus),* which could possibly become a new source of fish for the production of fish meal and oil, is extremely rich in oil, and it cannot be handled in the conventional manner with existing plant. The residual fat content

of fish meal made from this fish was reduced to a normal level by double cooking and pressing. By vigorously shaking or churning raw *Lampanyctus* with twice its weight of chilled fresh water, up to 75% of the total fat present in the raw fish could be separated out in the form of a butter-like scum from which the fat could be better removed as clear oil by heating.

Further attention was devoted to the application of anti-oxidants on a commercial scale. Tests confirmed that more uniform stabilization is obtained if ethoxyquin is added to the meal being pneumatically conveyed to the bagging plant than is obtained in the screw conveyor feeding the bagging machine. When ethoxyquin is added to a fresh fish meal the recoverable amount decreases to a low residual level, although the antioxidant effect is fully retained. Various attempts to determine the amount of antioxidant originally added have failed, both here and overseas.

The addition of an effective antioxidant is necessary for bulk handling of fish meal. Although untreated meal can be stored in bulk in a sealed space since it gaspacks itself and does not rise in temperature, it cannot be handled after storage without the danger of spontaneous heating. With an antioxidant the use of sealed spaces for fish meal is not necessary, and no precautions are needed to prevent spontaneous heating during subsequent storage. Various aspects of bulk handling have been studied, including flow properties and pelletization. FIRI is represented on the Bulk Handling Committee of the Fishing Industry.

It has been found that fish meal which was found to be free from detectable salmonella can become salmonella-positive if it is stored under unfavourable conditions, especially if it becomes wet. The increase of temperature during pelletization of fish meals was also shown to have an important effect on surviving salmonellae. Fish meal which is free from detectable salmonella can be produced by following the recommendations contained in FIRI publications.

Use of fish meals in farm feeds

Chicken and pork flesh can be tainted if the animals are fed on diets containing high proportions of fish meal. It was found that the levels of long-chain unsaturated fatty acids in tainted chicken flesh corresponded with the degree of taint.

The effect of ethoxyquin in increasing the proneness of fish meal to taint chicken flesh was again confirmed. The advantage of reducing the fish meal content in the diet during the last few weeks before slaughter, was again demonstrated. Investigations are in progress, in co-operation with the Stellenbosch-Elsenburg College of Agriculture, into other methods of suppressing taint.

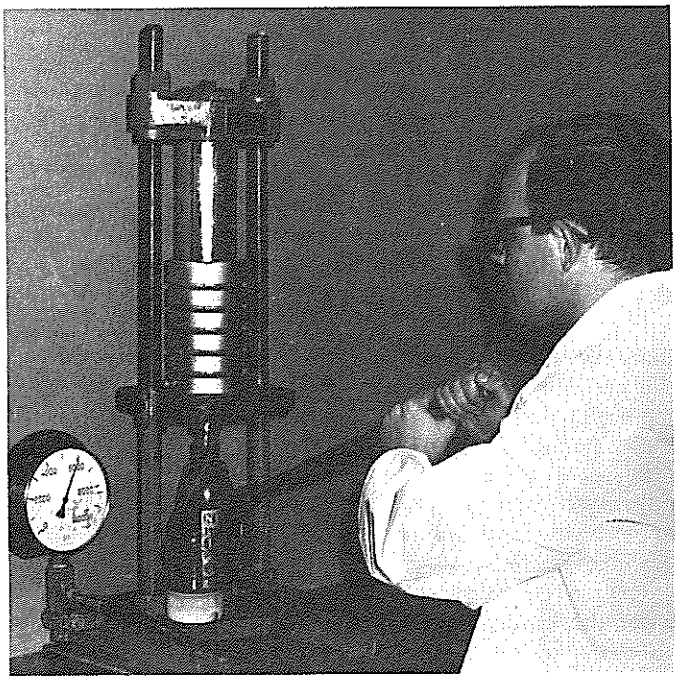
Fish oils

Attention is being focused upon new applications for fish oils. Promising results were obtained in the use of fish oil as a mould release agent, and also in the possible use of this oil in cattle and sheep feeds.

Fish factory effluent

The report of the South West African Harbour Pollution Committee, of which the Director was Chairman, has been submitted to the Administration, and research work has been suspended.

Pressing experiments to improve the removal of oil in the production of fish meal.



Sugar Milling Research Institute

Dr M. Matic, Director of the Sugar Milling Research Institute.

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

Composition of juice in cane

Tests were carried out to determine the cause of the changes in purity which are experienced when juice is expressed from cane by static pressure. Samples of cane were tested immediately after cutting as well as at varying times after cutting. The samples were shredded before being transferred to the press and subjected to increasing static pressures. The juices were analysed for pol, sucrose, reducing sugars, gums and refractometer Brix. The cane and the bagasse samples were analysed for moisture, pol, sucrose, reducing sugars and refractometer Brix. The results can be summarized as follows:

· The Brix, pol and the sucrose content of the juices expressed from the shredded cane by increasing pressure usually decreased slightly with increasing extraction over the range investigated, viz. from 14 to between 51 and 81 per cent pol extraction.

· The purity of the juice expressed was sometimes lower than the purity of the absolute juice. (These were sucrose/refractometer Brix purities of centrifuged extracts.) Confirmation of this was obtained in a subsequent series of measurements made at Mount Edgecombe.

· The purities of the juices were reasonably constant in a single test whether fresh or stale cane was being analysed.

· The changes in purity which were found could not be explained solely in terms of the changed concentrations of reducing sugars and gums in the juices expressed.

Polysaccharides of sugar cane

The polysaccharide isolated from deteriorated cane was eluted from a gel filtration column packed with iono-agar. Only one peak was obtained. The fractions representing the beginning and the end of the peak respectively were combined separately and then hydrolysed by pullulanase. The hydrolysis products were separated by paper chromatography, eluted from the paper and their respective amounts determined by titration. In both cases the same mixture of maltotriose and maltotetraose was obtained. This indicated that the material was made up of only one polysaccharide and was not a mixture. It also established that cane polysaccharide is not identical with pullulan, but is a new, not previously described, α-polyglucan.

In an attempt to establish whether an organism is responsible for the production of this polysaccharide, juice from stale cane was diluted and spread over sucrose media in petri dishes. After colonies had developed those which showed polysaccharide formation were further investigated in shake cultures. The polysaccharides were isolated by alcohol precipitation and after hydrolysis analysed by gas-chromatography. A number of polyglucans were obtained. However, none was hydrolysed by the enzyme pullulanase thus showing that the polysaccharides were not identical with the one formed in deteriorating cane. So far, no micro-organism has been connected with the formation of the latter.

Colour formation in raw sugar

An investigation of the factors affecting colour formation in raw sugar was undertaken with a view to the selection of the best ways to control colour formation of the sugar stored in bulk.

Major factors influencing the rate of colour formation were found to be temperature and time. Even at 25°C the rate of formation of colour in low polarizing raw sugar samples coated with defecation final molasses was such that the colour had approximately doubled in about three months. At 50°C the colour had doubled in less than one month. Corresponding with the increases in colour were substantial drops in pH.

Because of the known inhibiting effect of SO_3 on colour formation some low polarizing sugar samples which were prepared by using sulphitation instead of defecation final molasses were stored under similar conditions. The rate of colour formation was considerably slower with these samples over the first month of storage but subsequently it appeared to increase.

South African Paint Research Institute

Prof. G. M. Hamilton, Director of the South African Paint Research Institute.

Members of the South African Paint Research Institute (SAPRI) 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.

Gas liquid chromatography

Two new chromatographs which are particularly suited to the work being carried out have been constructed in the Institute. An electronic integrator has also been obtained—a most useful addition to the equipment.

Infra-red spectroscopy

An additional instrument has been acquired, one of higher resolution and therefore capable of revealing data so far inaccessible.

A series of alkyd resins has been produced in the laboratories and research is proceeding in an endeavour to equate the hydroxyl values of these materials with an absorption band in the infra-red spectrum. If successful, this would enable rapid measurements of the hydroxyl value to be taken. This value is becoming recognized as an important property controlling such matters as adhesion to metals.

Electrical conductivity of paint films

It is known that paint films protect steel from corrosion if their resistance to the passage of the electrical current is high. The apparatus described in the previous annual report has been modified and is now capable of recording changes in resistivity within the range of 10^{10} to 10^{3} ohms. With the aid of this equipment it has been found that the resistance drops rapidly with rise of temperature. This is of practical significance, because it indicates that premature failure by corrosion of metal protected by paint can well be accelerated by temperatures above ambient.

Adhesion of coatings

The epoxy tar system widely used for the protection of structural steel has been examined in some detail. Although it is known that epoxy resins react with water vapour from the air for some months after they are apparently cured, this reaction has been shown to be without significant effect on the adhesion of subsequently applied coats of epoxy tar.

The main cause of poor intercoat adhesion appears to be natural weathering of the surface of the first coat, particularly that induced by sunlight.

Release of solvents from paint films

Apparatus has been designed and constructed to investigate the release of solvents from surface coatings during drying. It is known that the solvents used in furniture lacquers tend to affect the eyes as they evaporate from the applied coating. However, only formaldehyde and butanol could be detected in the particular urea formaldehyde resin examined.

Analysis of materials

Nitrocellulose compositions have been analysed by means of infra-red spectroscopy and two papers on this subject have been published during the year. It is intended to follow up this work, and this will lead to a series of papers being issued in due course.

A simple method for the isolation and identification of polyols in alkyds and polyester resins has been developed.

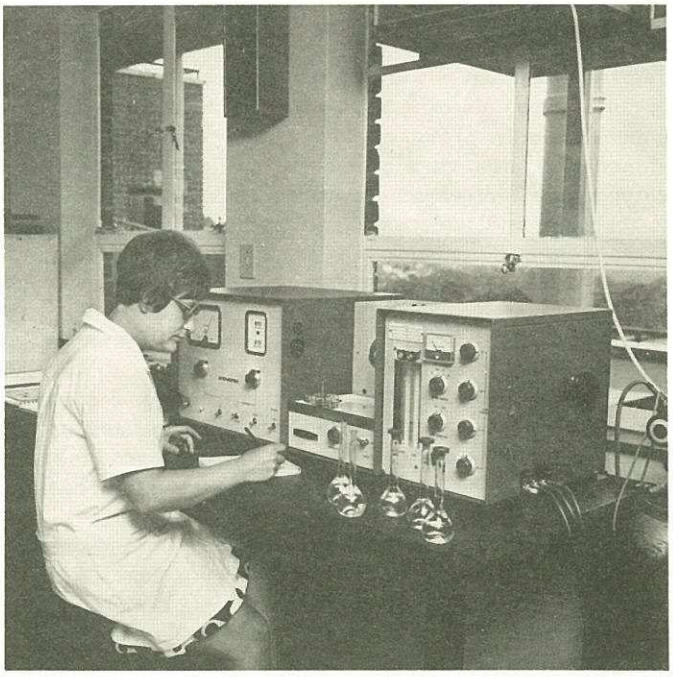
Marine finishes

Exposure tests on anti-fouling paints in the Durban harbour have been continued, and in association with one industrial firm, paints with a new material have been prepared in the laboratories and are at present undergoing evaluation.

Miscellaneous

A total of 1,317 samples for examination were received during the year. Many of these represented complaints resulting from faulty application.

Determination of fungicides in paint by atomic absorption spectroscopy.



Information and Research Services

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

The 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

There has been a further increase in the demands made on the services provided by the CSIR Library—both national and domestic—as shown by the following five-year statistics.

Year	Publications issued on loan and photo-copies provided	Books and pamphlets ordered	Periodicals—subscriptions and exchanges
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
1969	53,845	5,605	3,457

The past year saw the introduction of a scientific literature enquiry service which involves the handling of technical enquiries based on the Library's collection, and is also available to persons and organizations outside the CSIR.

A current awareness service relating to literature on library, information and documentation techniques and practice is also being developed for the use of the Council's own staff. If this service proves satisfactory, consideration will be given to making it available on a wider basis.

The compilation and publishing of the union catalogue *Periodicals in South African Libraries* has been given extra impetus by an increased allocation of funds for this project. Good progress is being made, and March 1972 has been set as the target date for publication of the remaining entries.

A second team of editors is being formed to revise the published entries from the beginning.

The application of computer techniques for this project is being investigated by the Information Processing Group.

Information Processing Group

This group, which was formed in 1968, has as its main function the study and application of non-conventional techniques to the dissemination of scientific and technical information and to various library procedures.

The project for computerizing acquisition procedures for serial publications is nearing its final stage and more attention is now being given to the mechanized production of the union catalogue *Periodicals in South African Libraries,* referred to above. A member of staff visited Canada to study the computer programmes used for the corresponding Canadian catalogue. These programmes have been made available to the CSIR without cost by the Canadian authority concerned.

The preparation of a comprehensive computer-produced index to CSIR publications is now in its final stage while work continues on the preparation of new editions of computer-produced indexes and directories in co-operation with the Publishing Division and the laboratories concerned. Assistance is also given to other institutes with the establishment of co-ordinate indexing systems.

Technical Information Service

This service was created in 1968 to provide a closer liaison between the CSIR and the small and medium-sized manufacturing firms. Members of the staff undertake regular visits to such firms to acquaint them with CSIR facilities and to establish personal contact.

The Technical Information Service also assists with the organization of industrial symposia and of visits to the CSIR by industrialists. In this regard special mention should be made of the Symposium on High Strength Low Alloy Steels and of a visit by representatives of the textile industry, both in November, 1969.

In addition to the handling of technical enquiries as a routine activity, *ad hoc* investigations were carried out to determine the need for production engineering research in South Africa and trends in the local production of electronic process instrumentation.

As a long-term activity, members of the staff are engaged in the compilation of technical pocket books and brief guides to sources of technical information. The Technical Information Service is further responsible for the production of the monthly bulletin *TI—technical information for industry.*

Foreign Language Information Service

This service undertakes the translation of scientific and technical literature from foreign languages on behalf of CSIR research workers. The present staff can cope with fifteen foreign languages while five more languages are covered by making use of free-lance translators.

The staff spend much of their time handling language enquiries and assisting the CSIR library with the processing of foreign language literature. Staff members also assist CSIR institutes and other scientific organizations in interpreting work when foreign guests are received.

Over the past few years the Foreign Language Information Service has given valuable assistance to local scientists in negotiations with the Portuguese authorities in Mozambique about research on the incidence of liver cancer in the area.

Publishing Division

The activities of this central editorial office include the production of general information publications dealing with the activities of the CSIR, the compilation of guides to sources of scientific and technical information in South Africa, and the provision of editing and language services in the two official languages for the CSIR as a whole.

Publication of a new four-monthly newsletter, *CSIR Research Briefs,* was started in January, 1969. It is intended mainly to supplement the CSIR Annual Report as a medium for reporting on current activities and the three issues which appeared during the year were well received.

As in the previous year a number of issues of the monthly magazine *Scientiae* were devoted to specific topics. These included the CSIR's work in the field of geology and activities in the Western Cape.

In addition to the editing services for various specialist groups within the CSIR editorial assistance was provided, by special arrangement, to a leading South African zoologist who is compiling a manual for the identification of African mammals in association with the Smithsonian Institution of the USA as a project of the International Biological Programme.

Further chapters of the publishing manual for CSIR authors and editors were completed during the year. In its present form the manual is essentially "domestic", although it is based on accepted international standards for scientific publishing. In view of a persistent demand from outside the CSIR, however, consideration may be given to the adaptation of the manual for general distribution once all the chapters have been completed.

In regard to Afrikaans scientific and technical terminology, the Division has hitherto provided a purely domestic service. In recent years it became apparent, however, that an urgent need exists, in particular for training purposes, for a comprehensive Afrikaans technical terminology in the field of textiles—a field in which the CSIR is active. A project for the compilation of a textile dictionary was therefore initiated in consultation with the appropriate authorities. This is a task of considerable magnitude which will probably take several years to complete.

Division for the Public Communication of Science

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. It also arranges visits to the CSIR by scientists, university students, scholars and the general public, both individually and in groups.

To mark South Africa's Water Year (1970), a new CSIR documentary film, entitled *The Life Stream,* is being produced. The film deals with water research in South Africa in relation to the country's economy and its water resources, and emphasizes the need to use and re-use water judiciously.

Another 35mm CSIR documentary film, *The Buildings in your Life,* was completed during the year. Both this film and *The New World of Wool* (completed the previous year) are on the 20th Century Fox cinema and drive-in circuit with two selected feature films.

During the year *The New World of Wool* was entered in the international documentary film festival in Venice and was awarded a Diploma of Special Mention.

The publicity for six major science conferences and symposia was handled during the year, including two international conferences—the Second South African Building Research Congress and the International Symposium on the Chemical Control of the Human Environment. Both conferences received wide coverage in the press and on the radio.

During the year the Division issued more than fifty press releases covering a wide range of CSIR activities, and arranged numerous interviews with the press and radio.

Statistics for the four months June to September show that there were nearly 900 visitors to the CSIR, including individual guests from the USA, England, the Scandinavian countries, Brazil, Rhodesia and Malawi.

The Division continued to handle the publication of *Scientific Progress* on behalf of the Scientific Advisory Council. This quarterly review of scientific achievements in South Africa was first published in October, 1968 and has been well received both locally and overseas.

Conference and Symposium Secretariat

In furtherance of the Council's policy of promoting research for industry and of creating opportunities for industrialists and scientists to meet and discuss mutual problems, the Conference and Symposium Secretariat arranged the following symposia for industry during the past year:

Symposium on physics in industry
Symposium on ground water in Southern Africa
Symposium on marine disposal of effluents
Symposium on coastal engineering
Symposium on stainless steels
Symposium on special steels.

Since 1964, when the first industrial symposium was arranged under the auspices of the Industrial Research Development Division, 35 symposia have been held at the CSIR. These were attended by approximately 3500 people including scientists, representatives of organized industry, representatives of government departments and statutory bodies.

The need for a service of this nature is substantiated by the fact that the number of requests for assistance with the organization of symposia has increased to such an extent that the Secretariat is fully committed until November, 1970.

Apart from the programme of symposia for industry, the Secretariat is also responsible for the planning and execution of large-scale scientific conferences or meetings such as the International Symposium on the Chemical Control of the Human Environment. Similar international gatherings of scientists in different fields are planned for 1970 and subsequent years.

Development of Research for Industry

The Advisory Committee for the Development of Research for Industry (ACDRI) administers the Council's fund for the promotion of industrial research, from which grants are made to the four existing industrial research institutes, viz., the Fishing Industry Research Institute in Cape Town, the Leather Industries Research Institute in Grahamstown, the Sugar Milling Research Institute in Durban and the South African Paint Industries Research Institute in Durban.

It is gratifying to note that during the past five years the basis on which the funds are allocated has changed from a rand-for-rand grant, where the CSIR matched all guaranteed contributions from the industries concerned, to a fixed maximum contribution by the CSIR, increasing at the rate of $6\frac{1}{2}$ per cent per annum, on condition that this is matched by the industry. In all four cases the amount has, in fact, been exceeded by the guaranteed income from the industries concerned.

With regard to other industrial sectors not served by their own research institutes or by existing CSIR research facilities, proposals concerning Government support for industrial research and development, similar to schemes in existence in Canada, Australia, the United Kingdom and Belgium, have been framed by the Advisory Committee. These proposals are being discussed at the highest level.

Techno-economics Division

Working in conjunction with organizations such as the Board of Trade and Industries and the National Productivity Institute, the Techno-economics Division undertakes industrial economic studies to provide information required for economic planning and research purposes. In addition the Division supplies the CSIR Executive, government departments and statutory

organizations with information on the techno-economic implications of scientific research on the South African economy generally. More specifically, research institutes of the CSIR are assisted in assessing the economic implications and industrial impact of their research activities.

During the past year the Division undertook an investigation of the basic chemical industry on behalf of and in collaboration with the Board of Trade and Industries. A first report has been published.

Other activities included a techno-economic survey of the pulp and paper industry, the results of which were published towards the end of the year, and an investigation into the techno-economic aspects of certain research projects of the National Institute for Water Research.

Research Economics Division

The Research Economics Division is mainly concerned with the economics of research and development. To provide the necessary background information, surveys of expenditure on research and development are carried out under the supervision of the Committee on Research Expenditure (CORE), which is a sub-committee of the Prime Minister's Scientific Advisory Council.

On behalf of CORE this Division also analyses the information on research expenditure to determine the optimum allocation of research support for the various economic sectors and scientific disciplines, with proper regard to the available resources and consequent economic benefits.

Formal arrangements under which the Department of Planning will partially finance the activities of this Division, were finalized during the year.

Reports dealing with expenditure on research and development during the financial year 1966/67 by the government sector, universities and university colleges, the private sector and also by the Republic as a whole were submitted to the Scientific Advisory Council. The data for the Republic as a whole were published towards the end of 1969.

These annual comprehensive surveys of research expenditure will be continued. Information on research expenditure for the financial year 1968/69 is being processed.

Science Co-operation Division

The activities of the Science Co-operation Division are centred mainly on the Council's commitments as the national member for South Africa of the international scientific unions which are grouped together under the auspices of the International Council of Scientific Unions (ICSU)—a non-governmental international association of scientific bodies.

In administering the national activities arising from membership of ICSU and its constituent unions the Science Co-operation Division is advised by a number of national committees of experts, for which it also provides the secretariat. Thus liaison 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.

National activities under the International Biological Programme are progressing well, while the permanent research programme in oceanography is proving to be an effective means of co-ordinating the activities of a large number of national organizations working in this field. Considerable progress has also been made with the South African Antarctic Research Programme, now in its second five-year period.

This Division played an important part in arrangements for the International Symposium on the Chemical Control of the Human Environment held in Johannesburg during July under the auspices of the International Union of Pure and Applied Chemistry. This highly successful symposium was attended by over 300 delegates, including 60 from abroad. More than 80 papers were presented including eight papers read at plenary sessions by eminent overseas specialists.

Arrangements are being made for the Second International Gondwana Symposium to be held in South Africa in July, 1970 under the auspices of the International Union of Geological Sciences.

Overseas Offices

Four offices overseas—in London, Paris, Cologne and Washington—provide valuable services to South African scientists and scientific institutions in maintaining contact with scientific developments in Western Europe and North America.

The addresses of these offices appear below:

Office of the Scientific Counsellor
South African Embassy
3051 Massachusetts Avenue, N.W.
WASHINGTON, D.C.20008

South African Science Office
Chichester House
278 High Holborn
LONDON W.C.1

Office of the Scientific Counsellor
South African Embassy
Heumarkt 1
5 KÖLN

Office of the Scientific Attaché
South African Embassy
38 Rue de Bassano
PARIS 8e

Regional Offices

Regional Offices in Durban, Port Elizabeth and Bellville (Cape) provide services to the CSIR's research institutes and their regional laboratories in Natal, the Eastern and Western Cape Province, in addition to maintaining general CSIR liaison and information services in these areas.

The addresses are as follows:

The Regional Representative
CSIR Natal Regional Office
P.O. Box 1
CONGELLA
Natal

The Secretary
CSIR Western Cape Regional Office
P.O. Box 288
BELLVILLE
Cape

The Regional Liaison Officer
c/o SAWTRI
P.O. Box 1124
PORT ELIZABETH.

Technical Services Department

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

The 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 cannot be undertaken anywhere else in the Republic. As the CSIR expanded the need for essential services increased until today the TSD has 329 white and 97 non-white employees.

New techniques and special services

The Department's Graphic Arts Division successfully produced a variety of printed circuit boards, including through-hole plated boards. The Special Projects Workshop, in collaboration with the National Chemical Research Laboratory, produced components by the explosive forming method and established an electroless nickel-plating facility. Other special services included electron beam welding, plastic injection moulding, electric discharge machining, metrology (using the universal Zeiss toolmakers measuring microscope), and numerically controlled milling machines which are not used by CSIR institutes only but also on behalf of outside organizations such as the Atomic Energy Board, universities and hospitals.

Projects

From amongst the numerous projects undertaken by the TSD the following merit special special mention:

- A number of projects were undertaken for the defence authorities, including a prototype mobile sterilizing unit which was designed and manufactured for the Medical Corps of the Army.
- When the new wind tunnels of the National Mechanical Engineering Research Institute became operative, requests were received for the production of aircraft models. Several of these were manufactured in wood, to high accuracies.
- Assistance was given to the Gatooma Research Station in Rhodesia with the repair and re-calibration of instruments used in the standardization of cotton.
- A prototype revolving wool comb was manufactured, in collaboration with the South African Wool Textile Research Institute and the Inventions Development Corporation.
- Various complicated glass instruments were manufactured by the Glass Blowing Section for the CO_2 laser research programme in the National Physical Research Laboratory.

National Training Centre for Scientific Instrument Makers

The National Training Centre for Scientific Instrument Makers at the TSD was officially opened by Dr. the Hon. C. de Wet, Minister of Planning, Health and Mines, on the 22nd November, 1968. 91% of the trainees successfully complied with the requirements of the National Trade Test Centre in their first trade test, which is considered an outstanding achievement for both instructors and trainees.

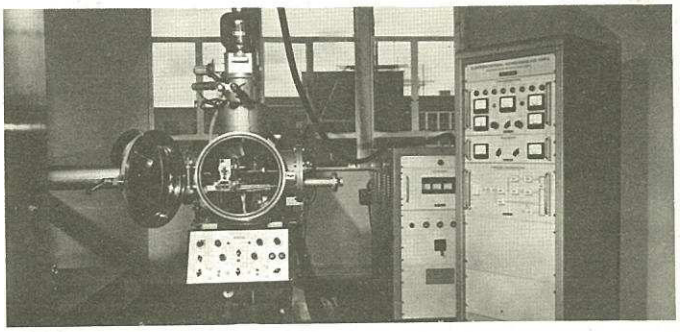
Training in design drawing

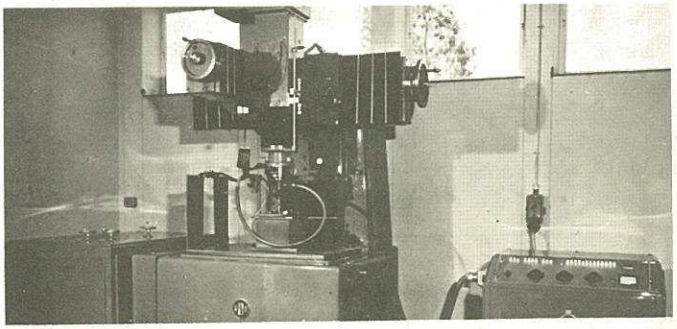
As the response from overseas applicants for design draughtsmen was poor, selected trainees who have completed their training at the training centre of the TSD and who have shown talent for design work during their training period, are now being offered the opportunity for specialized training in design/drawing to enable the Department to fill important vacancies.

Staff training

As the activities of the TSD are diverse and widely separated at Scientia and regional laboratories, a staff training programme has been instituted. This includes supervisory training, training in safety and training in technical aspects, to keep all supervisors and staff abreast of the latest technological and other developments in their field. The TSD is also responsible for the arrangements and planning of all first aid training at the CSIR.

Two of the highly specialized facilities available in the Technical Services Department—for electron-beam welding (top) and for electric discharge machining.





Financial Statements

Balance sheet

as at 31st March 1969

	General Fund	Building Fund	1969	1968
Accumulated fund			R31,349,947-25	R28,019,083
Balance as at 31.3.1968	R17,010,871-75	R11,008,210-86		
Inter-fund transfers	183,000-00 (–)	183,000-00		
Sub-total	16,827,871-75	11,191,210-86		
Capital receipts 1968-69				
Parliamentary grants:				
CSIR	1,467,800-00	700,000-00		
University institutions	248,160-00	—		
Donations:				
CSIR	89,655-05	35,156-52		
University institutions	2,687-31	—		
Interest	—	218,012-76		
Sale of assets written off:				
CSIR	38,754-80	—		
University institutions	45-00	—		
Investigations and services	740,946-64	—		
	2,588,048-80	953,169-28		
Less:				
Excess of expenditure over income	12,743-19	—		
Adjustment in respect of previous years:				
CSIR	9,063-52	—		
University institutions	120-65	—		
Cost of assets written off 1968-69:				
CSIR	165,520-90	—		
University institutions	22,905-18	—		
Sub-total	2,377,695-36	953,169-28		
Total	R19,205,567-11*	R12,144,380-14*	R31,349,947-25	R28,019,083
Current liabilities				
Advances for investigations and services			2,246,997-70	1,078,828
Sundry creditors and credit balances			1,337,331-15	3,160,989
Total			R3,584,328-85	R4,239,817
Grand total			R34,934,276-10	R32,258,900

Notes: *Contractual obligations against the General and Building Fund as at 31st March 1969 were R1,295,356 and R1,143,456 respectively.

S. M. Naudé *President*

J. H. Visagie *Secretary/Treasurer*

Pretoria, 19 August 1969

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

	Additions		Written-off		
	University Institutions	CSIR		1969	1968
Fixed assets (at cost)					
Land and buildings		R1,567,757-60		R11,348,476-30	R9,780,719
Sub-total		1,567,757-60		11,348,476-30	9,780,719
Laboratory and workshop equipment	262,643-97	1,910,064-63	126,856-82	14,301,305-30	12,255,453
Furniture, fittings and office equipment	2,029-30	132,115-77	7,361-31	921,195-73	794,412
Vehicles and cycles	1,349-00	126,388-44	50,100-69	367,913-66	290,277
Books and journals	1,384-05	96,668-92	4,107-26	810,123-33	716,178
Prefabricated structures	—	272-00	—	13,745-46	13,473
Shares in S.A. Inventions Corporation				140,000-00	140,000
Stores stock		7,273-92 (–)	—	326,365-83	333,640
Sub-total	267,406-32	2,258,235-84	188,426-08	16,880,649-31	14,543,433
Total	R267,406-32	R3,825,993-44	R188,426-08	R28,229,125-61	R24,324,152
Current assets					
Sundry debtors and debit balances				814,731-38	772,376
Investigations and tests in progress				970,460-98	658,133
Advances and deposits:					
Research grants			435,454-99		
Other			958,339-72	1,393,794-71	3,209,827
Investments				3,357,727-49	3,029,760
Cash:					
At S.A. Reserve Bank			149,088-25		
Petty cash imprests			19,347-68	168,435-93	264,652
Total				R6,705,150-49	R7,934,748
Grand total				R34,934,276-10	R32,258,900

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

H. R. P. A. Kotzenberg *Controller and Auditor-General*

Pretoria, 18 November 1969

Operating account

for the year ended 31st March 1969

	1968/1969			
	University Institutions	CSIR	Total	1967/68
Expenditure				
Salaries, wages and allowances	R293,513-57	R8,780,186-23	R9,073,699-80	R7,821,824
Consumable stores and services	23,032-54	5,716,616-93	5,739,649-47	7,786,640
Subsistence and transport	19,234-35	536,224-22	555,458-57	472,623
General expenses	49,330-90	1,703,180-55	1,752,511-45	1,348,640
Subsidies:				
Research by industry	—	246,886-00	246,886-00	234,700
Grants	956,171-15		956,171-15	778,212
Sub total	1,341,282-51	16,983,093-93	18,324,376-44	18,442,639
Less: Income for internal services	3,028-09	1,952,295-51	1,955,323-60	1,627,747
Sub total	1,338,254-42	15,030,798-42	16,369,052-84	16,814,892
Balance transferred to Accumulated Fund	74,955-24	87,698-43 (–)	12,743-19 (–)	237,950
Total	R1,413,209-66	R14,943,099-99	R16,356,309-65	R17,052,842

S. M. Naudé *President*
J. H. Visagie *Secretary/Treasurer*

Pretoria, 19 August 1969

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

	1968/1969			
	University Institutions	CSIR	Total	1967/68
Income				
Parliamentary grant	R1,382,640-00	R6,742,400-00	R8,125,040-00	R7,239,700
Investigations and services	249-25	7,659,153-54	7,659,402-79	9,398,257
Contributions to CSIR projects	27,471-12	497,589-20	525,060-32	382,832
Publications	2,849-29	6,399-20	9,248-49	9,249
Sundry	—	37,558-05	37,558-05	22,804
Total	R1,413,209-66	R14,943,099-99	R16,356,309-65	R17,052,842

CSIR Budget 1969/70

Statement No. 3

A. OPERATING EXPENSES

ACTIVITIES	EXPENDITURE								FUNDS	
	Salaries R	Supplies and services R	Subsistence and transport R	Scientific services R	Grants and subsidies R	General expenses R	Amount recovered internally R	Total R	Parliamentary grant R	Recoverable expenditure R
CSIR laboratories and departments	10,600,697	3,856,519	571,335	542,009	271,580	1,320,050	2,172,815	14,989,375	7,623,000	7,366,375
Grants and subsidies	501,770	33,206	34,970	28,640	1,390,940	54,781	63,242	1,981,065	1,910,800	70,265
Total	11,102,467	3,889,725	606,305	570,649	1,662,520	1,374,831	2,236,057	16,970,440	9,533,800	7,436,640

B. CAPITAL EXPENDITURE

ACTIVITIES	EXPENDITURE							FUNDS	
	Books/ journals R	Technical equipment R	Furniture/ office equipment R	Vehicles R	Stores stock R	Buildings R	Total R	Parliamentary grant R	Recoverable expenditure R
CSIR laboratories and departments	93,390	2,342,505	72,130	500	3,000	1,166,000	3,677,525	1,875,320	1,802,205
Grants to universities, etc.	900	124,030	1,600	—	—	—	126,530	125,480	1,050
Total	94,290	2,466,535	73,730	500	3,000	1,166,000	3,804,055	2,000,800	1,803,255
					Grand totals		20,774,495	11,534,600	9,239,895

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