CSIR

annual report 1971

Twenty-seventh Annual Report 1971

South African Council for Scientific and Industrial Research

Contents

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(as from 5.10.1971)

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Mr M.T. de Waal
Joint Managing Director, Industrial Development Corporation of South Africa Ltd
(as from 1.1.1972)

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President as from 5.10.1971

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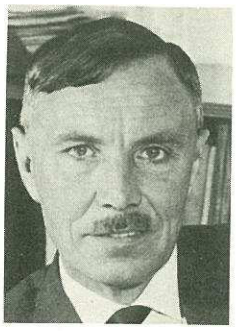


Dr P.J. Rigden,
Vice-President

Dr J.F. Kemp,
Vice-President

The Year in Retrospect

P.O. Box 395 Pretoria
1st April, 1972

Sir,
I have pleasure in presenting to you the twenty-seventh Annual Report of the Council for Scientific and Industrial Research. This Report covers the period 1st January, 1971 to 31st December, 1971.
Balance sheets and statements of income and expenditure for the financial year ended 31st March, 1971, certified by the Controller and Auditor-General, are included.

Yours faithfully,
C. v.d. M. BRINK
President: Council for
Scientific and Industrial Research

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

There were during 1971 several events and developments which deserve special mention.

In October Dr S. Meiring Naudé retired as President of the CSIR. He served the Council in this capacity for 19 years, and not only the Council, but also the Republic as a whole is indebted to Dr Naudé for his contribution to scientific and technological development in this country. After a distinguished academic career in South Africa and overseas he refused an attractive offer in America and chose to return to his fatherland and devote himself to science here. As a lecturer at the University of Cape Town and then as head of the Department of Physics at the University of Stellenbosch he did much to promote interest in science. Thereafter he played an important role as founder and first Director of the CSIR's National Physical Research Laboratory and later as Vice-President and President of the organization. As President he led the CSIR through an important stage of its development. The Council wish him every success in his new office of Scientific Adviser to the Prime Minister.

Dr Naudé was succeeded by Dr C. van der Merwe Brink who joined the CSIR in 1967 as Vice-President. As such he was responsible for the CSIR's chemically-orientated research and for the allocation of funds for university research. In 1970 he was appointed Deputy President. Dr Brink was previously a research chemist at the South African Iron and Steel Corporation Ltd. (Iscor), senior lecturer at the University of Pretoria and professor of organic chemistry at the University of the Orange Free State.

In January a new member of the CSIR executive, Dr J.F. Kemp, assumed duty. As Vice-President he is responsible for the engineering research activities and the technical services of the CSIR. Dr Kemp was previously professor of mechanical engineering at the University of Stellenbosch and before that was a senior research worker at the CSIR's National Mechanical Engineering Research Institute.

Dr G.G. Cillie, previously head of the National Institute for Water Research's Regional Laboratory in Bellville, C.P., became Director of this Institute on 1st November, succeeding Dr G.J. Stander who was appointed Vice-President and Executive Officer of the Government's recently established Water Research Commission. Dr Stander was Director of the NIWR from its establishment in 1958, and it was largely owing to his initiative and enthusiasm that the Institute was so successful with various large projects, *inter alia* the reclamation of drinking-water from sewage effluent.

The death of Dr G.S.J. Kuschke, who was appointed a member of the Council in 1970 in the place of the late Dr H.J. van Eck, was a great loss to this Council and to the country as a whole. As Managing Director and later as Chairman of the Industrial Development Corporation (IDC) Dr Kuschke made a valuable contribution to industrial development in South Africa. Mr M.T. de Waal, Joint Managing Director of the IDC, has been appointed a member of the Council in his place.

Another new Council member appointed during the year under review is Dr P.J. Riekert, Economic Adviser to the Prime Minister and Chairman of the Economic Advisory Council. He succeeds Dr R.L. Straszacker who resigned when his term of duty ended.

At the end of August Prof. G.M. Hamilton retired as Director of the South African Paint Research Institute in Durban, an autonomous institute financed half by the CSIR and half by the industry concerned. His successor is the Assistant Director of the Institute, Dr D.W.S. Evans, formerly head of the information department of Midlands Silicones in England.

The South African Wool Textile Research Institute became a national research institute of the CSIR during the year. The Institute was originally established as a co-operative industrial research institute and was incorporated into the CSIR in 1965. Up to now its activities have been limited to the research needs of the South African Wool Board and the Mohair Board. With its new status the Institute's activities will be extended to include research (national as well as contract projects) into other textile fibres – including synthetic fibres – and mixtures of other fibres with wool and mohair. This decision was made unanimously by the CSIR, the South African Wool Board, the Mohair Board and the Central Executive of the Wool Growers' Association. The Institute's research capacity will thus be used in the national interest to a greater extent.

One of the most important symposia held in 1971 was one on research and development as prerequisites for economic progress. The CSIR and the Engineers' Association of South Africa organized the symposium jointly with the object of providing an opportunity for representatives of government institutions, research organizations, institutions of higher education and industry to exchange ideas at a high level on the research and development necessary in this country in order to keep pace with increasing technological sophistication and to ensure future progress. Contributions were made by distinguished South African scientists, engineers and industrial leaders, as well as by an international authority on the process of technological innovation, Prof. James R. Bright of the USA. The guest of honour on this occasion was the Prime Minister, the Honourable B.J. Vorster. This symposium contributed to a better understanding of the whole process of technological innovation.

An international gathering of great importance was the meeting of the Executive Committee of the International Union for Biological Sciences (IUBS). As national member body of the IUBS the CSIR arranged the meeting which was held in Cape Town from 28th October to 1st November. Eleven committee members from overseas were present, and most of them gave lectures at universities and other institutions during their stay.

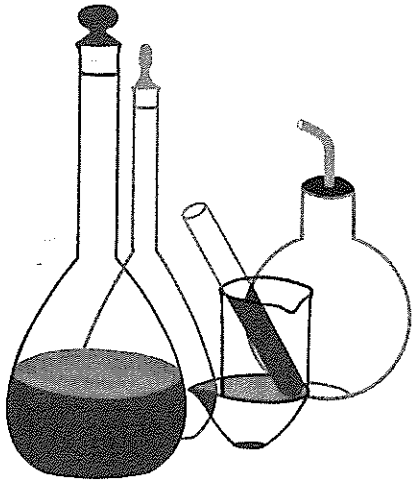
As part of its programme for making the implications of scientific research known the CSIR organized a two-day visit to Scientia in September for members of parliament. Talks and demonstrations in connection with activities were presented in the four main categories into which the CSIR's aims can be divided, namely :

- *the development of human resources, inter alia* basic research (whether projects in the CSIR's own laboratories, support of university research or national research programmes linked with international programmes) for the development of our research workers' potential; personnel research, training of technicians and research into educational techniques; facilities and buildings; international liaison; library and information services
- *the development of material resources* (industrial production), *inter alia* the study of technological innovation as a factor in industrial development and economic growth; the promotion of industrial research; research projects in the CSIR's own laboratories on behalf of various industrial sectors; services in connection with production technology
- *the development of community services* (local and regional), *inter alia* the need for co-ordinated research as a basis for planning regional development; research into urban development including housing schemes, removal of waste products and prevention of air pollution; research into the design of hospitals and other special buildings; nutrition and use of water
- *the development of national services, inter alia* investigation into the need for research for the development of an infra-structure for economic progress; research into roads, road transport and rail transport; harbours and sea transport; air transport; pipelines and communications.

Altogether 54 members of parliament and senators (including the Minister of Planning and two other cabinet ministers) and their wives visited Scientia on this occasion.

On June 21st the first issue of the *South African Journal of Antarctic Research* appeared. This journal, which will be published annually, is primarily a medium for the publication of original research results in the various disciplines to do with the Antarctic. It is published by the South African Scientific Committee for Antarctic Research, with the financial support of the Department of Transport, which has been maintaining the South African base, Sanae, in the Antarctic for a decade already. The CSIR attended to the editorial work and distribution. The first issue was well-received and aroused interest in different parts of the world, especially in the countries which signed the Antarctic Treaty.

Chemical Research



National Chemical Research Laboratory

Director: Dr P. C. Carman

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

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

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

It is the NCRL's policy to concentrate its fundamental research on fields where, for practical reasons, a demand for more knowledge exists. In accordance with this policy, 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 *ad hoc* committee set up by the Department of Bantu Administration and Development to place municipal production of Bantu beer on a national basis, has issued a report which has been accepted *in toto*. As a result a diploma course in brewing technology has been initiated and the next question under consideration is the setting up of regional breweries to avoid a multiplicity of small breweries. At present production seems to have settled down to a slow annual increase and 12 breweries, less than one-third of the total number, produce three-quarters of the beer.

In its attempts to improve souring techniques suitable for industry, the Laboratory found that it is practical to use frozen inocula to inoculate the souring stage. The process has been patented.

Corrosion

The demand for the services of the Corrosion Group has increased steadily, and a senior officer has been stationed in Cape Town to handle problems in the area, especially those experienced by the Navy.

An extensive and useful report has been compiled on a four-year programme in which steel specimens coated with various types of metallic protective coatings were exposed at nine widely differing sites.

Serious attention is being given to the perforation of galvanized iron hot-water pipes in Durban. This does not appear to be a problem elsewhere.

Pharmacologically active substances

Derivatives with hormone properties were prepared from steroids occurring in members of the cucumber species. To avoid dependence on steroids of plant origin this work is being supplemented by a wholly synthetic approach, in collaboration with a French firm.

Three South African plants have shown promising activity against cancerous tumours, and the active principles are being isolated.

Toxic metabolites from fungi

New toxic substances are being isolated and their structures determined. The question of how and why metabolites are produced by micro-organisms is also being studied. They do not seem to be essential since a fungal species which causes some strains to produce toxins can also exist in strains which do not produce toxins. A beginning has been made in following the metabolic pathways in biosynthesis.

The National Institute for Nutritional Diseases, the Microbiology Research Group and the Department of Agricultural Biochemistry at Pretoria University are also involved in this work.

Poisonous substances in plants

For many years it has been known that tubers of *Neorautanenia ficifolia* cause fatal poisoning but attempts to isolate the toxins were unsuccessful. This year, a substance with the required toxic properties was found. It is not very stable, which explains past difficulties.

The sap of another indigenous plant, *Smodingium argutum*, popular with gardeners, causes allergies similar to those caused by American poison ivy, though the plants are not related. It appears, however, that they produce active principles which are chemically similar.

Insect pheromones

Work on the gregarization of locusts is carried out in collaboration with the Department of Zoology at the University of the Witwatersrand. An active extract has been obtained from which two components have been isolated, which produce some of the effects of gregarization. As the whole gamut of changes is not obtained, however, the extract must be a mixture of several active substances.

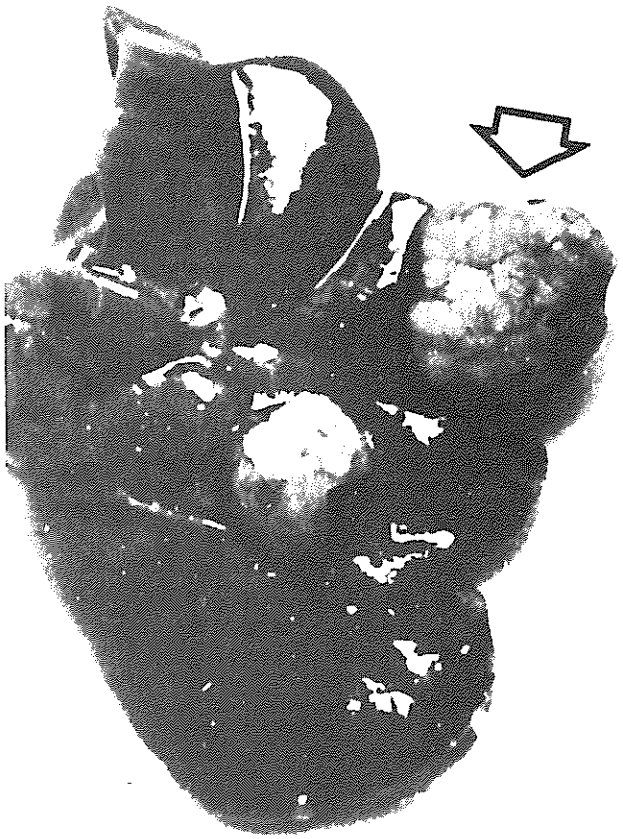
Digestion and metabolism in ruminants

This work, carried out in collaboration with the Veterinary Research Institute at Onderstepoort, is well known for the finding that the bacterial population in the rumen of sheep changes with diet.

When sheep feed on low-grade teff hay, the predominant cellulose-digesting organism in the rumen is *Butyrivibrio fibrisolvens,* while the *Ruminococci* species is present when their diet is of a good quality. If the low-grade diet is supplemented with urea or biuret the population changes from the former to the latter. *Butyrivibrio fibrisolvens* not only digests cellulose relatively slowly, but also does not break it down completely. This is in accord with poor appetite and loss of condition found in sheep when they are fed on unsupplemented, low-grade teff hay.

Large fistulas have been used successfully on sheep to obtain representative samples of coarse matter in the rumen. In this way the rumen contents can be well stirred and spooned out.

The officer concerned with this work has been invited to serve on a sub-committee on microbiology and nutrition formed by the Commission on Nutrition of Animals of the International Union of Nutritional Sciences.



Rat liver with tumour.

During the year a guest worker from the University of Munich applied the techniques for determining bacterial populations to several species of wild ruminants.

Cancer biochemistry

It was reported last year that after a single dose of a carcinogenic dye, i.e. long before tumour formation, the dye attaches itself to the protein fraction of inactive chromatin in the nuclei of liver cells and appears to weaken the binding between protein and DNA. This would affect genetic control in the cell.

It has now been established that a major difference between chromatin from tumour cells and from normal cells in the same liver is that in tumour cells nearly all the protein can be separated from DNA. Thus the biochemical changes detectable at an early stage are intensified in fully active cancer cells.

Large amounts of tumour nuclei and normal nuclei are being prepared for a close comparative study of their components.

Protein chemistry

Work on the sequence of cobra and mamba toxins has proceeded rapidly and the data so far accumulated was used to determine an evolutionary tree for eleven species. A paper on this new development has been published. Besides toxins, snake venoms contain several enzymes and a study of these is now well advanced.

Further studies have been made of the two components of phosvitin in the yolk of fowl, duck, turkey and ostrich eggs. Very pure fractions can be obtained from duck eggs, and sequence studies will be undertaken. A prerequisite however, is a means of removing the large amount of phosphate attached to the protein fractions.

Analytical chemistry

The systematic study of ion-exchange separation techniques has shown how much improvement in time and accuracy can be achieved in the analysis of solutions containing small amounts of many elements. The leader of this work is a member of the CSIR team which analyses moon samples and he regularly analyses samples used for international reference. His is the only complete ion-exchange system thus far used to analyse lunar material and it is believed to give more accurate results than classical silicate rock analysis or the newer instrumental methods. Analyses of two lunar samples have borne this out, even though twelve elements had to be determined in 0,25 g.

Pneumoconiosis

The formation of fibrous nodules in the lung is a characteristic feature of silicosis. Silica injections cause fibrosis in rat livers. This gives a convenient model system which has been used to test reports in literature that polyvinylpyridine-N-oxide (PVPNO) can cause regression of silicotic fibrosis in human lungs. Tests showed that PVPNO does indeed stop development of fibrosis in rat livers and cause partial regression of existing fibrosis.

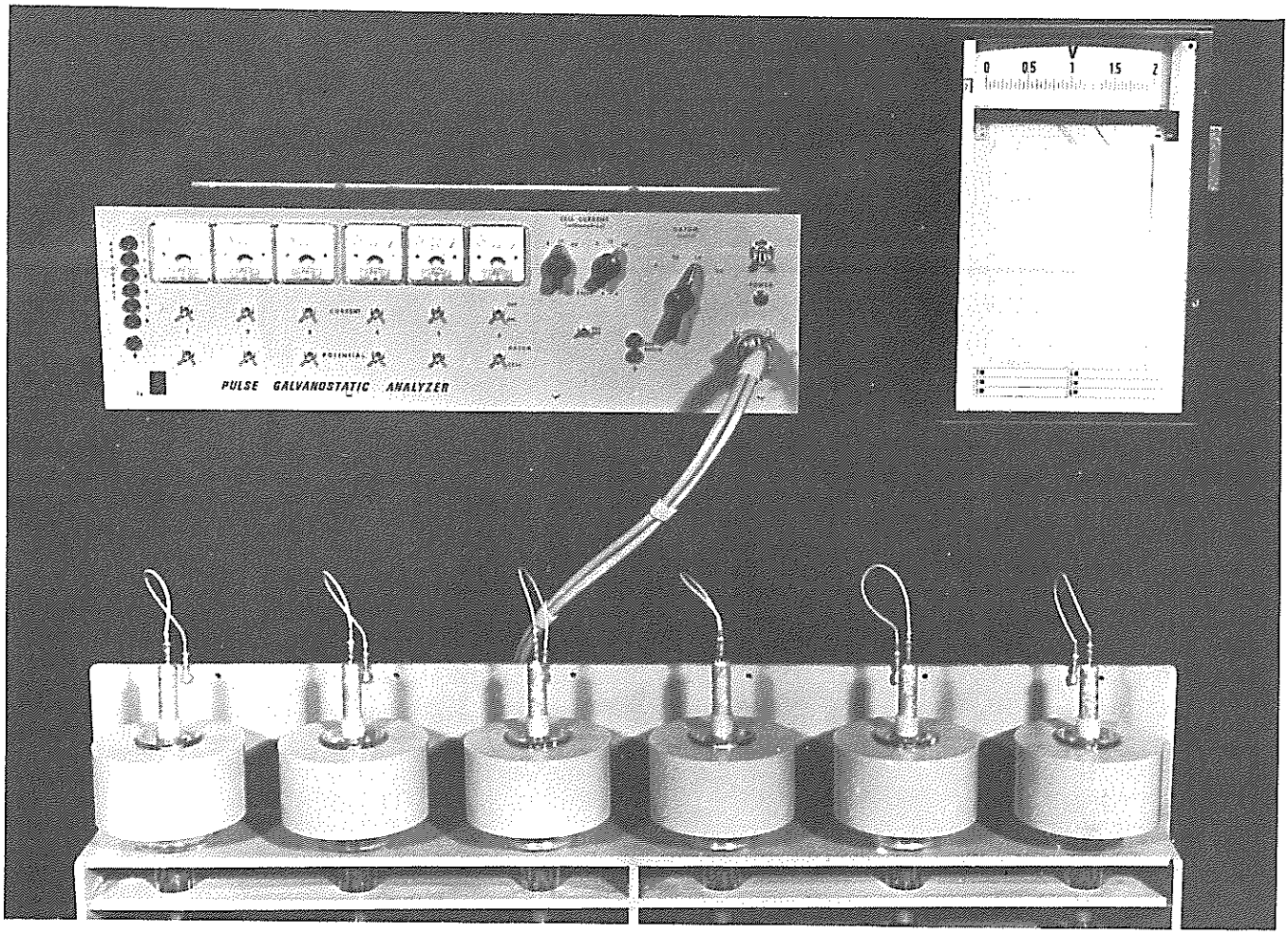
Human growth hormones

Although the legal position in South Africa makes preparation of human growth hormones almost impossible, enough has been prepared to treat one child suffering from dwarfism. The Medical School in Durban has undertaken to do this.

Chemistry of gold and platinum

This group of metals is currently a source of great interest and a series of papers recently published by the Laboratory was well received. As a result a junior staff member was granted a bursary to study at one of the most prominent research laboratories for inorganic chemistry in the USA.

In the case of gold, sulphur containing ligands are of interest, and some success has been achieved in their preparation and study. Considerable advances have been made in the development of new preparative techniques



The Pulse Galvanostatic Analyser for determining rapidly the suitability of manganese dioxides for dry cell manufacture.

for organometallic complexes of rhodium, iridium and ruthenium, and new compounds for homogeneous catalysis have been prepared.

This work receives financial support from the Chamber of Mines.

Heat exchangers

The computer program compiled by the Chemical Engineering Group for the optimised design of heat exchangers has been much used by industry. This service has been greatly improved this year since the Group joined an international Heat Transfer and Fluid Flow Service. As the Group supplied the service with its computer program the large entrance fee normally charged was waived.

Particle technology

In collaboration with a gold mining company two industrial-size thickeners in parallel were prepared for experimental work. One of the thickeners was used as a control. This was necessary since in practice feed to thickeners is not constant.

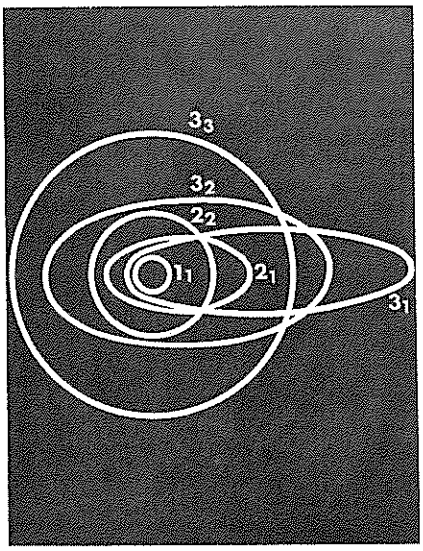
Methods of analysing particle size were improved. This is one of the services regularly provided for industry.

Dry cells

Since the properties of manganese dioxide ore can vary extensively within a single deposit it is necessary to mine selectively and to distinguish between dry cell active, metallurgical and chemical grade manganese dioxide.

An instrument for determining rapidly and accurately the suitability of manganese dioxides for dry cell manufacture has been developed by the Institute's Chemical Engineering Group for the mining industry.

Physical Research



National Physical Research Laboratory

Director: Dr A. Strasheim

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

Speech visualizer

A speech visualizer developed by the NPRL makes it possible to teach deaf children to speak more naturally. This instrument displays accent, rhythm and intonation graphically on the screen of an oscilloscope in such a manner that even a young deaf child can grasp their meaning. The child may compare his own vocal patterns with the standard pattern set by the teacher. With practice the child learns to imitate the standard voice patterns more closely. It can be said that this instrument enables the sense of sight to take over certain functions which, in the case of a person with normal hearing, are performed and controlled by the sense of hearing.

A deaf person experiences speech merely as a movement of the lips and jaw and if he lays his fingertips on the throat of the speaker he can also feel the sound vibrations. Using these two senses only, he can never hope to speak naturally since the production and control of speech also depends on the perception of stress, rhythm and intonation. For this, the sense of hearing is almost indispensable and the speech of a deaf person is therefore usually not very intelligible.

A member of the Laboratory investigated the basic requirements of a speech visualizer and developed the first two prototypes which used electromechanical systems to display the desired patterns on a screen. The device was then tested in practice at a school for the deaf. In the latest model, built by the National Electrical Engineering Research Institute, the use of modern electronic techniques simplifies manufacture and increases the usefulness of the instrument.

At present a South African manufacturer is considering producing a number of these instruments as a recent investigation showed that there is widespread interest in them.

Transfer function for evaluating optical and opto-electronic systems

In the past the image quality obtained by optical and opto-electronic systems was usually determined by subjective methods, but nowadays transfer function methods are generally used. Suitable equipment for the determination of transfer functions is therefore indispensable in the development of specialized optical systems.

During the year the necessary equipment was acquired from overseas and put into operation. A large number of optical systems have already been evaluated and problems previously experienced with the assembly of, for example, optical and opto-electronic components, can already be solved.

X-ray diffraction at high pressure

An apparatus has recently been constructed to obtain *in situ* X-ray powder diffraction patterns at pressures of up to 250 kilobars. Filtered molybdenum radiation (wavelength 0,71069 Å) passes into a high-pressure cell via an annulus of lithium hydride, and is collimated by means of platinum bars. The diffracted pattern is recorded by a flat plate camera 11 cm from the sample. Excellent patterns are obtained with well-ground samples. Temperatures above ambient can be obtained by external heating of the cell, but thus far have been limited to 120°C.

With this apparatus the crystal structures of new phases which are stable only at high pressure, can be determined. The results are expected to help clarify crystal chemistry not only at high-pressures but also, by inference, at ambient conditions.

Weather radar

The Laboratory's research on thunderstorms in the Pretoria-Witwatersrand area will be greatly aided by a high-resolution 10-cm weather radar recently installed at the Houtkoppen Radar Facility. The radar has a resolution at short ranges comparable with that obtained from the surface patterns of hailstorms.

The surface data are provided by more than 4 000 voluntary observers in the area. Many additional observers were enrolled before the summer of 1970/71 so that far greater detail on hailstorms is now being obtained.

The radar will also provide valuable information for use in connection with the network of lightning direction finders established in collaboration with the National Electrical Engineering Research Institute.

Fosforatelometer

At the request of the Government Printer the Laboratory has designed and manufactured an apparatus which monitors the quality of the phosphorescent border on postage stamps during the printing process.

The apparatus, the fosforatelometer, duplicates the temporal and spectral qualities of the Department of Posts and Telegraphs' sorting and cancelling machines which use the phosphorescent properties of the postage stamp to identify its position.

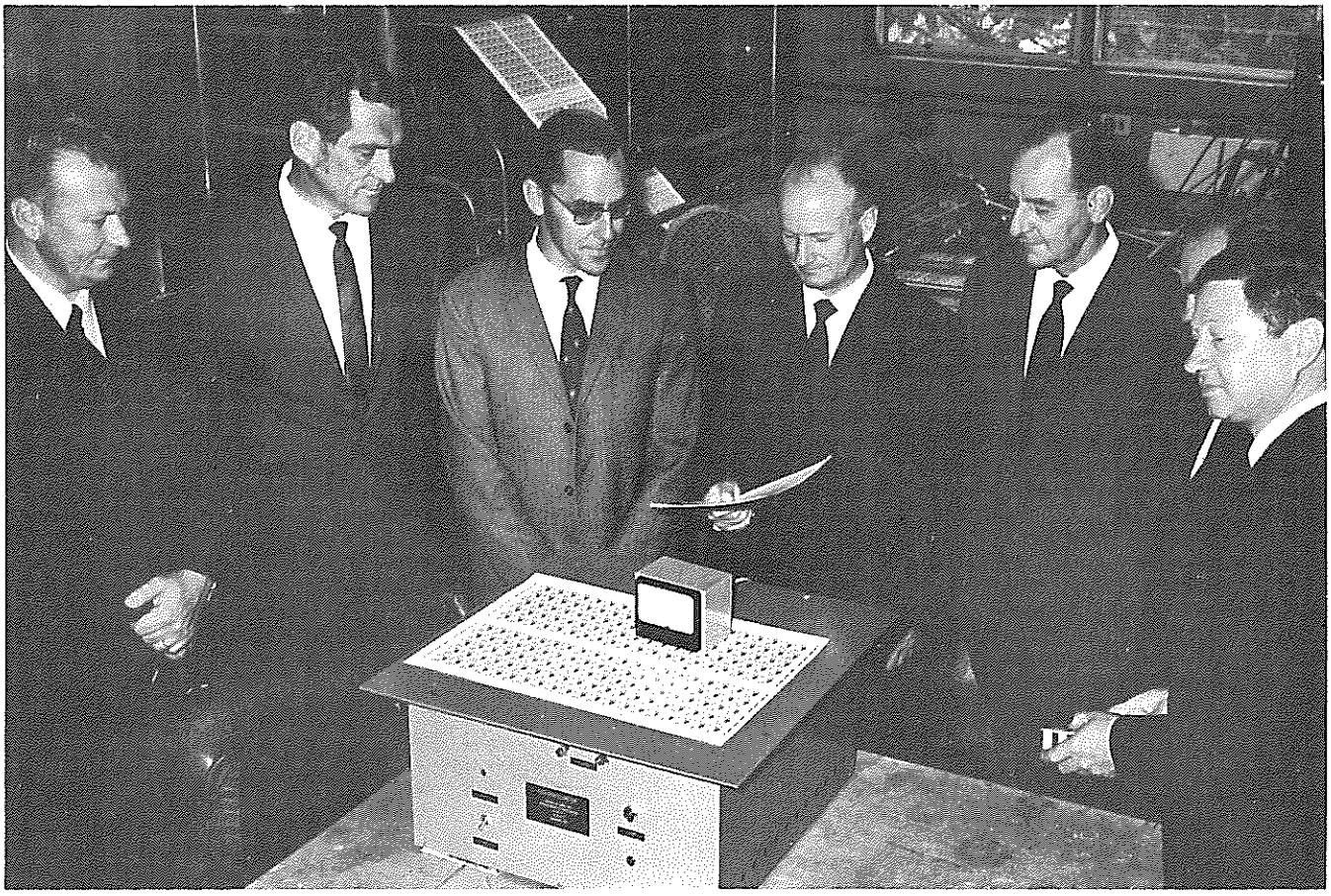
hitherto accepted dating of human development in Southern Africa. It must now be accepted that the transition from the Middle Stone Age to the Later Stone Age occurred well before 40 000 BC and not at about 15 000 BC as previously estimated.

These new dates are important to anthropological research since they prove that a developed form of *homo sapiens* existed here before 46 000 BC which is at least 8 000 years earlier than in areas such as the Middle East and Europe.

Moon rock analysis

The National Chemical Research Laboratory and the National Physical Research Laboratory are together analysing moon rock. A selection of ten samples of different

Handing over of the fosforatelometer to the Government Printer.



Laser mass spectrography

Advantages of analysis by means of the laser source over analysis using the usual spark techniques are that samples need not be electrically conductive and that analyses can be performed *in situ*. In a study of the use of a high repetition-rate laser probe as an ion source in mass spectrography a further advantage was established, i.e. after recording the first mass spectrum it was shown that the spectral line shape is superior to that obtained using spark excitation.

The method has been used for the analysis of geological materials, especially in the study of lithium isotopic ratios of terrestrial, meteoritic and lunar samples.

Chronology of the Stone Age in Southern Africa

C-14 determinations on archaeologic finds of the Stone Age period have necessitated a drastic revision of the

origin, including five basalts and five granites (one of which has been analised in 35 international laboratories) and two lunar samples recently received, have been analysed by five different methods.

The methods used included separating elements into chemical groups by means of ion-exchange and the subsequent analysis of these by gravimetric, volumetric and colorimetric methods and also by atomic absorption spectrophotometry; direct X-ray fluorescence analysis of the powdered rocks; analysis of fused beads of the samples by X-ray fluorescence (lithium tetraborate used as flux); spark source mass spectrography; direct analysis of the rocks in solution (without prior separation) by atomic absorption spectrophotometry.

Because of the very nature of the techniques any one method cannot determine all the elements. For example, in spark source mass spectrographic analysis elements

present at concentrations greater than 2 to 3 per cent are not determined because of inherent inaccuracies at this level. An indication of the agreement obtained between the various techniques can be seen from the following results in which the mean deviation for a few elements is given together with the concentration level in brackets :

Al_2O_3 : 0,22% (15%); FeO : 0,07% (10%), 0,08% (2,5%); MgO : 0,37% (9%), 0,08% (0,7%); CaO : 0,08% (10%); K_2O : 0,1% (4,0%), 0,05% (0,5%); TiO_2 : 0,035% (1,8%), 0,02% (0,42%); MnO : 0,01% (0,14%); Cr : 0,008% (0,17%); Ni : 0,9 dpm (12 dpm); Ba : 51 dpm (950 dpm); Y : 33 dpm (200 dpm); Rb : 25 dpm (170 dpm); Co : 7 dpm (25 dpm); V : 5 dpm (30 dpm); Cu : 3 dpm (20 dpm).

From the values obtained it can be shown that very accurate direct analysis of powdered rocks by X-ray fluorescence is possible and that spark source mass spectrography may be considered a fully quantitative technique. This information is particularly valuable in the analysis of silicaceous materials for trace elements which may act as indicators of mineral deposition.

Sea current studies

If effluents are to be deposited off Richards Bay inshore sea-current regimes must be known. Accordingly, since May 1970 regular bi-monthly current studies have been undertaken on the continental shelf off Richards Bay. Preliminary results show a current pattern closely related to changing weather conditions. The current pattern includes the south-flowing Agulhas current moving offshore beyond the edge of the shelf; the formation of an eddy; the occurrence of patches of cold water caused by upwelling close inshore and the wind changing from an initially north-easterly to a south-westerly direction; and finally, a calm when the Agulhas current again flows strongly along the edge of the shelf.

These regular current measurements have been made possible by a new radar range positioning system with shore-based transducers. Distances measured are accurate to within 10 metres.

Gold analysis

A technique has been developed to analyse gold, silver and copper in gold bullion by means of a Grimm glow-discharge lamp spectrometer system.

Interelement effects have been eliminated by the introduction of a mathematical function compiled for the purpose. The average deviations obtained were 0,13%, 0,99% and 2,0% for gold, silver and copper respectively, in gold samples containing 0 to 5% copper and 0 to 15% silver. The average deviations of the standards used were 0,10%, 0,70% and 2,0% for gold, silver and copper respectively.

This technique has already been accepted by a refinery as a routine method for analysing gold bullion.

Geophysical and natural isotope studies

Ecologists are concerned about the high salinity of Lake St Lucia and various remedies are being considered. To plan countermeasures efficiently the water budget must be known as accurately as possible.

One of the important unknown quantities is the amount of groundwater that enters the lake along the eastern shore. A preliminary electrical survey in the area has shown that this method is suitable for determining the thickness and size of the sandy aquifer. A full-scale geophysical survey of this kind, combined with pumping tests, could determine accurately the groundwater seepage. Such an investigation is being planned.

Regular measurements of the oxygen-18 content of the lake water show that during the past season evaporation in the area between the estuary and False Bay increased. This suggests that considerable amounts of sea water were entering the lake through the estuary. This conclusion was confirmed by measuring the concentration of natural tritium. The tritium content in the southern part of the lake is between that of the fresh water entering the lake and sea water. Further measurements are being planned in an attempt to determine the ratio of sea water to fresh water in different parts of the lake.

Cross-section of an anti-shark barrier cable.

Precise physical measurements

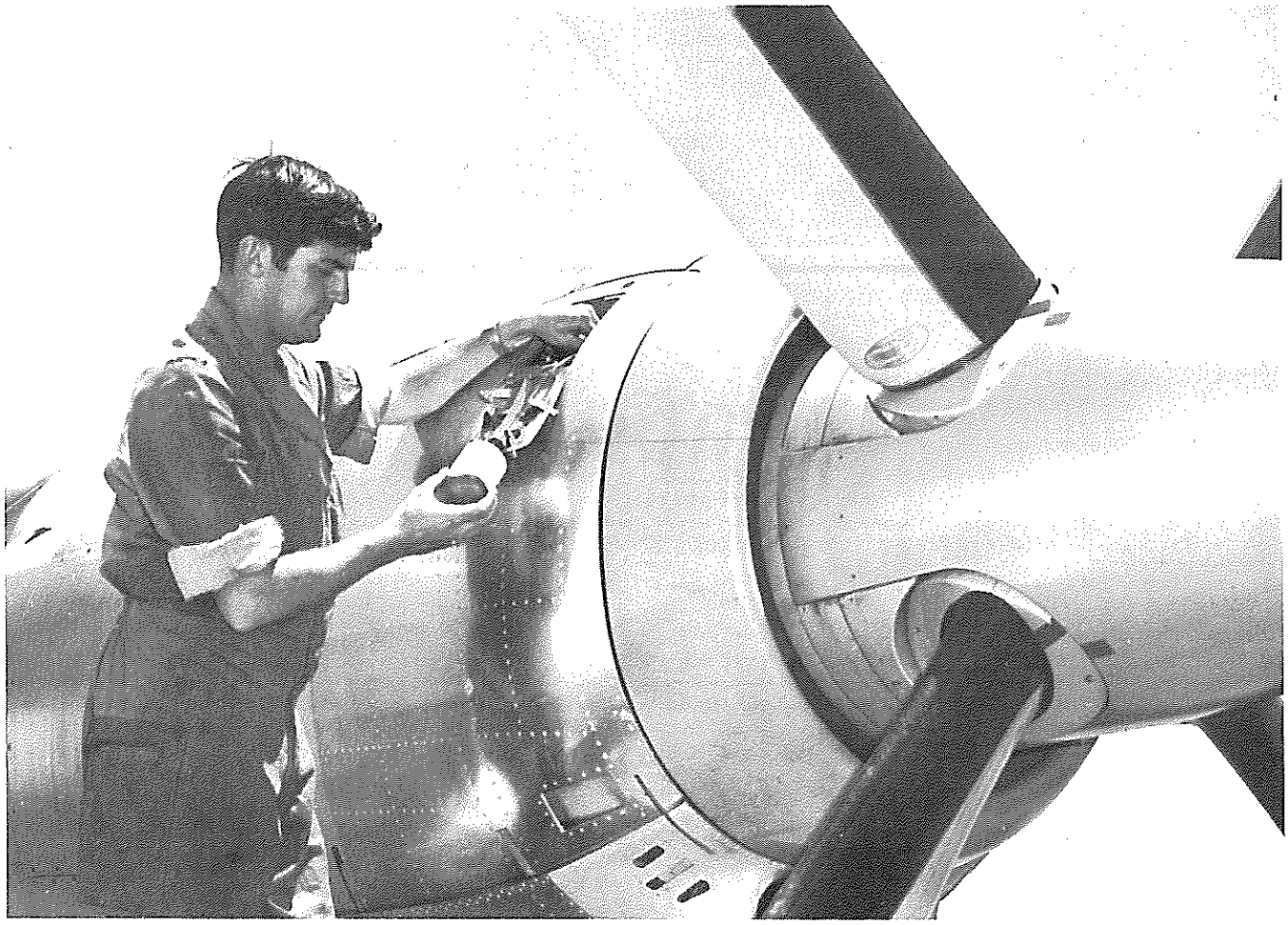
With the development of South African industry the need for precise standards of measurement and accurate calibration facilities has increased. This need is reflected in the amount and variety of work which the Precise Physical Measurements Division now has to perform. The ability of the Division to keep ahead of demand depends on the work which continually goes into the improvement of equipment and on the research into better methods of measurement.

The D C measuring facilities of the Division were recently brought up to world standards and the length measuring facilities are now under review and will also be improved.

The Division has helped to solve a number of specialized industrial problems and now co-ordinates the lending of standard measuring equipment amongst industrial bodies.

Optical filter design

The Laboratory recently acquired and began operating a synthesis programme in order to be able to determine beforehand the structure of an optical filter. It was obvious that the development of optical filter technology could be accelerated if the structure of the film were determined beforehand, either with the help of literature or by computation with a digital computer. In general there are two programme types for such a computation.



Taking oil samples from an aircraft of the South African Air Force.

Firstly, an analysis programme may be used. In such a programme the construction data about the filter are used as a starting point to compute the transmission curve. This means that the structure of the film must be known *a priori* and that this is therefore a hit-or-miss procedure.

Secondly, there is a synthesis programme in which the end result, i.e. the transmission curve, is used as starting point. The computer calculates, within certain constraints, the construction data. The value of this method is that the structure of a filter with practically any transmission curve may be computed.

The synthesis programme recently acquired, was written by a world expert on thin-film optics. This comprehensive optical filter design programme is a valuable addition to the scientific and technical facilities in the Republic.

Optical remote sensing

Literature on new developments in the field of remote sensing and its application in the management of natural resources was studied during the year.

On the instruction of an interdepartmental committee, a member of staff led the South African delegation to the International Workshop on Earth Resources Survey Systems organized on the authority of the United States government. In preparation an attempt was made to obtain an overall view of present and potential applications of remote sensing in South Africa. A symposium on this subject is being planned for 1972.

Short-lived radioisotopes for medical use

During the year a programme was launched to produce regularly short-lived carrier-free radioisotopes for medical applications in South African hospitals.

These radioisotopes, which are either unavailable or very difficult to obtain from overseas have radiation characteristics which make them very valuable in diagnostic medicine.

For example, iodine-123 which has a half-life of 13 hours is delivered fortnightly to Groote Schuur and Karl Bremer hospitals in the Cape for thyroid diagnoses, while 78-hour gallium-67 is sent weekly to Groote Schuur, Karl Bremer, the Provincial Hospital in Port Elizabeth, and the H F Verwoerd Hospital in Pretoria for localizing malignancies. Up to mid-September 1971, 70 batches of Ga-67 (totalling 900 millicuries) had already been delivered.

Radioisotopes for intravenous injection must conform to high standards. Quality control during the chemical processing of the bombarded cyclotron targets is therefore very strict. To ensure that products are free from pyrogens (agents which cause uncontrolled rise of temperature in patients) trial samples are tested regularly at the SABS with the aid of experimental animals.

Shark barrier

Work has started on the first electrical anti-shark barrier which will protect an established seaside resort on the Natal coast. The installation of the cable with a mass of 30 tons, around the area is a lengthy, complicated procedure. A bathing area of 45 000 m^2 will be enclosed.

Analysis of lubricating oil

The spectrometric determination of the concentrations of certain wear metals in lubricating oil is one of the most sensitive methods for detecting abnormal or excessive wear in engines. The Spectrochemistry Division of the Laboratory has developed such a technique for application to aircraft engines and has trained South African Air Force personnel to do the work. For the past eighteen months this technique has been used to monitor certain aircraft engines of the South African Air Force with a view to preventive maintenance.

The project has proved very successful and has already resulted in considerable savings. As soon as the Air Force has equipped a laboratory, the programme will be transferred to them and will be extended to cover all their aircraft.

Geomagnetic depth sounding

A geomagnetic depth-sounding programme to determine the electrically conductive areas in the earth's crust and upper mantle, is at present being undertaken by the Geophysics Division in co-operation with the University of Edmonton, Alberta, Canada.

In the present investigation, the first of its kind in South Africa, both the 1 000 million-year-old metamorphic zone in Namaqualand and the older shield area further east have been included. Previous geophysical measurements by the Laboratory such as deep electrical soundings at Pofadder and Dealesville, and heat-flow measurements and seismological investigations by the Bernard Price Institute have shown that these terrains are different.

It is hoped that the project will provide more information on this major geological feature.

Geochronology

Radiometric dating of minerals by the Laboratory for South African universities and the Geological Survey played an important role in the publication of a revised geological map for South Africa, Lesotho and Swaziland. This is the first time in the history of geological research in Africa that a stratigraphic column based on radiometric measurements has been established for a stratigraphic sequence of geological systems and formations.

Coast-to-coast correlation problems were solved by radiometric dating to pave the way for a tentative stratigraphic column for Southern Africa including the Republic of South Africa, Swaziland, Lesotho, South-West Africa, Botswana, Rhodesia and Mozambique.

The successful application of radiometric dating in geological research has led both the Geological Survey and the South African universities to contribute financially on an annual basis towards these services.

Acoustics

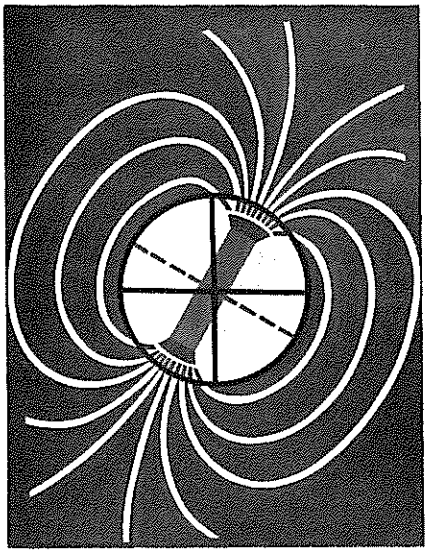
The acoustic design of new buildings, advice to improve the acoustics of existing buildings and the varied problems of industrial and traffic noise occupy the staff of the Acoustics Division full-time.

The Division was responsible for the acoustic design of the Nico Malan opera house which was opened this year, and also completed the acoustic design of the SABC's Pietersburg studios. The acoustic treatment of a large conference room and the design of a novel stereophonic sound-recording system for it proved highly successful.

The acoustics for four new churches with no natural ventilation are being designed for noisy areas in four cities. Work continues on the acoustic design of opera houses, broadcasting studios, university lecture rooms and school rooms.

After a successful symposium on the design of church buildings enquiries into acoustic problems in churches increased noticeably.

Geomagnetism



Magnetic Observatory

Head : Mr A. M. van Wijk

Although the activities of the Magnetic Observatory at Hermanus have, from their very nature, an international character, the needs of local research workers and national organizations are also taken into account. The functions and current programme of the Observatory include the continuous recording of geomagnetic and allied geophysical elements, the determination of the configuration and variations of the magnetic field in Southern Africa, the maintenance of magnetic standards, the analysis and dissemination of the data, and co-operation in both national and international geophysical programmes. The Observatory's own research programme is concerned mainly with the analysis and interpretation of time variations in the recorded data.

Geomagnetism

The changes in the earth's magnetic field are recorded continuously at the Observatory at Hermanus and also at Tsumeb in South-West Africa. The recording station at Tsumeb is situated in the grounds of the Ionospheric Research Station of the Max Planck Institut für Aeronomie and is operated by the staff of the research station.

In view of the extensive geographical area served by the Observatory, it has been decided to establish at least two more magnetic recording stations in the Republic. Considerable progress has been made with the automation of the existing recording stations and special variometers of modern design are being developed at Hermanus for the proposed new stations.

A special fluxmeter is used at Hermanus for the continuous recording of geomagnetic pulsations in the frequency range 0,2 to 0,003 Hz. The pulsations are classified in accordance with international procedure and reported in the Observatory's monthly magnetic bulletins.

The object of the primary magnetic field programme is to determine the absolute values and secular variation of the magnetic elements in Southern Africa. For this purpose a network of sixty primary magnetic field stations (repeat stations) is maintained in the Republic and South-West Africa. Whenever possible the observations at the field stations are co-ordinated with similar surveys in Rhodesia and Mozambique.

Three long-term projects were initiated during the year to investigate the nature of the magnetic variations in the seismic region of the Western Cape, the possibility of piezomagnetic effects at the site of the proposed Theewaterskloof Dam, and the influence of the sea and/or the edge of the continental shelf on geomagnetic variations.

An analytical investigation of the magnetic quiet-day (Sq) diurnal variation has revealed an interesting seasonal effect.

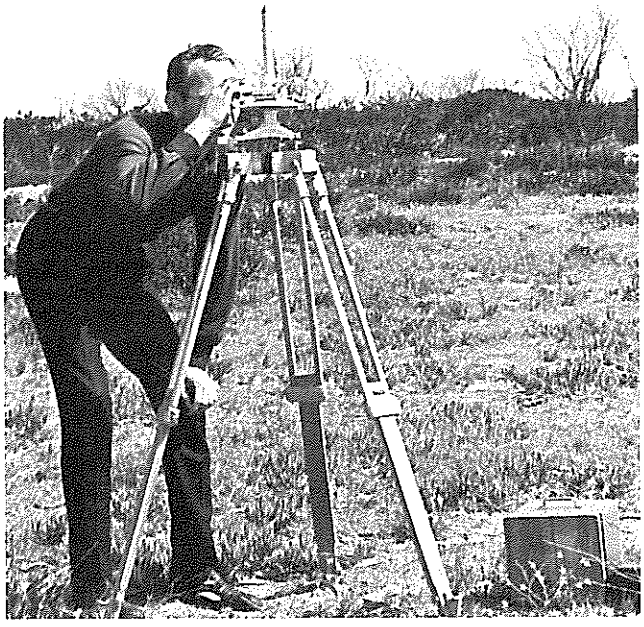
Cosmic rays

Variations in cosmic ray intensity are continuously registered by a neutron monitor (type Chalk River 3-NM-64). The programme is carried out in co-operation with the CSIR Cosmic Rays Research Unit at the Potchefstroom University. The data are processed on the computer at Potchefstroom and published by the Observatory.

Because Hermanus is favourably situated for studies of long-period and short-period variations of cosmic ray intensity, it was decided during the year to enlarge the neutron monitor to four times its present size. The addition of nine counters to the existing three will increase the counting rate by a factor of four (to approximately 4×10^5 per hour) and reduce the standard deviation by a factor of two (to 0,16%).

At the instigation of the Cosmic Rays Research Unit a special device was added to the read-out system of the existing monitor to provide information on the multiplicity of the nucleon component of cosmic rays.

A member of the 1971 South African Antarctic team becomes acquainted with one of the field magnetometers he will be using at Sanae.



Since June 1971 the atmospheric pressure data required for the reduction of the neutron counts have been obtained directly from a servobarometer. The commissioning of the servobarometer was the final step in the automation of the monitor and the barometric data are now far more accurate.

Ionospheric observations

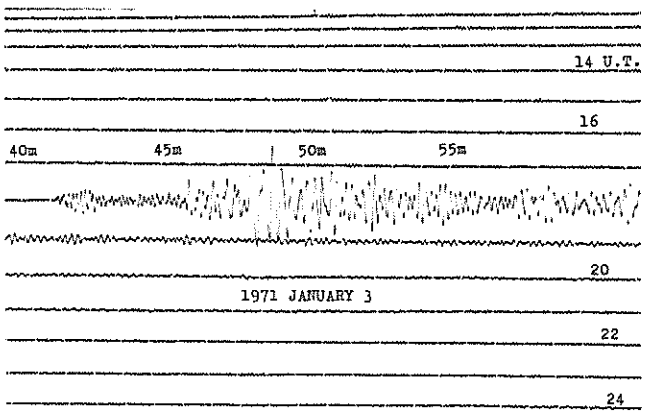
The Observatory is included in the network of 30 MHz riometer stations established in 1963 by the Air Force Cambridge Research Laboratories (Bedford, USA). The continuous records of cosmic radio noise provide information of the relative opacity of the ionosphere to radio waves. The data recorded at Hermanus are of interest to geophysicists in South Africa and are currently being used by a postgraduate student of the Potchefstroom University for research into the absorption of cosmic radio noise.

The integrated intensity of atmospheric noise was continuously recorded on the 27 kHz receiver. The data are used to identify solar flare effects on the magnetograms.

The ionosonde of the National Institute for Telecommunications Research (NITR) was moved from Cape Town to Hermanus on 10th May 1971 and began operating at the Observatory on 13th May 1971. The data are processed at the NITR in Johannesburg and published in its *Monthly bulletin of ionospheric characteristics.*

Seismology

Preliminary reports of earthquake phases recorded by the two Milne-Shaw seismographs are supplied to the seismological centres in Washington, Strasbourg and Edinburgh on a three-monthly basis. Although the seismological programme is a side-line for the Observatory, the reports have proved useful in detecting local earth tremors and in distinguishing between pulsations of magnetic and seismic origin. Seismograms were loaned to the Geological Survey in Pretoria and to the Goetz Observatory in Rhodesia for research into the Western Cape earthquakes of 1969-70.



A seismograph record of an earthquake in the South Atlantic Ocean 450 km west of Bouvet Island.

Ozone observations

The Observatory began operating an ozone recorder for the Max Planck Institut für Stratosphärenphysik in September 1970. The immediate object is to determine the latitude effect and time variations in the ozone content of the lower atmosphere. The sixteen selected observation posts lie within a narrow longitude strip from Tromsö (Norway) in the north to Hermanus in the south.

Aerosol sampling

During the period 1st October to 7th November 1971, the Observatory operated an aerosol sampler for the National Centre for Atmospheric Research, Boulder,

A distant field station operated by the Magnetic Observatory.

USA. The apparatus uses special filters to collect extra-terrestrial magnetic spherules. The object of the investigation conducted simultaneously in the northern and southern hemispheres, was to determine the nature, incidence and global distribution of the spherules.

Geophysical alerts

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

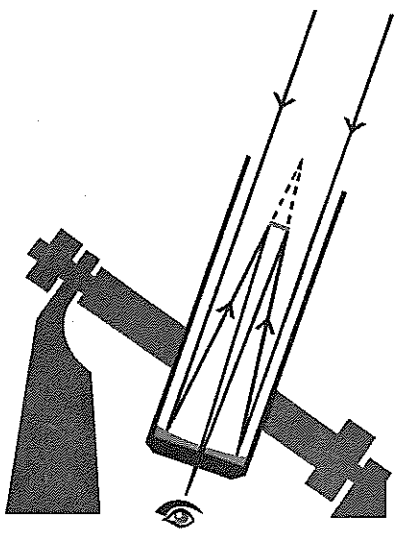
Magnetic activity indices

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

Antarctic research

The Observatory provides laboratory and other facilities for the geophysicist from the Potchefstroom University who organizes the Antarctic programme for geomagnetism and aurora on behalf of the Department of Transport. The geophysicist is stationed at Hermanus and is assisted by a research officer of the Observatory who has been seconded to the Antarctic research group.

Astronomy



Republic Observatory

Acting Director: Mr J. Hers

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

The principal long-term programmes of the Observatory comprised 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.

The short-term projects of the Observatory included the successful search for Proxima Centauri, our nearest known stellar neighbour apart from the sun, the dectection 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.

During the year the British Science Research Council and the CSIR signed an agreement to establish a new South African Astronomical Observatory. As from 1st January 1972 the resources of the Republic Observatory (Johannesburg) and the Royal Observatory (Cape Town) are to be combined. Although astronomical observations on a limited scale will be carried on in Johannesburg for some years, the new observing sight will be at Sutherland, C.P., and the headquarters in Cape Town.

Long-period variable stars

Observations of this important group of variable stars have been carried out with the 20-inch reflector. The availability of this telescope for extensive periods throughout the year has made 22 500 observations on 127 nights possible. As a result a number of light curves were constructed and published.

Planetary photography

This programme which is organized and financed by the Lowell Observatory is carried out at a number of observatories well separated in longitude in order to provide an almost continuous watch on the planetary surfaces.

The 26½-inch refractor is equipped with a camera using 35-mm monochrome film combined with red, green and blue filters. During the year 55 000 photographs of Mars and 37 000 of Jupiter were exposed and sent to the Lowell Observatory for processing. Unfortunately incessant dust storms on Mars spoilt many of the photographs of that planet.

Comets and minor planets

The Franklin Adams telescope at Hartebeestpoort Dam was used to expose 201 minor planet plates and 21 comet plates on 22 nights. This gave 272 positions of minor planets and 10 of comets.

National time service

The Observatory provided the national time frequency service until 2nd December. The Radio Space Research Station at Hartebeesthoek then took over temporary transmission of the ZUO signals pending the transfer of the service to the National Physical Research Laboratory.

Visual double stars

The 26½-inch refractor was used to obtain 378 measures of visual double stars.

Photometric double stars

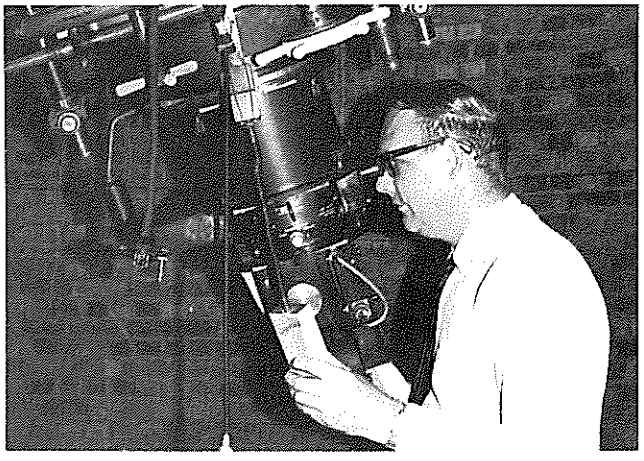
The 20-inch reflector was used on 86 nights to obtain about 6 000 photo-electric observations of 12 eclipsing binaries. The instrumentation was improved by adding a new integrating amplifier and electronic timer to the photometer.

Occultations

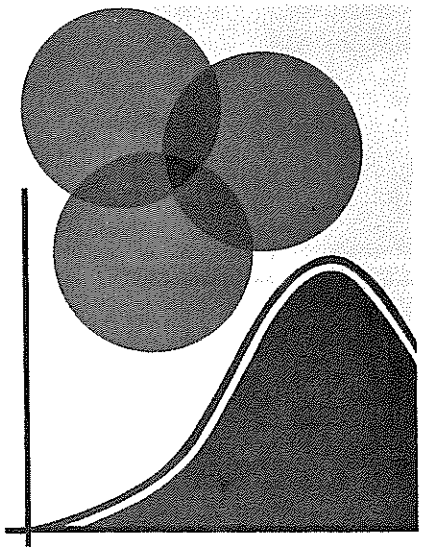
Thirty-four occultations were observed, including five which were timed photo-electrically. On May 13 the occultation of Beta Scorpii by Jupiter was successfully observed by using a photo-electric photometer and data analyser incorporating a portable computer attached to the 20-inch reflector.

Photographic records were also obtained using the planetary patrol equipment on the 26-inch refractor.

A planet camera attached to the 26-inch refractor.



Mathematical Sciences



National Research Institute for Mathematical Sciences

Director: Dr A. P. Burger

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

Weather prediction

With the active co-operation of the South African Weather Bureau considerable progress has been made in investigating methods for the numerical prediction of weather. As the application of a mathematical model to prediction at a single altitude above South Africa and a large part of the southern hemisphere was reasonably successful, methods are now being investigated which involve two altitudes or levels. A computer program for the simplest two-level model was developed and applied in practice. As had been expected, this model was not practical and a slightly more involved two-level model was developed. The corresponding computer program has been written and extensive tests can now be carried out.

Mathematical theory of fluid flow

New theorems have been developed relating to the existence and nature of the solutions of equations applicable in cases in which the boundaries of the fluid change during motion.

Road traffic problems

A study carried out for the National Institute for Road Research indicates that two recently opened freeways near Pretoria reduced travelling times by about 20 and 25 per cent respectively.

Statistical analysis of the rates of all traffic accidents and also of fatal traffic accidents in the Republic between 1961 and 1969 indicates a pronounced periodic variation in the rates.

Statistical analyses were carried out to determine standard conditions for the use of the skid test trailer being developed by the National Institute for Road Research to measure the skid resistance of roads.

At the request of the South African Road Safety Council a sample survey is being organized with the co-operation of the South African Police to obtain data on the consumption of alcohol by drivers involved in traffic accidents. The effectiveness of a recent campaign to promote pedestrian safety was also investigated at the request of the Road Safety Council.

Lightning research

Statistical analyses were carried out on behalf of the National Electrical Engineering Research Institute to determine differences in accuracy when lightning discharges are located by measurements from two or from three points.

A study was made of the variation in current strengths during lightning discharges. Although the equipment could not record currents smaller than 2 kA, the probability of the occurrence of lightning discharges with current strengths less than this could be determined by means of statistical theory.

Nutrition studies

For the National Food Research Institute, the degree to which soya meal has been cooked, its bitterness and beantaste (all as judged by a test panel) were related to the time various samples of meal had been cooked. The Institute developed new statistical theory for this purpose, and also a computer program for performing such analyses in very general cases.

In a nutritional experiment on five species of rats which were specially inbred, nitrogen determinations were made and statistically analysed. It was found that there are some species whose excretion of certain types of nitrogenous compounds is more reproducible than that of other species. In future experiments on these compounds, it would thus be expedient to use the suitable species of rats.

Urbanization of Bantu

In May 1968 South African participants in the International Biological Programme (Human Adaptability) carried out a survey on about 250 rural Venda males in the vicinity of Sibasa. In September 1968 a similar survey was done of urban Vendas from Tshiawelo near Johannesburg. Organizations from eight disciplines took part and made observations on each of the individuals in the two sample populations. These data were statistically analysed. Altogether 73 of the variables were quantitative.

The analyses created the impression that it is not particularly important from the statistical point of view that all disciplines should collaborate simultaneously in surveys of this kind. If this is so, the organization of such a survey could, of course, be simplified. Results were presented in April 1971 at the congress of the International Biological Programme at Blantyre in Malawi.

Percentage butterfat in milk

The NRIMS carried out a statistical analysis for the Animal and Dairy Research Institute to determine, for a given herd, how many samples of milk must be tested

for butterfat each day to ensure that the true average value can be determined with prescribed accuracy and probability of error.

In order to provide the necessary data the Animal and Dairy Science Research Institute determined the percentage of butterfat in composite samples of milk obtained in a random manner from 28 dairy herds on 30 consecutive days.

By using techniques of mathematical statistics it was found that the variation between herds from day to day is so great that one sample a day is necessary in order to state with sufficient certainty that the sampling average approximates the true average closely enough.

Medical studies

The following is an example of the numerous statistical analyses carried out for the South African Medical Research Council.

The Nutritional Clinic for Children carried out a variety of biochemical determinations on children suffering from three types of jaundice. The question to be decided was whether the illness of a child with symptoms of jaundice could, on the basis of the biochemical observations alone, be correctly diagnosed as one of three main types of jaundice. Statistical analysis showed that only six of the measurements are sufficient to make the classification. However, as complete data for a full analysis were not yet available from sufficiently many patients, the result is as yet provisional.

Computing centre

The computing service available to CSIR institutes and outside organizations has been improved. One of the developments was the direct coupling, by fast telephone lines, of an electronic computer at the National Institute for Telecommunications Research in Johannesburg to the central computer at Scientia.

Engineering structures and metrication

The Institute aided civil engineers with structural analysis by computing the stresses and strains in large structures. The computer programs for such computations have been adapted for use with metric units.

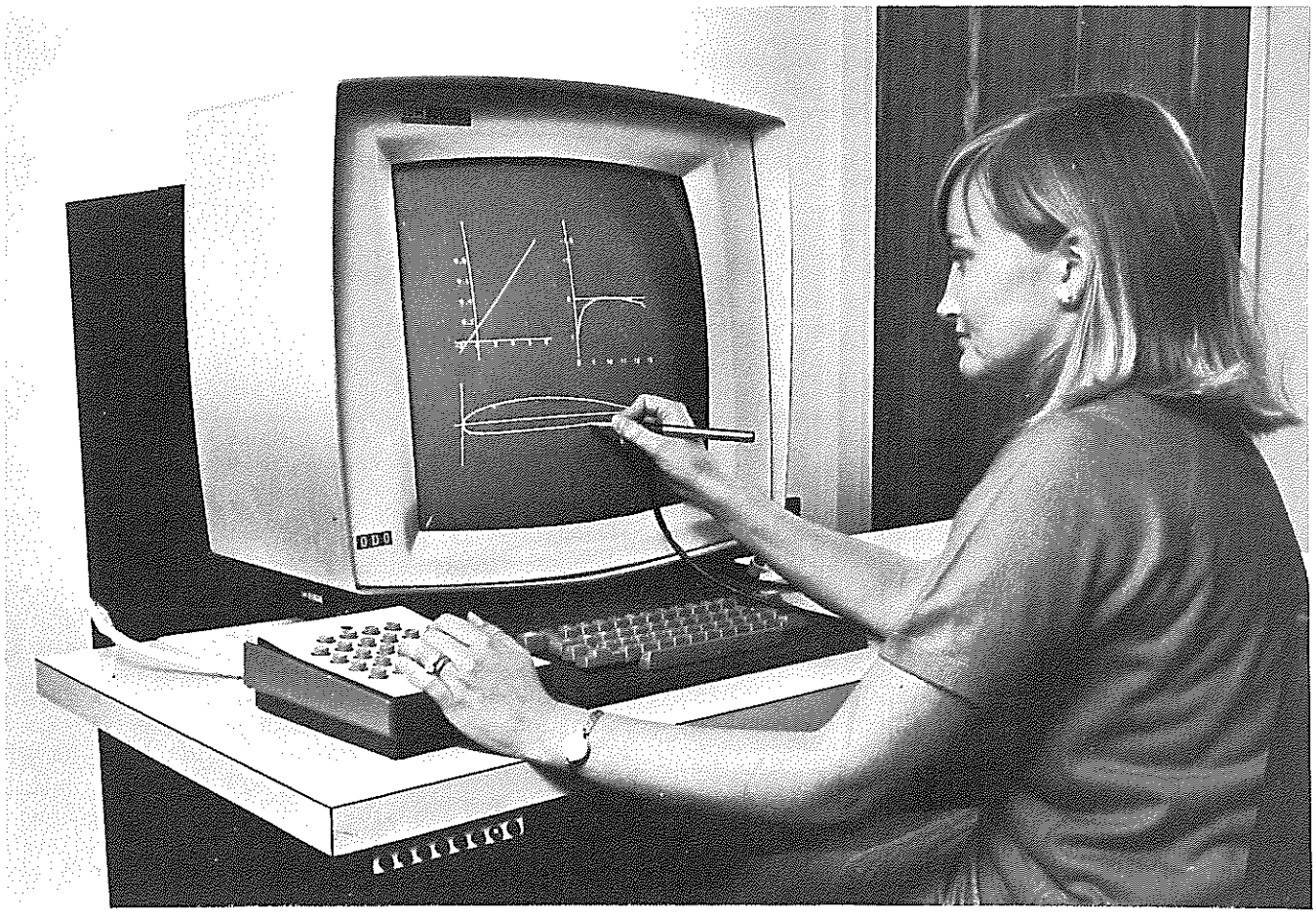
Computer-aided design and numerically-controlled machine tools

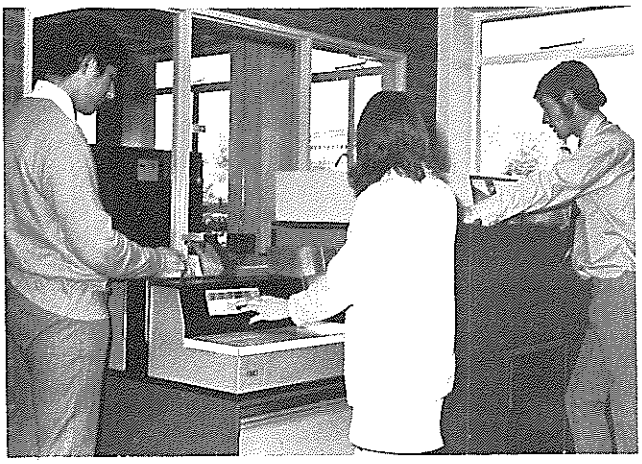
The degree of automation which has been achieved in design and metal cutting may be illustrated by the example of a controlling cam for a textile machine. The dimensioned design drawing of the cam was executed directly onto the graphic display screen of a computer. Without further programming of the computer this design was used to provide a control tape by means of which an automatic milling machine was operated to produce the metal cam.

Kinematic display

Special computer programs have been developed making more flexible use of the display screen of the computer

With the aid of a hand-held light pen and a typewriter keyboard the cathode ray display screen, which is coupled to the computer, is used for a theoretical study of wing profile aerodynamics.





The popular self-service computer terminal station in use at the NRIMS computing centre.

possible while the full stream of computing tasks is being processed during the day shift. Continuously moving images of graphs or geometrical shapes can be produced so that, for instance, a three-dimensional shape can be viewed from different angles, thus greatly facilitating the interpretation of results.

Formulas produced by computer

It is now possible to obtain direct from the computer mathematical formulas instead of separate numerical values. The formulas can be exhibited on a display screen so that the mathematician can manipulate them conveniently. Using the final result it is, of course, possible to obtain as many numerical values as desired.

Geometry of curved surfaces

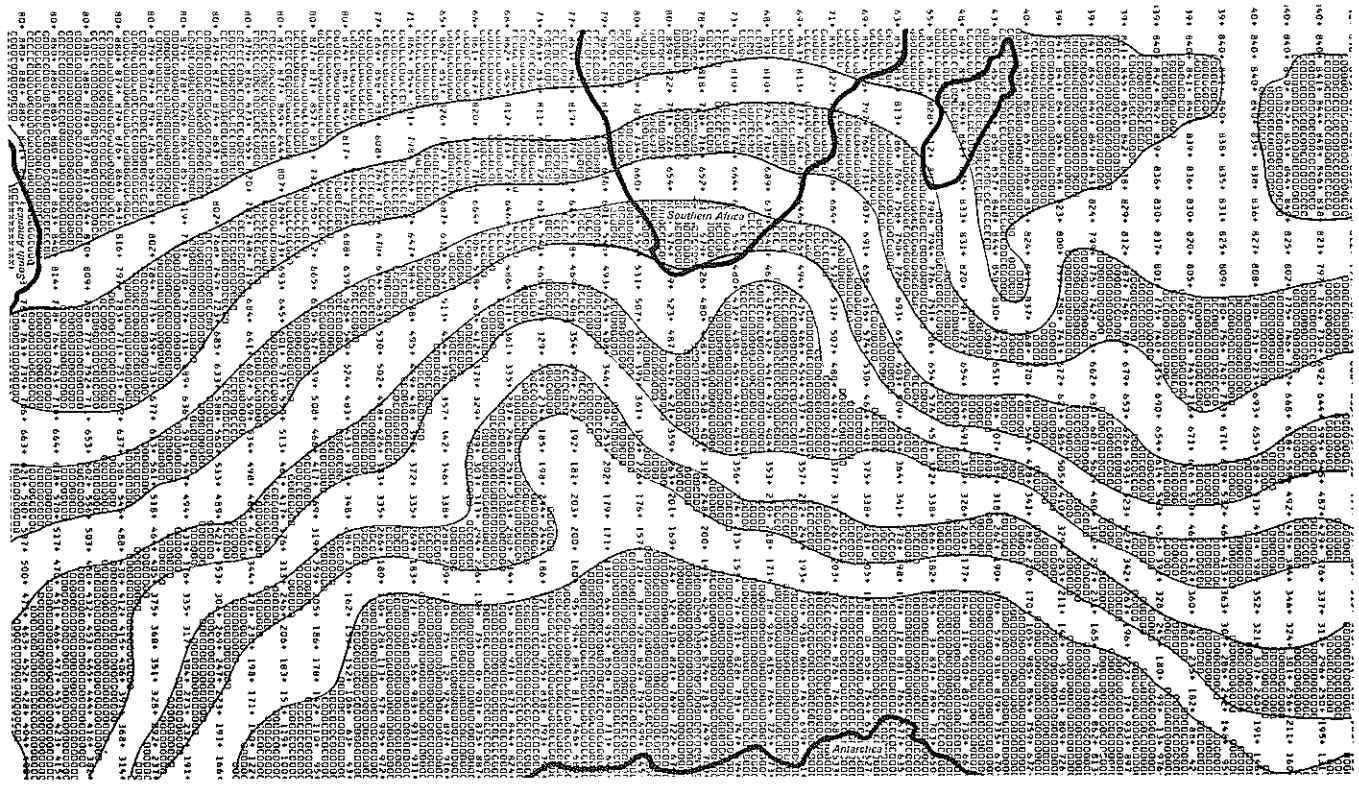
A versatile computer program has been developed to define digitally an arbitrary curved surface, using a minimum number of measurements. The method has been used to check the accuracy of alignment of the trisonic wind tunnel at the National Mechanical Engineering Research Institute.

The standard error of measurement was 0,04 mm and one great advantage of the method was that accurate centring of the theodolite, which would have been almost impossible, was not necessary.

Scientific programming

During the year several large programs for other CSIR institutes were completed. Amongst the subjects involved were electron microscopy, aircraft noise in the vicinity of airports, aircraft dynamics, ionospheric analysis, spectrochemistry, chemical kinetics, the processing of lightning data, wave analysis, diffusion processes, ore prediction and astrophotometry.

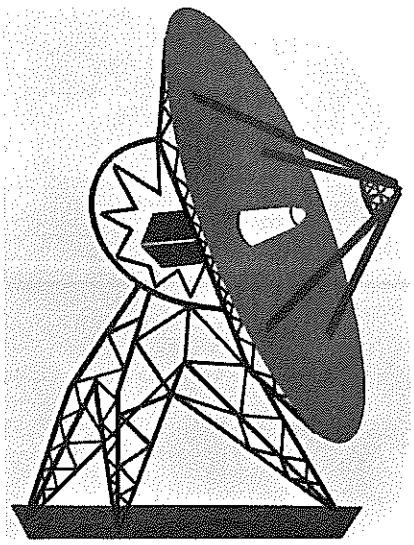
A weather prediction chart computed and printed graphically by computer.



Job training

During the past two years the Institute has given officials or students from the CSIR or external organizations the opportunity of working under supervision on a computer program or a training task, for periods varying from a few days to a number of weeks. During the past eighteen months about fifteen persons made use of this opportunity.

Telecommunications Research



National Institute for Telecommunications Research

Director: Mr R. W. Vice

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

The Institute carries out research into the ionosphere and its influence on the propagation of radio waves. Routine ionospheric observations are made at Hermanus and near Johannesburg, and bulletins of ionospheric data and predictions of optimum frequencies for use in short wave radio communications are issued monthly. Observations of airglow are made at Hartbeespoort Dam.

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

Measuring rainfall by radar

Research into the use of radar to study clouds and precipitation was interrupted by the transference of the radar to a new site at Houtkoppen, north-west of Johannesburg. Here a joint radar facility has been established in co-operation with the National Physical Research Laboratory.

The Institute has now completed its preparations for an experimental programme of rainfall measurements over a wide area by means of radar. These measurements will be used in a hydrological research project to investigate the correlation between rainfall and run-off in a river catchment area.

An 8 mm Doppler radar for use in a more fundamental study of clouds and precipitation has been developed. The system has a high resolution in range and in velocity and has been used to measure the velocity spectrum (and hence the drop size distribution) of falling raindrops.

Lightning research

The Institute uses a system of spaced VHF receivers to obtain coherent records of the noise emitted by lightning. These are processed to give a three-dimensional image of the lightning stroke. Pictures obtained in this way are compared with models of the cloud based on simultaneous radar observations.

The system, with which lightning processes within clouds can be observed, has proved to be a powerful tool in the investigation of lightning. One of the conclusions of the research is that (contrary to reports from investigators in North America) the path of a lightning discharge is generally related to a distinct feature of the cloud. Another finding is that the lightning discharge does not take place, as hitherto assumed, between charge centres of opposite polarity.

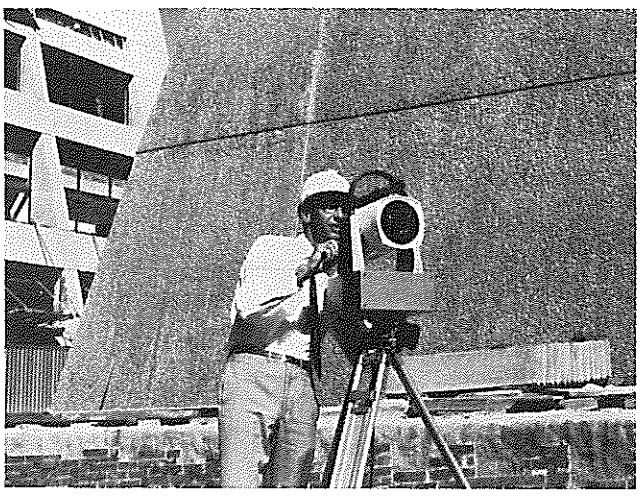
Distance measurement

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

The Institute has also investigated the use of modulated infra-red beams of distance measurement. This work recently led to the production by a South African firm of a very precise system capable of measuring distances of up to two kilometres to within one or two millimetres.

The advent of such optical systems with an accuracy of about one part in a million has brought about the need for a standard against which they can be calibrated. The Institute is therefore planning to construct a suitable standard baseline one or two kilometres long and accurate to within a fraction of millimetre.

Using the infra-red distance measuring equipment at a building site.



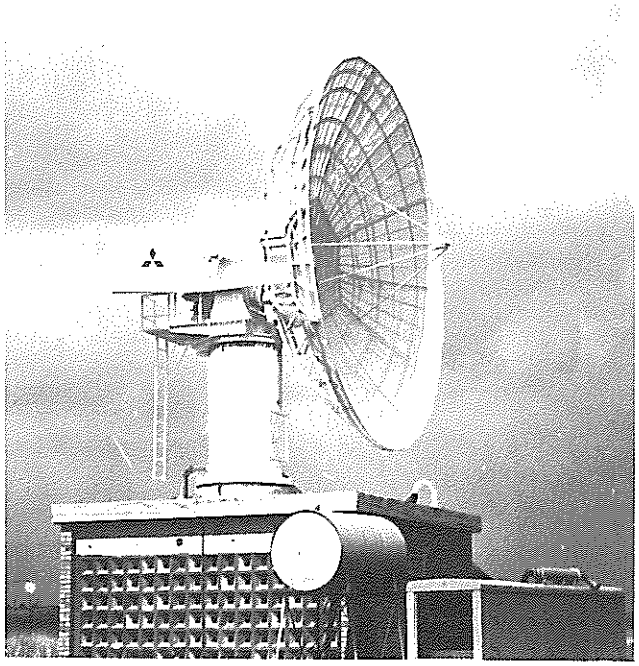
Space research

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

The DSIF uses a 26 m parabolic antenna to track and communicate with space probes to the moon, the planets and interplanetary space, and has played an important role in most of NASA's deep space projects. During the year the station was occupied mainly with tracking the Mariner Mars 1971 space probe and the Pioneer 6 space probe which was launched in 1965 and has now come within range again after orbiting the sun.

The STADAN station is one of the world-wide network of stations established by NASA to track and communicate with scientific earth satellites. Over the past year extensive modifications and additions to the equipment have been carried out to bring the station into line with the latest standards of the network.

The 7 m weather radar antenna at Houtkoppen, near Johannesburg.



Radio astronomy

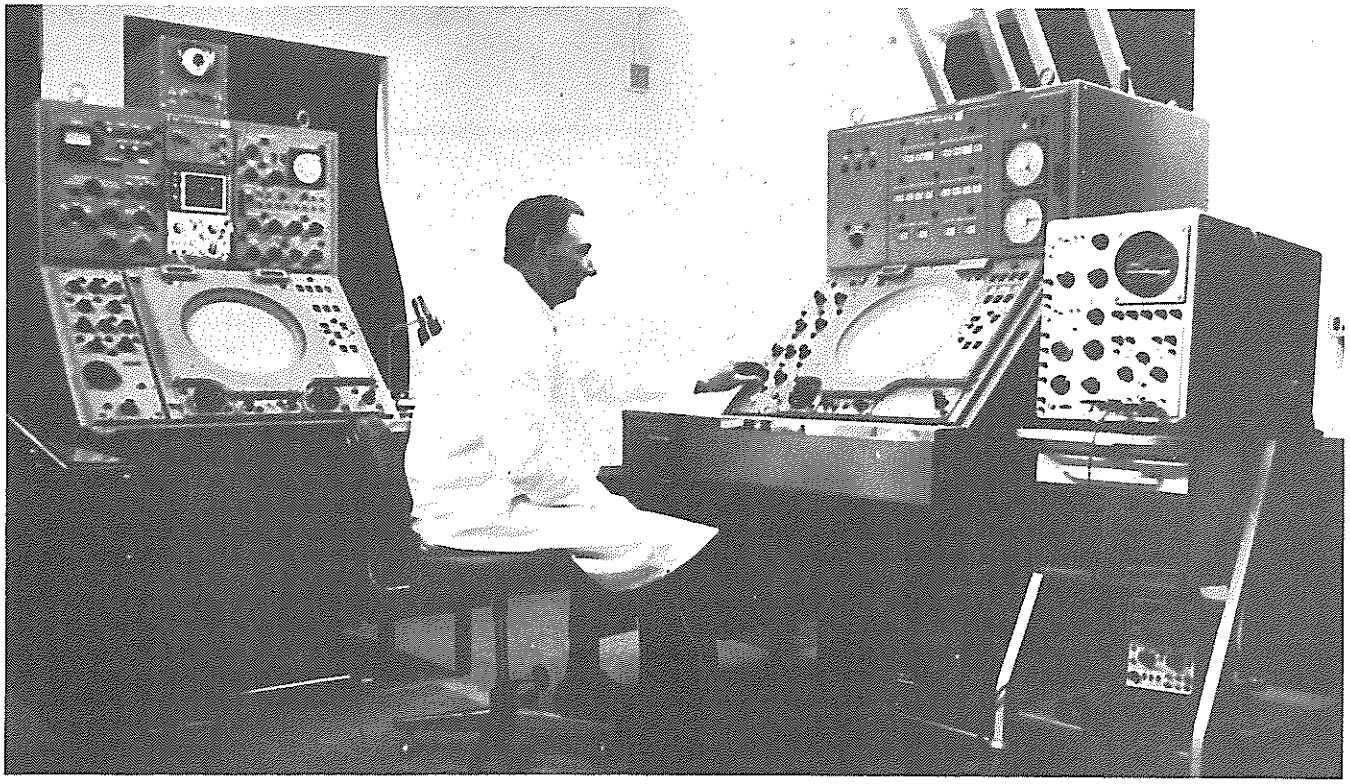
When the 26 m antenna at Hartebeesthoek is not required for tracking operations it is used in a programme of radio astronomy. Appropriate ancillary equipment operating at a wavelength of 13 cm was designed and constructed by the Institute. Modifications are being developed to extend the operation to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

Most of the time available in the past year was devoted to a survey of southern radio sources between the declinations of –20° and –36°. The survey of this zone is almost complete, and should include about 400 sources of which roughly 30 per cent are listed in the Parkes Catalogue.

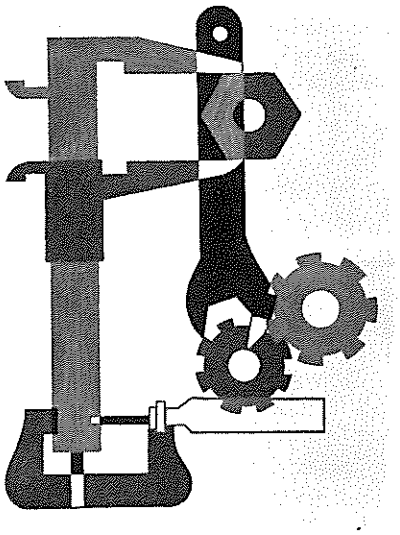
The major continuing programme is the investigation of intensity variations in extragalactic sources. This has been under way since June 1967 and at present 80 sources are being studied, of which at least 30 are variables.

Long baseline interferometry has been carried out in co-operation with observers in California, Spain and Australia.

The console of the weather radar at Houtkoppen.



Mechanical Engineering



National Mechanical Engineering Research Institute

Director: Dr H. G. Denkhaus

The National Mechanical Engineering Research Institute (NMERI) is concerned mainly with the development of new ideas and techniques in mechanical engineering as well as the improvement of machines and materials used in industry. The Institute is also active in fields such as rock mechanics in order to improve efficiency and safety in mining. 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.

Technological foundry problems

Activities in the field of foundry research are co-ordinated with the South African Foundry Research Foundation which assists in financing and directing the projects.

The interrelationship between moisture loss and erosion resistance in green sands in moulds is being investigated. A survey of moulding materials used in local foundries was also carried out. The findings of this project are to be used as a basis for a South African foundry-sand specification.

Besides the investigations carried out many enquiries into the properties of moulding materials, the quality of castings and the occurrence of casting defects as well as foundry problems in general, were dealt with.

Plastic deformation

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

A high-speed tensile testing rig with piston speeds ranging from 12 to 20 m/s resulting in strain rates of about 100 m/s was designed and constructed. Tensile tests using this device were carried out on commercially pure aluminium sheets (99 per cent Al) in the annealed, as received condition. Comparing these values with values for annealed and unannealed samples obtained at lower strain rates in an Instron machine it was shown that the ultimate tensile strength increases with increasing strain rates. The total elongation to fracture in annealed specimens is not influenced by the strain rate. For unannealed specimens, however, the elongation increased from about 8 per cent at low strain rates to about 25 per cent at high strain rates. There is at present no explanation for this unusual behaviour.

Tests on other materials such as pure nickel, cobalt and iron continue.

Effect of additives on cast iron

Research into the solidification of magnesium-modified cast iron continued. The previously reported interrelationship between the interfacial tension of graphite and liquid cast iron and the graphite shape was confirmed. More attention, however, was paid to cooling speed and super-cooling conditions.

Results indicated that not only high surface tension, but also high cooling speed promotes the formation of nodular graphite in cast iron. A final report is being prepared.

Surface quality of ferrous castings

The growing demands on the South African foundry industry, especially by car manufacturers in view of the efforts to increase local content of vehicles, have necessitated an increase in quantity and improvement in quality of castings.

A literature survey was made to establish what research has already been done on the surface quality of castings. In a preliminary test programme claims that casting surfaces were improved by using a paddle mixer instead of a roller mill, were investigated. Results indicate that there is sufficient improvement to justify further investigation. It is believed that the mechanism of mixing is completely different in the two mixers and that the paddle mixer distributes the clay binder more uniformly.

Impact properties of metals

A literature survey was conducted to examine the most important aspects of impact technology and the current areas of interest in impact mechanics.

A testing facility for low-pressure impact, initially for compression specimens, was designed and constructed. Instruments were successfully developed for measuring piston velocity immediately prior to impact and also the force exerted on the specimen.

A displacement transducer with a fast response, which will be able to withstand repeated impact loading is being developed. A testing programme, within the limits of the test facility, will be initiated based on the conclusions of the literature survey.

Rock mechanics services to industry

Industries in the Republic and abroad made use of these services which comprise a consultative service, a service for testing rock properties and a service for measuring rock stress. Particular use was made of the former service and about 1 000 rock specimens were tested.

Large-scale testing of rock and coal in situ

During the year nine coal specimens, 1,5 m by 1,5 m in cross-section and of different heights, were prepared and tested in a colliery. The complete load-deformation characteristics of some of these specimens were obtained in the field. Because of practical difficulties the complete load-deformation characteristics of the very low specimens could not be obtained. To test these specimens, hydraulic loading equipment was modified to double its loading capacity.

More data are needed on the strength and deformation of coal specimens with a width-to-height ratio of greater than four. The strength of coal specimens increases considerably as the width-to-height ratio increases so that further tests are not possible with existing equipment. It is therefore planned to investigate next year the development of equipment and methods which can be used in similar tests.

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

Model studies of fracture development

Work continued on the development of a material suitable for brittle fracture models which are used to study fracture development around excavations. In particular attention was paid to reproducibility of results and the influence of composition on the mechanical properties of the material.

Work on the production of moiré grids and on photographic recording of moiré patterns continued. In addition numerous models were tested to determine the influence of loading on the stress level causing failure.

A small-scale autogyro rotor being tested on a mobile test rig.

Stability of rock slopes

Several projects on the stability of rock slopes were undertaken, all involving the measurement of joint orientations. In one case the orientations of over 250 joints were measured to provide information on the predominant joint sets. These data were used to determine the stability of the slope. Various methods were used including stress analysis by finite elements. A preliminary study of the stability of the slope at an open-cast mine was undertaken.

The finite element method was also used to determine the stress distribution around a proposed underground power station.

Comminution and grinding

An investigation was started to develop a scientific basis for the design of control systems for mill grinding circuits. A milling system must be able to produce, at minimum cost, a product of any desired size from any given material, the physical properties and condition of which are known.

Before a suitable control system can be designed the fundamental mechanics of the grinding process must be understood. The project therefore includes research into the mechanism of grinding as well as the design of control systems.

Phormium tenax processing

The two main consumers of *Phormium tenax* fibre in the Republic are a new bag mill in the Transkei which can use coarse fibre, and an old bag mill in Benoni with jute spinning machinery which requires a fairly fine fibre.

Fibres for the old mill are decorticated, washed and then subjected to brief carding, partly to split the fibre but mainly to remove dust and short lengths of fibre so that a clean fibre with fairly long staple is obtained.

Experimental work was done on a carding machine to determine the modifications required to give the correct degree of carding. All carding machines in use were then modified.

The first production models of the so-called 'Mini' decorticator were completed. One of these was installed at a fibre farm of the Department of Bantu Administration and Development. When correctly operated with leaves of a good quality, the machine can produce half a ton of first-grade fibre a day.

Fibre-washing experiments continued on a laboratory scale. They led to a promising method in which two intermeshing bladed rotors agitate and brush out the fibre under a waterspray, and two rubber rollers, joined by a spring, pull the fibre from the brushing rotors and squeeze excess moisture from it. This method can easily be adapted to full-scale automatic operation and a unit larger than the present laboratory model is being built for pilot-scale trials.

Basic properties of fibre

During the work on *Phormium tenax* decorticators it was found that the performance of these machines is very dependent on the age, size and quality of the leaves processed, and that there is little reliable information

available on the fibre content of leaves, the distribution of the quantity and quality of the fibre along the leaf, the effect of the age of the plant and of the leaves, and the locality and season of production.

A research programme to investigate these variables was started in order to assess the economic possibility of making a better quality fibre by using only part of the leaf to determine how old the leaf should be to achieve maximum output of the fields, and to collect other data needed for the proper management of *Phormium tenax* estates.

Ore-loading facilities

As a result of a proposal to construct ore-loading facilities at Saldanha Bay, ISCOR commissioned the Hydraulics Research Unit to carry out an extensive survey of wave and wind conditions in the bay in order to obtain basic design information for the most favourable siting and layout of harbour facilities. The field observations included wave recordings at selected positions within the bay, daily wave observations with a wave clinometer at the bay entrance and continuous recording of wind conditions. Simultaneous wave recordings (using four boats) are also being made for selected wave conditions.

After a year of field studies it was decided to continue them for another year in order to compile a more comprehensive set of data.

A fixed-bed model will be used to study wave conditions and to determine the best position for a loading terminal in Saldanha Bay.

Conveyance of granular material

A study was undertaken of the feasibility of pumping bauxite slurry at a rate of between 750 000 and 1 900 000 t per annum over distances of up to 100 km. By testing samples in the capillary tube viscometer it was found that slurries containing 60 per cent bauxite by mass could be transported. On three of the four pipeline routes proposed the available head is greater than the calculated pipeline pressure losses and thus no pumping is required for these three routes.

Another investigation dealt with the pumping of tailings to a slimes dam. The intention was to increase the rate of pumping from 60 t/h to 200 t/h. Data on pipe diameter, mixture velocity and the power required for different throughputs and static heights were supplied to the sponsor concerned.

A test circuit consisting of a circular pipe 0,10 m in diameter and 75 m long as well as a test circuit with a pipe of the same diameter and length but with a segment plate inside, were constructed. Tests with anthracite with a size-range of 0,2 to 20 mm showed that, depending on the concentration of the solid, 15 to 30 per cent less power is required to pump the same amount of solid through the segmented pipe than through the circular pipe. This is because the zone where the concentration is highest, namely at the bottom of the pipe, is greater in a segmented pipe than in a circular pipe.

Hydraulic hoisting

Tests on a model to determine the most important parameters for a hydraulic ore-hoisting system were completed. These tests, in which the entrainment of particles into the uplift pipe could be visually observed, helped to explain certain performance characteristics.

By dimensional analysis and using test data from a pilot plant, an equation was evolved for calculating the discharge concentration under various conditions. However, the influence of certain minor factors has still to be determined. Norite with a mean diameter of 20 mm and a relative density of 2,96 has been transported through an uplift pipe 0,25 m in diameter at 400 t/h. This represents a volumetric concentration of 26 per cent, or 57 per cent by mass.

Air conditioning and refrigeration

The results of investigations into the chilling of meat were made available in advisory services to consultants, particularly where problems were experienced with additions and alterations to existing refrigeration plants and the design of new plants.

The design of air-conditioning systems for certain industrial and research applications is often complicated by unrealistic requirements in connection with air movement and by a lack of basic information. These factors affect the overall cost of a plant more than is usually realized.

The Institute now has facilities for studying air flow patterns in air-conditioning applications, with the aid of which the performance of different air diffusers can be tested.

Climatological data for designing air-conditioning equipment

Extensive analyses of climatic data (wet-bulb and dry-bulb temperatures, dewpoint temperatures and intensities of solar radiation) were carried out and critical combinations of weather elements for summer as well as for winter were published in the form of maps of Southern Africa. Numerous requests for the published information were received.

An instrument for the direct measurement of effective temperatures was built and is being tested for performance.

Testing of steel wire ropes

The Mine Equipment Research Unit continued the testing of steel wire winding ropes in accordance with the Republic's statutory requirements. Mining companies in Rhodesia, Zambia and other Southern African states made extensive use of the facility. From 1st October 1970 to 30th September 1971, 5 212 ropes were tested.

Fatigue of winding ropes

A universal machine for testing fatigue in wire ropes was designed by the Institute and installed at the Mine Equipment Research Unit to simulate loading conditions experienced by steel winding ropes, particularly those in Koepe winders. This machine was extensively used throughout the year.

A test programme is being undertaken to assess the fatigue properties of steel wire ropes of different design and construction used in Koepe winders.

Test programmes based on conditions prevailing at two mine shafts were formulated and the first series of tests has been completed. The second test series is now in hand and it is anticipated that the machine will be fully utilized throughout the coming months.

Thrusting device for rock drills

It is well known that rock drills used in stopes are underthrusted and attempts to improve drilling by increasing the air pressure makes them more so. It was thought therefore that a device capable of applying a thrust to a rock drilling machine under conditions similar to those in which it is normally used in stopes, would probably increase drilling efficiency.

A study of the feasibility of the design of a thrust device, light but capable of applying up to 2 700 N thrust to a rock drilling machine, was carried out and preliminary designs were submitted to sponsors for approval. After certain modifications in the design a prototype was built and tested underground in a test stope. The results indicate the rig has considerable promise provided it is modified silghtly to make it more suitable for arduous underground conditions.

Sediment movement in the sea

Littoral transport in the Richards Bay area was investigated further and the results were described in reports

on the project. A report was also drawn up on the movement of suspended river sediment along the Natal coast.

The direction of littoral transport at the Tugela, Umgeni, Isipingo, Umkomaas and Umzimkulu River mouths was investigated by analysing the heavy mineral contents in the river sediments. Similar investigations are planned for other rivers in Natal.

Ocean wave research

The collection of wave data around the coasts of the Republic continued. A paper on various aspects of the wave project was presented at a symposium and reports on wave and wind conditions in the East London and Port St Johns areas and along the South-West African coast were published during the year.

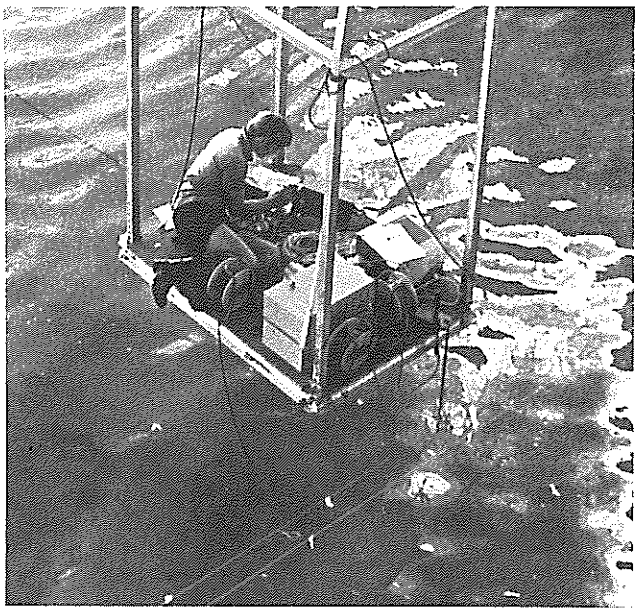
The Mozambique Department of Transport is considering the installation of a wave recording station. Should this plan materialize the Department will make the data it collects available to the Institute's ocean wave project.

Harbour siltation and beach erosion at Durban

Continued monitoring of the underwater mound, built off the Durban beaches to protect them, showed a maximum difference of approximately 10 per cent between the volume of the mound and the volume of sand dumped. This order of variation is quite normal and dredgers continued to dump sand throughout the year. The dumping rate increased from September 1971 when material from a new pier being built in Durban harbour, became available.

Surveys of nearby beaches showed that considerable changes took place during the year. Accretion occurred on all beaches except those in the extreme south. This is thought to be because the adjacent northern beaches,

Making wave measurements in a model of the Richards Bay harbour.



badly eroded in 1970, formed a 'sand trap' which inhibits recovery of the southern beaches until it has been filled in. Analysis of beaches north of the Umgeni River started recently. The data obtained should provide a clearer picture of sand movement in the Durban bight.

Richards Bay harbour development

In general the field work on the development of Richards Bay harbour progressed according to schedule. The wave-recording coverage was greatly improved by the installation of additional recording equipment.

The model tests in connection with this project progressed satisfactorily. Various entrance layouts were tested in the sediment model so that possible sedimentation problems could be eliminated or reduced to a minimum.

Lamberts Bay fishing harbour

The wave study in connection with possible extensions to the fishing harbour at Lamberts Bay was completed. A study of sediment movement is now in progress to determine and solve any sediment problems which may occur after the new harbour has been completed.

Muizenberg marina project

In connection with a proposal to build a marina at Muizenberg the Hydraulics Research Unit was commissioned to determine the optimum entrance channel and breakwater configuration and its effect on the adjacent beaches.

Seasonal beach variations, sea-currents and wave periods, heights and directions were measured. Tracer tests were carried out to determine the quantity and direction of longshore transport. A fixed-bed model was built to investigate wave penetration with various breakwater layouts.

Swakopmund beach development

To give guidance on the development of beaches in the Swakopmund area a hydrographic and geomorphological investigation was started during 1970 to establish the wave, wind and current conditions as well as beach and bottom changes in the nearshore area off Swakopmund. A model will be constructed to establish the most effective and most economical method of beach improvement.

Sand dam research

In order to determine a design code for the development of sand storage dams a mobile-bed hydraulic scale model of the Ondekaremba sand storage dam in South-West Africa was constructed.

In the first phase of a test programme the influence of the shape of the dam wall on the upstream flow velocity and on the settlement of the finer material which adversely affects the storage efficiency, was investigated. In the second phase the extent to which groynes can be used to influence the small flows in large water conservation schemes of the future will be studied. In addition, a mathematical model which describes unsteady non-uniform flow is being assembled in order to ascertain the most desirable height increases for each stage of the dam wall. Several permeameters were constructed to measure the permeability of the sand.

Low-speed wind tunnels

Preliminary proposals for a low-speed wind tunnel in the Aeronautics Research Unit, with a working section of approximately 16 m by 11 m, were documented and tests on a scale model of such a tunnel were initiated.

The impeller for a proposed 0,5 m water tunnel was ordered from overseas and the tunnel is being constructed.

The working section of the 2 m by 1,5 m wind tunnel was modified in order to obtain a more uniform axial pressure distribution. Model tests were also performed to ascertain the modifications necessary in the hot air dump system which tended to impair the flow pattern in the working section.

The 2 m by 1,5 m tunnel is in continual demand for sponsored *ad hoc* testing.

Flight dynamics

A towing boom, which can be attached to a large truck, was developed for further tethered-flight testing of the experimental CSIR autogyro. Testing started on an improved rotor-head system, but because of rotor blade vibrations tests had to be curtailed pending further investigations into blade flexing.

After successful experiments with small-scale rotor blades the development of a free-flight test rig in the form of a simple, very light autogyro was considered.

Rotating wings

A test programme to investigate fluctuating control forces in autorotating rotor systems was satisfactorily concluded.

Acceleration recording equipment being installed on an aircraft for research into atmospheric turbulence.

A mobile rig was used consisting of a pilot-controlled test bed or a truck, suitable for testing model rotor systems 7 m in diameter. Metal and plastic rotor blades were tested.

The results obtained and information gleaned during an overseas visit were used to begin the development of a full-scale rotor system with metal blades and improved dynamic characteristics.

The wind tunnel investigation into autorotating rotor systems and the analytical study of rotor behaviour continued.

High-speed wind tunnel

While the manufacture of modified flexible walls for the trisonic wind tunnel was delayed, an urgent tunnel test had to be done for a sponsor. As an interim measure, a pair of rigid nozzle blocks were contoured on a numerically-controlled milling machine using the new method of digital computation for supersonic wind tunnel nozzles. According to calibration tests the deviation from the nominal Mach number along and across the test section was in the case of these nozzle blocks within ± 0,5 per cent. The sponsored tests were successfully completed.

Stability and control of missiles and high-speed aircraft

Considerable progress was made with the provision of experimental analytical facilities for investigations into the flight dynamics of missiles.

The intricate apparatus constituting a model of a free-flight launching section was completed, and the section will soon be commissioned for use in the trisonic wind tunnel. With this dynamic model a wide variety of flight vehicles can be tested.

Two advanced computer programs form the basis for analytical investigations. One is a powerful data-reduction program used to analyse free-flight data obtained in the wind tunnel or in free flight. The other is used to simulate the motion of a rigid vehicle under conditions of flight in six degrees of freedom. The aerodynamic characteristics of the vehicle, which are required as input for this program, may be determined by means of the data-reduction program.

A start was also made with analytical work aimed at predicting the flight-dynamic stability of flexible high-speed aircraft.

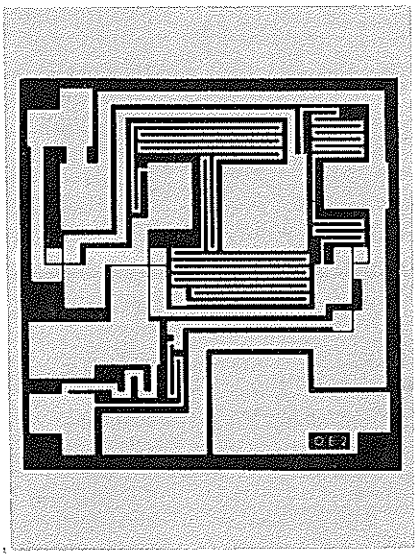
Aircraft noise

The method of aircraft noise assessment developed by the Institute's Aeronautics Research Unit was adopted by Provincial authorities to control the development of new townships in the vicinity of airports, thus preventing future noise problems in these areas. Studies aimed at the improvement and extension of the method continued.

The Unit still participates in the activities of the International Organization for Standardization (ISO). The staff member of the Unit who serves on the ISO working group concerned with aircraft noise was appointed, together with representatives from the Netherlands and USA, to consider revisions to an existing code of practice and to investigate the noise assessment of unconventional aircraft (such as helicopters and other VTOL configurations), taking into consideration the subjective influence of noise variability as a function of noise duration.

Work was concentrated on noise variability and a new concept was developed for predicting the subjective response caused by variability in the noise produced by any source.

Electrical Engineering



National Electrical Engineering Research Institute

Director: Mr J. D. N. van Wyk

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

Thin-film technology

In spite of a large increase in the demand for thin-film coated substrates and thin-film circuits, the Institute's production facility was able to satisfy its own, other CSIR institutes' and outside organizations' requirements efficiently. Amongst the circuits manufactured were a filter circuit for digital applications, and a read-only memory with a capacity of 32 words, each of 12 bits. An automatic wire bonder was developed to provide external connections for circuits to be incorporated into larger systems.

The manufacturing process for thin-film capacitors was developed further and capacitors suitable for use at frequencies up to 25 MHz can now be produced. The use of rhenium as resistive material for producing resistors with ohmic values higher than those achieved with nickel-chrome was investigated. Resistive layers with ohmic values between 500 and 2 000 ohms per square have been produced whereas a value of only 100 ohms per square was obtained with nickel-chrome. Attempts are now being made to improve the temperature co-efficients of these resistors and to produce a circuit which contains componets of high and low resistivity as well as thin-film capacitors on the same substrate.

Thin-film technology was also used in a study of the propagation of ultrasonic surface waves, which can be used in signal processing.

Semiconductor technology

The acquisition of a suitable diffusion furnace has made it possible to investigate the processes used in the manufacture of monolithic semiconductor integrated circuits. Oxidation, one of the most important processes in the manufacture of silicon semiconductors, has already been studied and simple elements such as diodes are being manufactured by the diffusion of suitable dopants.

The Institute designed the masks and prepared the master artwork of a special integrated circuit operational amplifier. The masks were sent to a firm in the United Kingdom where the silicon was processed.

The dimensions of the final circuit, which contains 25 transistors, 15 resistors and one capacitor, are 1,4 mm by 1,2 mm. About 30 of these were returned for evaluation. Initial tests show that the circuit functions correctly.

Semiconductor analysis

In the previous annual report the digital memory which converts an ordinary oscilloscope into a storage oscilloscope was mentioned. This was used to display voice pitch and amplitude signals on a continuous time base and found application in two speech visualisers which are being used by the Transoranje School for the Deaf in Pretoria and by the University of Pretoria.

Preliminary work has been done on the construction of a scientific device, incorporating the continuous time-base digital memory, for recording various other signals. Such a device will find application mainly in the biomedical field. There is a possibility of commercial production and an investigating team leaves for overseas in the near future to assess the demand for such a device elsewhere in the world.

The use of the transistor as a temperature-sensing device was investigated further and on invitation this work was described in a paper delivered at an overseas congress.

Ultrasonic holography

Holography is a method of representing objects three-dimensionally by processing the signal amplitude and the phase of waves reflected from them. Ultrasonic holography may be used in the non-destructive testing of materials and the detection of objects under water. The possibility of applying the principles of ultrasonic holography to practical underwater problems is being examined.

Computer technology

A hybrid computer, consisting of a digital and an analogue computer coupled through an interface, has been completed and the software necessary for making general use of the computer is being developed.

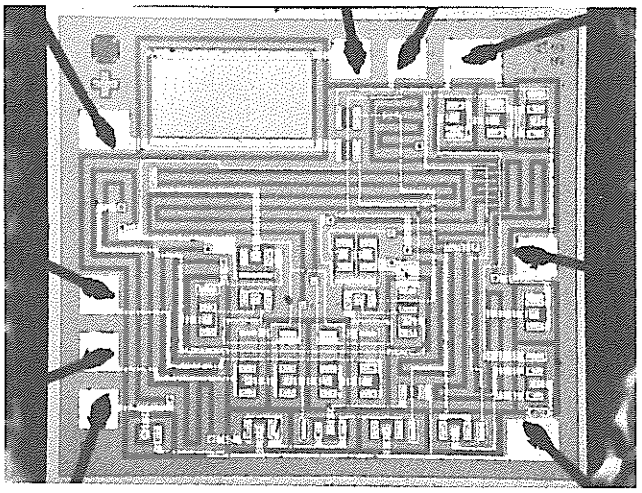
The system has already been used by the National Mechanical Engineering Research Institute to simulate aircraft take-off paths in a study of aircraft noise, and for computating the path of model projectiles in a wind

tunnel. Rainfall data of previous seasons were used in simulating a natural underground storage dam (aquifer) for the Department of Water Affairs with the aim of predicting the water available for use.

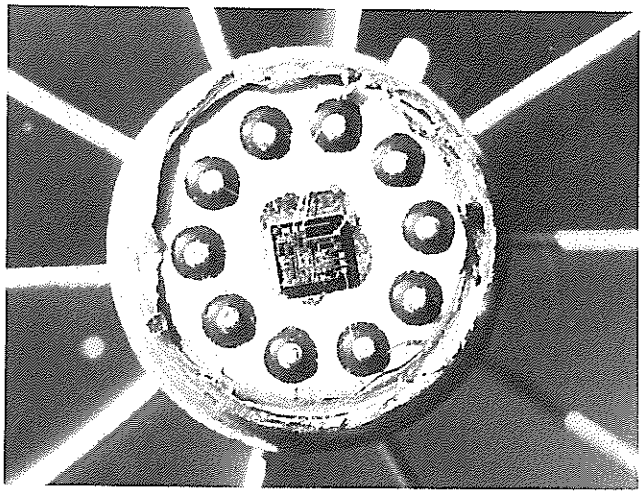
An analogue computer for solving field problems has also been completed which can simulaate potential fields described by Poisson and Laplace equations. This makes it possible to study the design of electron lenses and the magnetic flux in heavy current machines, and to determine lines of flow in laminar flow, and temperature profiles in conductors of heat, etc. The computer is unique in that a dry medium is used for simulation, viz. a conducting paper, and yet the equipotential lines can be plotted automatically under the control of a small process computer. The system has already been used to study the potential field surrounding a metal tower of a three-phase transmission line.

Data-acquisition systems

A computer-controlled data-acquisition system has been installed at ESCOM's distribution station, Apollo, to gather general data on high-voltage transmission lines and especially data on surges. Meteorological data will also be recorded, i.e. wind velocity and direction, temperature, rainfall, rate of precipitation and barometric pressure. In addition, recordings will be made of corona intensity and electrostatic field strength.



An operational amplifier in chip form measuring 1,4 by 1,2 mm.



The chip mounted on a can (diameter approx. 9,5 mm) for use in a circuit.

Electromagnetic and electrostatic antennae are used to measure the currents and voltages in the lines so that it is unnecessary to establish direct contact. This contactless method of measurement is of great potential value and will probably eventually be used for monitoring such lines.

NEERI, ESCOM and the University of Pretoria are working together on this project with the collaboration of the SABS.

Process control

The research project undertaken in collaboration with a sugar company in Natal on the construction of a mathematical model of a sugar factory has reached the stage where a process computer is being installed in the factory to gather real-time data on the operation of the system. So far, models have been constructed for the cane-milling process, juice heaters, multiple-effect evaporators and vacuum pans. The National Chemical Research Laboratory is assisting with the work on the chemical processes concerned.

Data acquired by the computer in real time are used to test the accuracy of the mathematical models under dynamic conditions. The general accuracy of these models was previously tested by using the operating data provided by the refinery.

The study and simulation of an ore-reduction plant is being undertaken in collaboration with a gold mining company and the University of Pretoria. The study is concentrated on the selection and distribution functions of ore grinding mills with the aim of controlling the milling cycle and obtaining the optimum particle size. Two ball mills in a pilot plant at the National Mechanical Engineering Research Institute are also being used in the study.

Information theory

A study has been made of algebraic codes which can be used to correct errors in messages received over noisy transmission channels. Electronic circuits for these applications are being developed.

The interaction between man and machine is also being studied in order to present solutions obtained by means of a hybrid computer in such a way as to achieve maximum transference of information.

Signal processing and time series analysis

The application of the fast Fourier transform algorithm in special-purpose computers has made it possible to process signals with fairly high frequencies in real time. Because of a computer's high processing speed it is possible to simulate on it the behaviour of system components such as filters, modulators and correlators and to allow these simulated components to operate as part of an external system. These methods can be applied in the study of mechanical vibrations, the analysis of seismic or sonar signals, in oceanography, acoustic research and speech analysis, the study of electro-cardiograms, the analysis of electro-encephalograms, picture-data analysis, pattern-recognition studies, etc.

A Time Data analyser has been acquired which can handle signals with frequencies of up to 35 kHz in real time. Although the system is not yet fully operative, it has already been used to solve various problems.

Lightning research

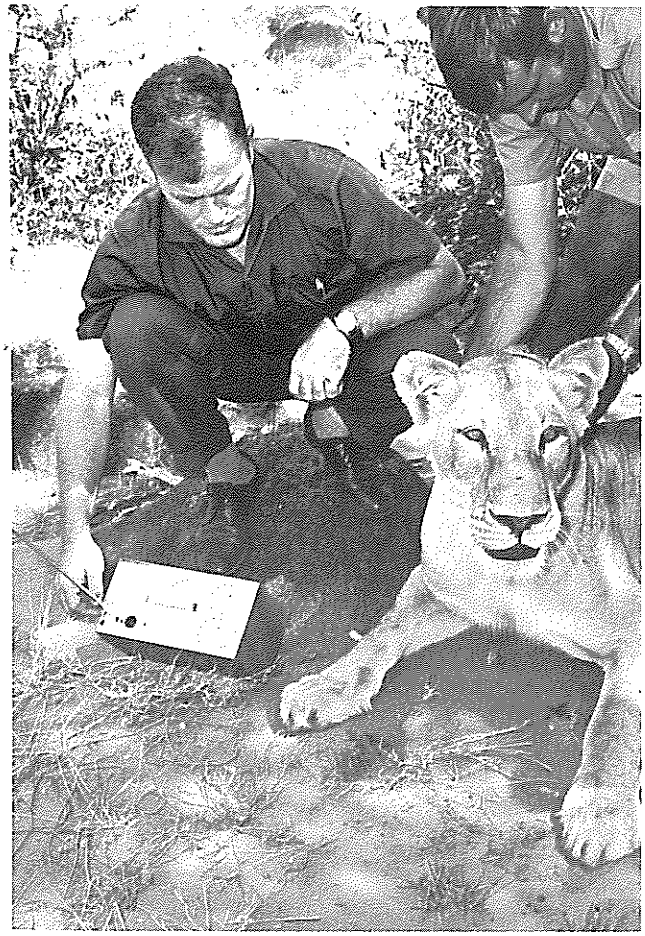
To measure the density of ground discharges in the Republic various lightning counters are being tested and calibrated. Information on cloud-to-ground discharges is of assistance when electrical power transmission and dis-

tribution systems have to be protected in the most economical way. An international programme of the Working Group for Lightning of the International Conference on Large Electric Systems (CIGRE) concentrates on this aspect. South Africa plays a leading role in the planning and execution of this programme as a member of staff of this Institute is the convener and chairman of the working group.

During the year the use of four electromagnetic direction-finding stations made it possible to obtain a greater quantity of reliable information. These stations are calibrated by using data obtained from photographs recorded by all-sky cameras in the stations. In this way deviations can be taken into account which are caused, for example, by the effect of the terrain on the propagation of electromagnetic waves.

During the lightning season 73 separate thunderstorms were recorded by the four lightning direction-finding stations and the number of lightning discharges observed varied between about 40 000 and 55 000. These data are being used to determine the effective range of counters. The average value of the effective range of the CIGRE counter has been calculated to be 34 kilometres.

Further work was done on a theoretical explanation of the mechanism of lightning discharge. A new model was proposed by means of which the electrical conditions during an intercloud discharge can be defined so as to distinguish them from those present during a ground discharge. This model is being investigated.



While waiting for the lion to recover, the receiving equipment is adjusted.

Power distribution

On behalf of the South African Railways an automatic voltage-surge recording station was designed and erected to record voltage surges on a 3-kV direct-current overhead power supply. The station equipment, which includes a CIGRE lightning counter and an all-sky camera, will be synchronized with that of four lightning stations in order to find a possible correlation between voltage surges and lightning discharges.

Voltage surges on an 11-kV line are still being recorded.

Insulation

Research in this field is concentrated mainly on the life of the insulation of large electric motors, particularly the prediction of potential insulation breakdown. Methods of evaluating insulation, including accelerated life tests, are being investigated and suitable equipment for the purpose is being developed.

The measurements taken on motors of the Rand Water Board two years ago are being repeated in collaboration with the Board, with the aim of discovering any changes.

Resistivity measurements

Suitable methods which relatively unskilled personnel can use to determine the electrical resistivity and thermal conductivity of soil in situ are not yet available. The measuring instruments developed by the Institute for this purpose were tested in practice during the year. Work to establish suitable calibration techniques for a resistivity meter, continues.

Medical electronics

On behalf of the Military Medical Institute work has begun on the radiotelemetry of electrocardiographic data obtained from parachute jumpers. The radiotelemetric transmission of measurements of fluid pressure within the brain is being investigated in collaboration with a surgeon. A simple frequency-modulated detector, in which a single integrated circuit is used, has been developed for possible use in the telemetric transmission of data.

A new fibre-optical probe is used in a technique being developed for analysing liquids by colorimetry. The great advantage of the method is that only a small sample is necessary. The measuring process is also speeded up considerably as a special container within the colorimeter is no longer necessary. A manufacturer of medical equipment is interested in marketing the device, should it come up to expectations.

The Institute has constructed drip-rate monitors for use in intravenous medication, and a device which detects small movements of a limb, for use in the physiotherapeutical treatment of impaired limbs.

Equipment for tracking wild animals

During the year miniature radio transmitters for tracking monkeys and rhinoceros were adapted or redesigned for various other animals including impala, wildebeest, zebra, rhebuck and lions. Transmitters are now being designed for bush-buck, kudu, nyala, blue buck and mice. The directional antennae had various designs in order to satisfy the different requirements with regard to sensitivity, portability and transportability.

A symposium on biotelemetry, organized by the CSIR, the South African Medical Research Council and other organizations, was held towards the end of 1971. Eminent overseas research workers in this field were guest speakers.

The work is being done in collaboration with the National Physical Research Laboratory and the National Institute for Telecommunications Research.

Instrumentation

A number of data-acquisition systems were completed, which record data in a digital form suitable for processing by computer. The systems included a recording unit for the axle-load distribution meter developed by the National Institute for Road Research, as well as other systems for the Magnetic Observatory at Hermanus and the Radcliffe Observatory in Pretoria.

Calibration services

The Institute's calibration service for electronic instruments is extensively used by the CSIR and by external organizations. Once again it was found that up to 50 per cent of all new instruments received from manufacturers fail to comply in some respect or other with the specifications issued by the suppliers. This state of affairs may be attributed mainly to the suppliers' failure to check the equipment adequately when it is received.

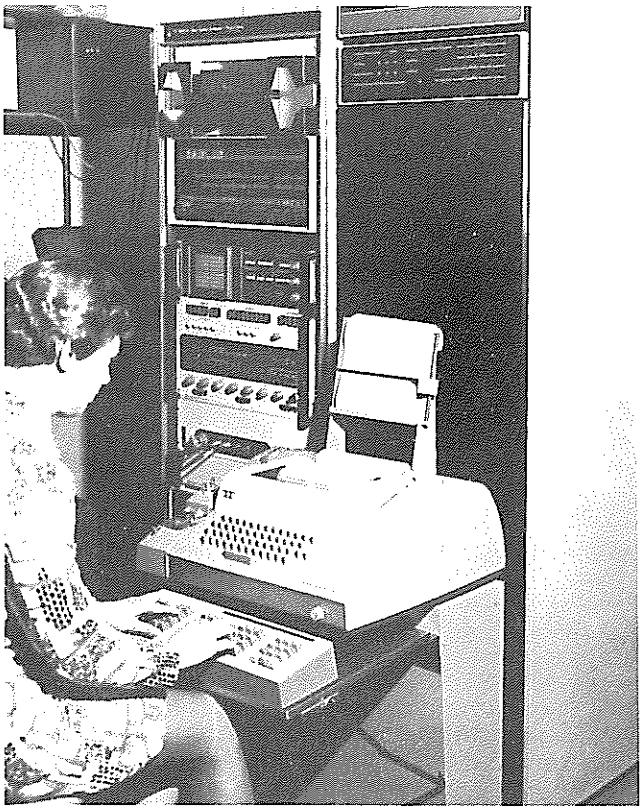
Instrumentation information service

The Institute subscribes to and circulates more than a hundred and fifty periodicals, mainly on electronics. Numerous enquiries are constantly received from the CSIR and external organizations about the availability of equipment and components.

Training electronics technicians

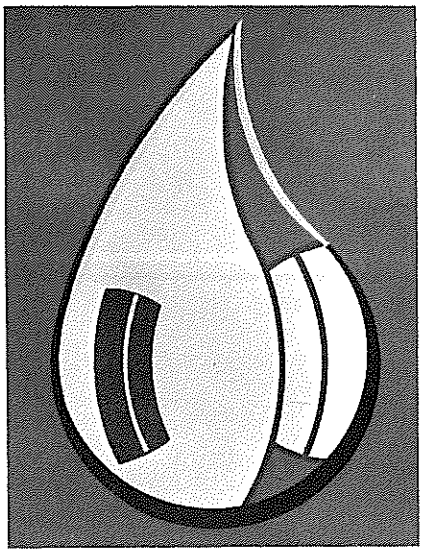
The practical training of electronics technicians, for which the Institute is responsible, has reached a very high standard.

Candidates who obtain the National Diploma for Technicians at the Pretoria College for Advanced Technical Education undergo four semesters of practical training at the Institute. On completing their studies they are able to design and construct electronic instruments and provide adequate user's manuals. They also play an important part in assisting research engineers.



The 1923C time series analyser with magnetic disc, teleprinter and keyboard.

Water Research



National Institute for Water Research

Director: Dr G. J. Stander
– until 30.9.1971

Dr G. G. Cillie
– as from 1.11.1971

As water research covers such an extensive field the National Institute for Water Research (NIWR) conducts research in various disciplines such as chemistry, botany, zoology, microbiology, civil engineering, chemical engineering and geohydrology. 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. The regional laboratories concern themselves mainly with problems peculiar to the areas in which they are situated.

River research in Natal

The Institute continued its river research in Natal and is at present engaged in a survey of the chemical, hydrobiological and bacteriological quality of water in the rivers of Southern Natal. This constitutes the final phase of a programme of general surveys of Natal rivers which began before 1960 and which is being conducted in cooperation with the Natal Town and Regional Planning Commission. The results of river surveys in the rest of the province have already been published in five comprehensive reports.

No serious pollution has thus far been encountered in Natal and the quality of the water in the larger rivers was particularly high. The smaller rivers in the area are now being investigated as they will probably gain importance as local sources of water supply and as recreational centres, especially at the estuaries.

Oceanographic investigations at Richards Bay

With the projected development of Richards Bay it has become essential that ecological studies should be conducted in order to determine to what extent the water environment may be disturbed. By collecting information on the subject at an early stage steps may be taken in time to prevent serious disturbances.

The NIWR is conducting ecological surveys in collaboration with the Natal Town and Regional Planning Commission. A considerable amount of information on conditions in the area has already been collected. It has been established that there is considerable biological productivity and this should not be disturbed.

Research is also being conducted to determine the toxicity of certain materials to fish and shrimps. Particular attention is being paid to the effect of fluorides which are expected to reach Richards Bay when the aluminium foundry comes into operation. Short-term tests indicate that fluorides are relatively harmless in sea-water and attention is now being given to the long-term effect of sub-lethal doses, to establish the extent to which fluorides accumulate in fish and shrimps.

In collaboration with the National Physical Research Laboratory, conditions in this area are being investigated in so far as they have a bearing on the possible disposal of effluents into the sea. The NIWR is measuring currents, determining the chemical and biological quality of water in the deep sea and along beaches and carrying out biological surveys. On the basis of information gained it is possible to predict the effect of discharging effluents into the sea on the quality of the water and on flora and fauna. Information is also being gathered on the undisturbed conditions in the area and this may be used in future to determine the degree of pollution.

Utilization of sandbeds for storage and purification

The Institute continued its research on the use of natural sandbeds on the Cape Flats for the advanced purification and storage of purified sewage effluent. The rapid socio-economic development in the Western Cape is straining the present water supply and if this project is successful, it could benefit the future water supply of the area.

Underground formations in the selected area have been mapped by means of seismic surveys and electrical conductivity measurements. The results of these two methods agreed fairly well and test boreholes which have since been drilled confirmed the geophysical observations. Results indicated that bedrock was usually more than 40 metres deep and at a gully more than 60 metres deep runs from north to south. This area is very suitable for the withdrawal of water and particular success was achieved here with an experimental borehole. Its suitability as a production borehole is being investigated.

Survey of the Berg River

As a source of water the Berg River is probably the most important river in the Western Cape. As the use of this river increases, it is essential that a clear picture should be gained of the quality of the water and the extent to which it could be polluted as a result of municipal, industrial and agricultural development along the river.

A report on the results of surveys conducted over almost seven years is now being finalized. The results indicate that the quality of the water in the Berg River is good and that pollution in the Paarl-Wellington area can be adequately controlled by self-purification in the river bed. There were, however, signs that the river became brackish in its lower reaches as a result of intensive irrigation. It will probably become even more brackish when more water from the Theewaterskloof dam is made available for irrigation.

The information gained will serve as standard reference in the future utilization of the river.

Water reclamation

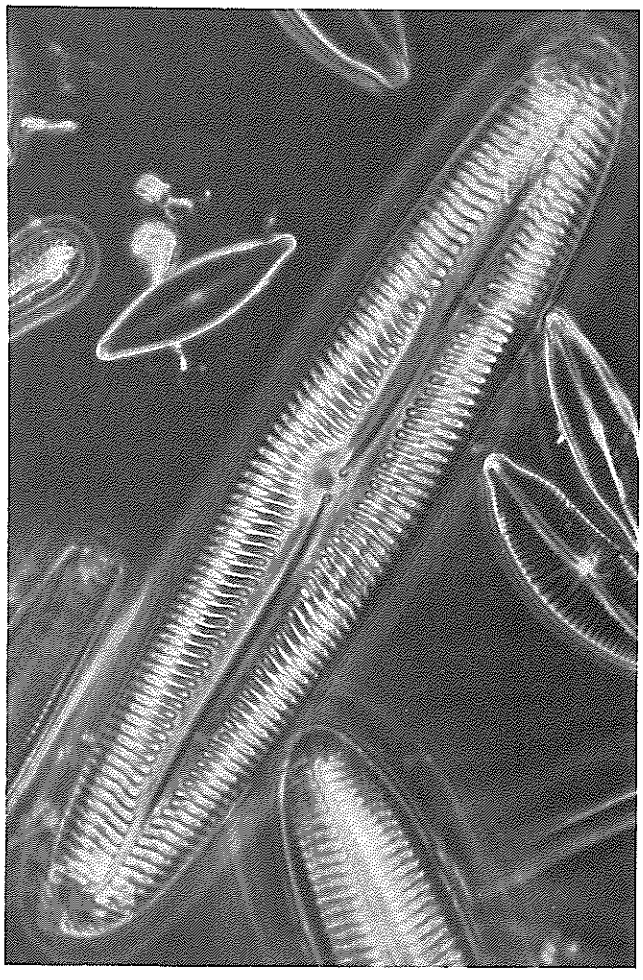
After the Stander Reclamation Works at the Institute's pilot plant at Daspoort, Pretoria, had been opened towards the end of 1970 by the Minister of Water Affairs, trial runs were continued in order to optimize the performance of the various process units. Initial results indicate that the quality of the water reclaimed from sewage effluent will bear out expectations based on earlier pilot plant investigations. This means that the water complies with drinking water standards laid down by the World Health Organization.

Numerous visits are paid to the plant by representatives of professional organizations, the press and experts from overseas, which indicates that the concept of water reclamation is gaining acceptance in ever-widening circles.

In addition to pilot plant tests, laboratory-scale investigations are conducted in order to determine the influence of certain harmful materials on the effectiveness of the reclamation process. Particular attention is being paid to certain metal ions occurring in the effluent of some industries.

The Cape Regional Laboratory of the NIWR is also operating a pilot reclamation plant, mainly for demonstration purposes. Because of the urgent need for water reclamation in the Cape Peninsula, it has here too become necessary to give priority to operational research. Although comprehensive data on the operation of reclamation plants are already available from the work done in Pretoria and Windhoek by the Institute, the processes have to be adapted, with due consideration of local conditions, to the potentially usable water in the area. The research is aimed mainly at refining a flotation unit for removing suspended solids from purified sewage effluent. Considerable success has already been achieved with a refined flotation technique.

Diatoms – unicellular water plants which are being intensively studied by the NIWR.



Desalination of brackish water

The underground water in large areas of South-West Africa and the North-Western Cape is very brackish and impedes the full development of the agricultural potential of the areas concerned. The total salt content of the brackish water is often too high for human and animal consumption and the water often contains toxic substances such as nitrates and fluorides, in too high concentrations.

The Institute, in collaboration with the SWA branch of the Department of Water Affairs, examined various designs for a solar distillation unit which would function effectively in South-West Africa. Prototypes of the chosen designs were then erected in different places in South-West Africa to evaluate their performance under various conditions.

On the basis of results obtained, a manual for the construction of the tested solar distillation unit is being compiled. Farmers could easily install the unit which would yield an adequate, safe supply of drinking water to farm dwellers.

Because of the relatively low yield of a solar distillation unit, it cannot be used to supply water for stock. The Institute is therefore designing and constructing a mobile desalination unit which could be moved from farm to farm to desalinate brakish water for stock-watering. The unit will be tested in South-West Africa in collaboration with the Department of Agricultural Technical Services which will use it to determine the effect on cattle of brackish water of various compositions.

Services to public bodies

In addition to long-term research done under contract for the Provincial Administrations of Natal, the Orange Free State and the Cape, the Institute is often requested by provincial and local authorities and by government departments to solve *ad hoc* problems in connection with sanitation, water supply and effluent control.

Pathogenic organisms in water

Very little is known about the concentrations of pathogenic bacteria, viruses and parasites in hospital effluents and what happens to them. The Institute is at present conducting an intensive investigation to determine the extent to which hospital effluents contribute to the total load of these organisms in municipal effluents.

The effluents from two hospitals have already been thoroughly examined. The hospitals were so selected that the two sets of data will give a very good over-all picture. One of the hospitals disinfects the effluent and then discharges it into the municipal sewage reticulation system. The other does not disinfect the effluent, but purifies its own waste water.

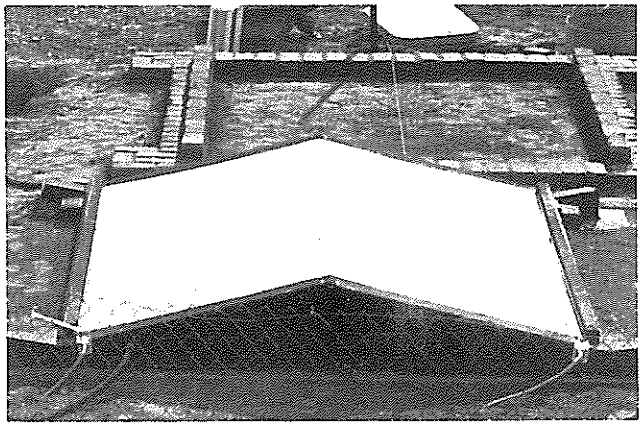
Environmental pollution by means of pathogenic organisms is also being investigated. The Institute is at present engaged in a survey of the microbiological pollution of streams and rivers in the Witwatersrand area, which feed the Vaal River. The investigation is being carried out in collaboration with the Rand Afrikaans University. It has already been established that some of the rivers, streams and dams in the area contain high concentrations of faecal bacteria.

A study is also being made of the load of parasite eggs carried by the Apies River which flows through Pretoria. The river receives effluent from the Pretoria sewage works and sewage sludge is used as fertilizer for some of the vegetable gardens on its banks, so there is a possibility that the drainage water contains parasite eggs which could eventually land in the river.

Criteria for water quality

The Institute has launched a research programme to revise and augment existing criteria for the quality of drinking water and for pollution. Many of the present criteria were drawn up years ago and do not provide for pollution of the water environment by modern insecticides and other special chemical compounds. Research is therefore aimed mainly at determining the incidence and effects of this type of material. The focus is not so much on the toxic limits of these materials – research has already been done on this subject – but on their long-term effects.

The solar distillation unit developed by the NIWR for demineralizing brackish water for domestic use.



The investigation includes, *inter alia*, the long-term reaction of organisms in the food chain to effluents from sewage purification works, reclaimed water and water from existing fresh water sources. The experimental organisms used are bacteria, algae, protozoa, fish, mice and rats. The organisms are studied individually and in combination with each other.

An important aspect of the investigation is the chemical identification of the organic materials retained by carbon filters when ordinary tap water or water reclaimed from sewage effluent passes through it. Carbon filters can adsorb organic compounds with large molecules. In this connection it is important to note that in the water reclamation process developed by the CSIR, carbon filters are used, whereas in the conventional water purification process which has been applied for many decades, this is not the case. The possibility therefore exists that the so-called organic micro-pollutants are not removed in the conventional water purification process.

Experiments are also under way to determine to what extent known toxic compounds are removed from water by carbon filters.

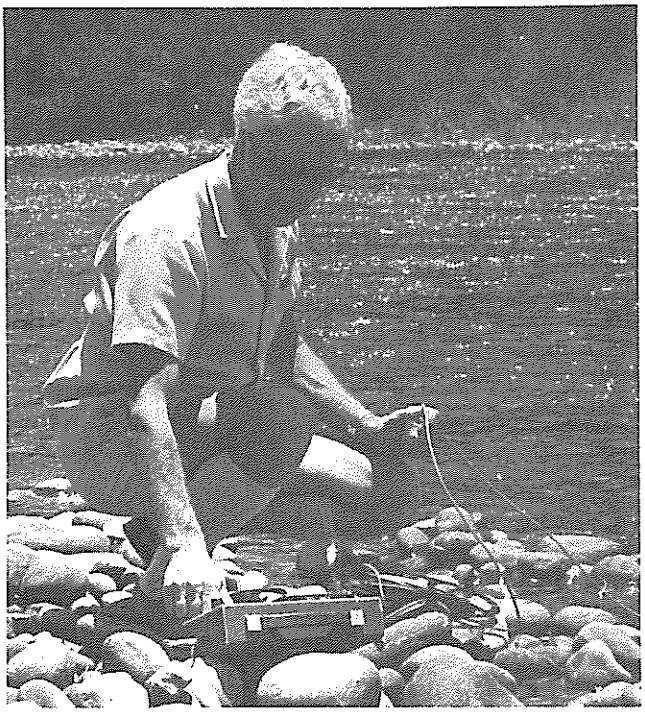
Diatoms as indicators of water quality

Diatoms – unicellular water plants – are very sensitive to the quality of the water in which they exist. With a thorough knowledge of the ecology of diatoms, it will therefore be possible to use these organisms as indicators of water quality.

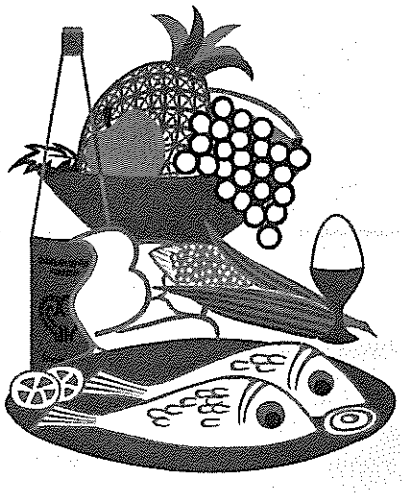
In South Africa alone more than a thousand different species of diatoms occur. It is therefore a tremendous task to describe and make an ecological study of them. The NIWR has for many years been studying South African diatoms and has reached the stage where it is possible to gain a very good idea of the quality of the water of a river, stream or dam by analysing statistically the diatom associations found in it. A useful scientific method has thus been evolved to detect pollution of water sources at an early stage.

Knowledge of South African diatoms has also been increased by a study of the systematics, taxonomy and ecology of diatoms in Lesotho. In the course of the investigation 34 new species were described. It appeared from the diatom associations found at the various sampling points that most of the water sources in Lesotho are alkaline and rich in oxygen, and already badly polluted with organic nitrogen compounds – probably because of the densely populated rural areas with their high animal populations. In a few cases there were also indications of carbohydrate pollution.

Tests being done in a comprehensive chemical and biological survey of the Berg River in the Western Cape.



Food Research



National Food Research Institute

Director: Mr J. P. de Wit

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

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

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

Indigenous foods

Edible leaves, tubers and fruits of indigenous wild plants are still important constituents in the diets of some rural population groups. The Institute has for some years been investigating the nutrient composition of these products and samples of more than 200 veld foods have been collected and analysed.

In the case of edible nut-like seeds the fatty acid composition of the oil and the amino acid composition of the proteins are also studied.

Foods with commercial possibilities are investigated in collaboration with interested organizations.

Flavour chemistry

The application of modern techniques to the study of food flavours has rapidly increased man's knowledge of this complex subject. Knowledge of the substances responsible for specific flavours makes it possible to obtain better synthetic flavours and to identify and prevent off-flavours caused by contamination more easily. It also leads to a better understanding of the development, as well as the deterioration, of flavour during ripening, processing and storage.

A study of the structure and properties of the flavour substances in roasted groundnuts and the changes in flavour during storage, was the main research activity in this field.

A start was made with a study of the flavour of the well-known wild fruit of the Northern and Eastern Transvaal, the marula, and of the flavour of guavas and guava products. Of particular interest was the fact that the spectrum of flavour substances found in South African guavas differed from that reported in overseas studies.

Grain processing

Research into the direct conversion of starch in ground degermed mealies or mealie meal to dextrose led to the development of a process which is already being applied in industry. The process comprises three stages:

- liquefaction of a suspension of the raw material under pressure, using alpha-amylase enzyme and a continuous heat exchanger;
- saccharification by means of amyloglucosidase enzyme;
- removal of impurities in the form of protein material, mineral salts and undesirable colourants by means of conventional refining processes using, for example, activated charcoal and ion exchange resins.

This investigation is now directed towards the preparation of other breakdown products of starch, which can be used in the food industry.

Dehydration of vegetables

Because the quality of dehydrated vegetables has improved these products have conquered a considerable part of the processed food market. As there is a strong tendency to use instant or quick-to-prepare foods, methods of preparing dehydrated cooked vegetables are being investigated. Using new techniques it was possible to prepare dehydrated cooked carrots of reasonably good quality. This investigation will be extended to include other vegetables.

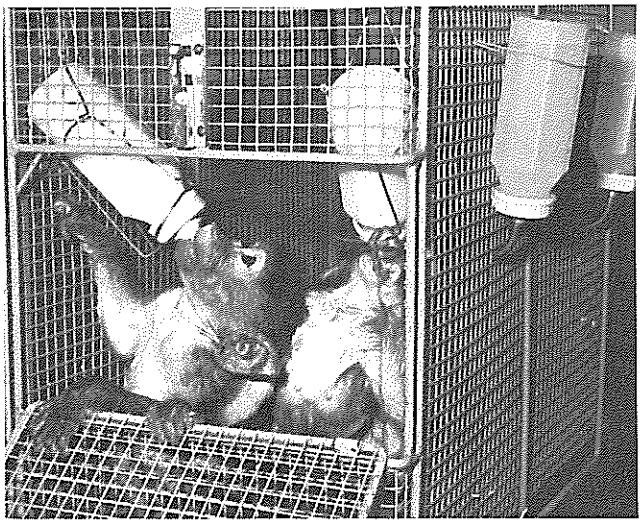
Biltong manufacture

The manufacture of biltong from beef, ostrich meat and game has developed into a sizable industry. The transition of this winter home activity to an industrial operation carried on throughout the year created a variety of problems.

The NFRI started investigating all facets of biltong manufacture. A special experimental dryer was designed with the aid of the National Mechanical Engineering Research Institute and is at present being constructed. With this optimum drying conditions will be determined and the effect of brining conditions studied. Microbiological aspects of biltong manufacture and packaging are also being investigated in collaboration with the Microbiology Research Group.

Diet and tissue calcification

Previous work on the use of the rat for investigating the ability of foods and diets to cause tissue calcification has shown that this animal is highly susceptible to kidney



Young baboons are used in experiments to determine the nephrocalcinogeneity of foods.

calcification and that sex and strain differences influence this susceptibility. It was therefore decided to use an experimental animal closer to man, namely the baboon.

The purpose of the first investigation, in which 12 baby baboons were used, was to find out whether kidney calcification could be caused by reducing the magnesium intake in an otherwise well-balanced diet, and if so, to determine the minimum amount of magnesium required to prevent calcification.

So far – 20 months since the beginning of the trial – there has been no evidence of kidney calcification, not even in animals on a diet containing less than 10 mg per cent magnesium. Further investigations will include studies of the effects of the phosphorus and calcium contents in diets.

Iron intake and siderosis of the liver

The liver of most adult Bantu is known to contain large deposits of iron-storage compounds such as hemosiderin and ferritin, which cause siderosis of the liver. This phenomenon is associated with the composition of the diet as a whole and the level of iron intake.

Recent studies on rats confirmed previous findings suggesting that siderosis of the liver depends on protein intake level and on the form in which iron is present in the diet. Liver iron content was lower in rats receiving a protein supplement (egg protein) to their diet of dried mealie porridge than in rats not receiving the protein supplement. Metallic iron, fed to rats on a diet of dried mealie porridge, was more siderogenic than an iron salt (iron citrate).

It was also found that the presence of silicate particles in a diet of mealie porridge increased the tendency of metallic iron to cause siderosis. The reason for this is as yet unknown.

MICROBIOLOGY RESEARCH GROUP

Taxonomy of yeasts

During a study of the yeast and fungal symbionts associated with timber-destroying beetles, 407 yeast strains were obtained from insect sources in the Northern Transvaal, Northern Natal and Southern Cape. Results to date indicate that the yeast domain is considerably larger than that described in the recently published second edition of *The Yeasts*. Some 30 undescribed species, including representatives of three new genera, have been found. While descriptions of most of the ascogenous species have been published or submitted for publication, progress with the anascogenous taxa is slower, chiefly because of the apparent absence of characteristic sexual stages. It may, therefore, still be some time before these 407 strains are classified and an indication can be given of any definite relationship between the yeasts and the insect hosts.

From an ecological point of view, however, it is already apparent that the yeast symbionts fall into four categories : non-specific invaders of the insect tunnels, species associated with insects but also occurring elsewhere, species associated with a wide range of insects, and species associated with a restricted group of insects.

One of the new ascogenous species is characterized by the formation of both true mycelium and blastospores. This necessitated a change in the present nomenclature of the ascogenous yeasts.

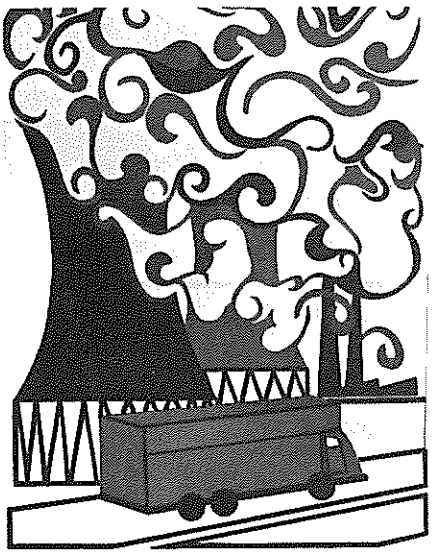
On the outbreak of coffee borer (*Anthores leuconotus* Pasc.) in coffee plantations near Eshowe, material was collected to identify the yeasts which may be symbiotically associated with this beetle.

Because of the Microbiology Research Group's active role in yeast taxonomy local medical and non-medical laboratories submit a considerable number of yeast strains to it annually for identification.

Fungal taxonomy

The classification of the industrially important fungal genus *Penicillium* is primarily based on morphological criteria. Although this system is satisfactory for groups in which species are well differentiated morphologically, there are species which are not easily distinguished by their morphology, e.g. the *Pen. cyclopium-Pen. viridicatum* series. Investigations have been initiated to establish whether the production of secondary nitrogenous metabolites might provide a more reasonable basis for species delimiting in areas in which morphological differentiation is poor.

Air Pollution Research



Air Pollution Research Group

Head :
Dr E. C. Halliday

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

The group studies the type and concentration of pollutants, 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.

Public interest in pollution of all kinds has been aroused by the propaganda of the National Air Pollution Control Agency of the United States, and demands on the Air Pollution Research Group have increased as a result. During the year under review literature was supplied to many inquirers and special reports were written at the request of government departments and private organizations.

Dissipation of pollutants

The Group was occupied during the year with measurements designed to assist and advise planners in the engineering and city development fields. Measurements were made at a number of sites where factories were due to be established or where residential zones were due to be declared.

By means of a temperature-sensitive device on a tethered balloon it is possible to measure the ability of the atmosphere to disperse pollutants at various times and during different seasons. In addition it is possible, by means of recording anemometers, to find areas in which pollutants will accumulate. It is therefore possible to indicate sites in a given area which should not be used for industry and sites which are unsuitable as residential areas or towns.

Reports have been presented to organizations such as Iscor, Escom, and the Town and Regional Planning Commission of Natal.

Pollutants from motor cars

For four months of the year the Group's mobile laboratory recorded concentrations of carbon monoxide, oxides of nitrogen and ozone at selected sites in the streets of Pretoria, Johannesburg and Durban. The same sites were used during a survey in 1969.

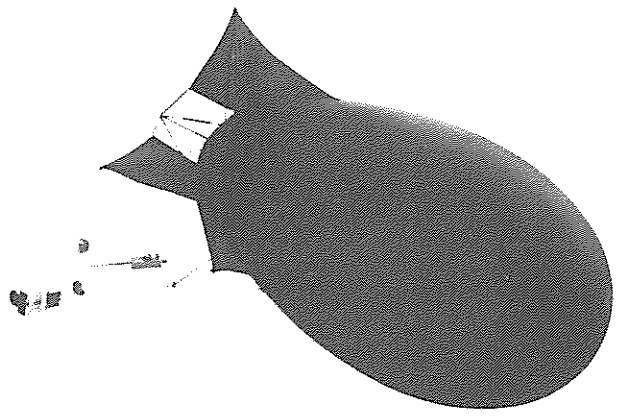
The aim is to chart the changes in these pollutant concentrations with lapse of time because at present concentrations are considerably lower than they are in the larger cities of the west coast of America.

Effect of fluorine on sugar cane

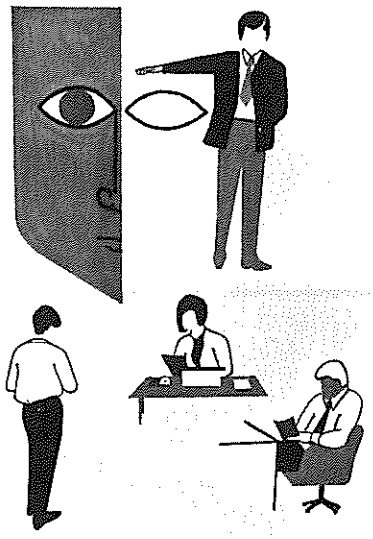
Because of the establishment of an aluminium smelter at Richards Bay, experiments were undertaken on the effect of hydrofluoric acid on sugar cane. Although the specification for the erection of the smelter included an undertaking that emissions of fluorides would not be higher than the level found in Switzerland to be tolerated by grasses and plants in the surrounding regions, the study was considered necessary as there was no published literature on the sensitivity of sugar cane to fluorides.

It was found that sugar cane is not very sensitive to fluorine. It is not yet known if low concentrations of fluorine retard the rate of growth of the cane as this will involve long-term experiments.

Captive balloon for measuring wind directions, wind speeds and temperatures at altitudes up to 300 m.



Personnel Research



National Institute for Personnel Research

Director: Mr D. J. M. Vorster

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

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

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

The overall role of the NIPR

The variety of functions which the Institute has to perform can best be illustrated by a few examples of its work.

Its active participation in basic research is stimulated not only by its own need to acquire new knowledge to contribute towards relieving labour problems, but also by assignments from outside the Institute. For example, the Committee of Inquiry into Psychopathy requested the Institute to conduct electroencephalographic and psychometric investigations of aggressive and non-aggressive psychopaths in order to find out more about abnormal brain function and its possible role in the development of psychopathic behaviour. The study was conducted with the co-operation of the Departments of Prisons and Health.

The NIPR has been entrusted with co-ordinating the South African contribution to the International Biological Programme's study of medical, physiological, genetic, anthropometric, nutritional and psychological adaptation to environmental change. This is another example of the recognized part the Institute plays in basic research.

In addition, the continuing demand for applied personnel studies and for the introduction of personnel practices in a variety of industrial organizations illustrates the opportunity which the Institute has of combining basic and applied research.

The many requests received during the year for senior staff to address post-graduate classes, business schools, professional bodies and managers on topics relating to man at work are further evidence of the Institute's role as a source of information. Of particular importance was the invitation to the Institute to contribute to the annual South African Business Outlook Conference on the manpower situation in the Seventies.

Although a certain amount of sponsored research was undertaken, this part of the Institute's work has decreased. This is because of a growing tendency for employers and others to expect research into manpower and personnel problems to be a national service rather than a service for which sponsors have to pay.

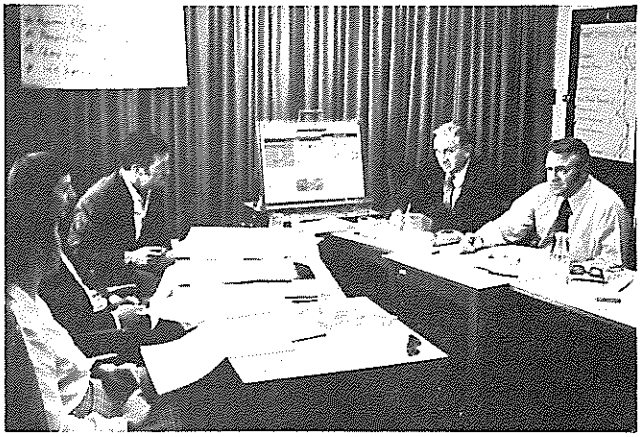
The Institute's close association with personnel management through the South African Institute of Personnel Management (SAIPM) was maintained. The NIPR now provides literature abstracts and review material for the SAIPM's monthly publication, *Personnel Management Digest.*

Classification test battery for Bantu labourers

More than 20 years ago the NIPR constructed a general adaptability battery of tests to determine the trainability of illiterate Bantu labourers. Simple tasks involving sorting, assembling, fitting and building were used, and since the subjects spoke many different languages and dialects a novel technique for administering the test was devised in which all instructions, both for the test procedure and for the performance of individual tests, were given by means of a silent film.

This battery still functions satisfactorily if appropriately used, but various factors, such as greater exposure to a Western way of life, have necessitated a new instrument for classifying this industrially unsophisticated labour force.

At the request of the Chamber of Mines of South Africa a new classification test battery (CTB) has been constructed and validated. This battery is the outcome of extensive psychometric research, and while it retains much of the simplicity of administration of the old battery (the film technique for example), it takes into account the general development and intellectual sophistication which has taken place amongst tribal Bantu during recent years. The CTB is now available for use in industry.



The Organization Development (OD) Seminar in progress.

Selection and training of divers

The NIPR has for a number of years been studying the psychological problems in diving. The investigation has now been concluded with the successful development of selection procedures and improved training methods for divers. This was a particularly difficult study because of the wide range of technological, biological and psychological problems involved in underwater operations. Survival and effective underwater work were found to depend on man's ability to adapt, emotionally and physically, to an alien environment.

The diving research situation provides a laboratory for the study of human behaviour reduced to the essentials required for survival, and thus promises insights into man's reactions to stress.

Diving research is of growing importance because of the rapid increase expected in the utilization of oceanic resources.

Management and organization development

Organizational and managerial studies conducted by the Institute over a number of years have culminated in a promising management and organization development system, directed at the maximum utilization of human resources.

The OD (organization development) Seminar which introduces the system uses several new instruments for assessing personnel and organizational development. It makes extensive use of closed-circuit television for identifying and reinforcing desirable group behaviour. The system is being applied in certain companies.

Job evaluation

The NIPR system of job evaluation which has over the years gained wide acceptance in South African companies, was revised and abbreviated without significant loss in accuracy. In addition, standard procedures for the rapid evaluation and classification of Bantu industrial jobs were developed, complete with training manuals. The demand for training in the use of these procedures suggests that they meet a very real need in improving the utilization of labour in South African industry.

Supervisory training

Supervisory training is traditionally sadly neglected, particularly in smaller companies, mainly because supervisors cannot be taken from work long enough to undergo conventional training courses. This problem can now be relieved with the help of three supervisory training manuals developed by the Institute. These manuals cover personnel management functions of the supervisor, job instruction and human relations, and have been drawn up according to the technique of programmed instruction.

With this method of self-instruction supervisors can be trained individually or in groups. Each progresses at his own speed so that slow learners do not delay fast learners. This method makes it possible to take supervisors from work and train them at convenient times without disrupting the production process too much.

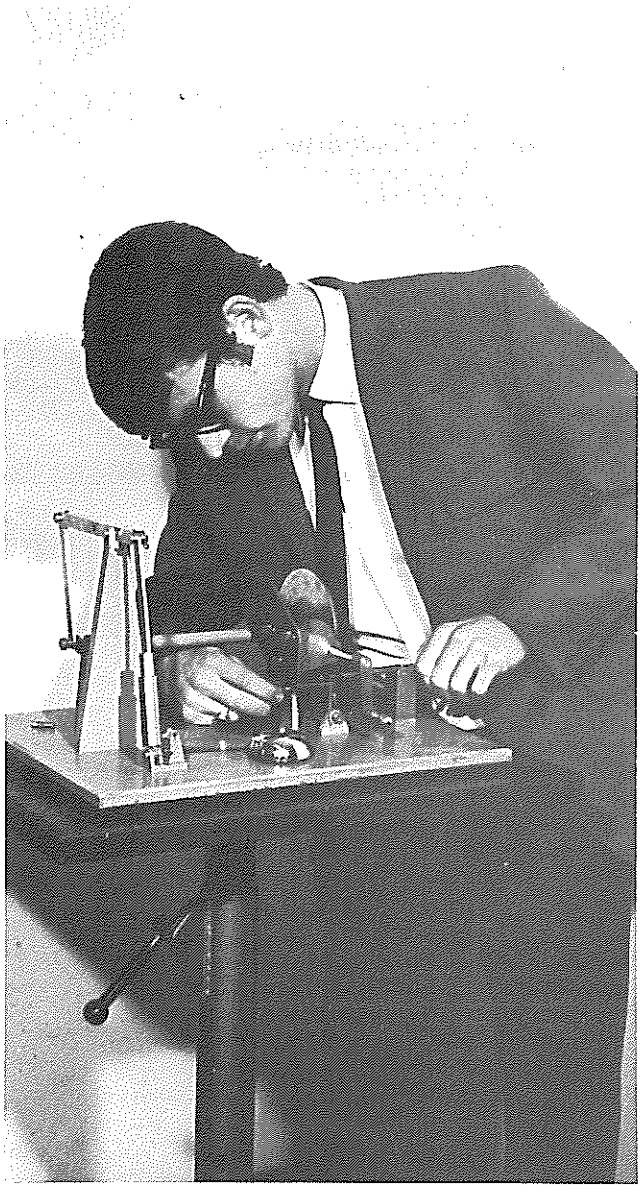
The three programmes and an instructor's manual are available to industry, universities and all other interested bodies.

Work motivation

Work motivation and adaptation to industrialization are vital to increased productivity which is a major determinant of the rate of economic development. This aspect of personnel research is therefore receiving increasing attention.

Work motivation concepts are particularly complex and variable, at the levels of both affluence and underdevelopment. Since conventional sociological and social-

The Fault Finding Test of Mechanical Ability, used in vocational guidance.



psychological survey studies have not been very successful it is necessary to try to find out whether there are fundamental characteristics in individuals and groups which may be related to the differences observed.

The Institute is now pursuing two new lines. Firstly, a study is being made of 'stimulus seeking behaviour' or 'curiosity'. It is noticeable that some people explore their environment without there being any biological need to do so. For example, a child will build a house in a tree as a form of play, without having any need for shelter. This type of activity may be related to motivation in general, including work motivation.

A prerequisite in a study of this kind is the development of suitable tests. Experimental tests have been constructed and applied to students at the Universities of the Witwatersrand and Fort Hare. Simultaneously, a number of measures have been made of intelligence and physiological arousal in an attempt to correlate these with curiosity.

The second approach is a neuropsychological one. It has been found that athletes, capable physiologically of the same level of performance, differ noticeably in their achievements. This may be due to differences in stress tolerance which are in turn partly dependent on motivation.

To a large extent motivation involves learning processes within the autonomic nervous system. The Institute is attempting to correlate the learning ability of the autonomic nervous system with performance on the athletic track.

Personnel and social implications of automation

The scope of the Intitute's computer division has been extended to include the study of the personnel and social implications of introducing automation in South Africa. Overseas experience emphasizes the need to study these aspects of automation concurrently with the technical, production and economic aspects.

South Africa has, on the one hand, the advantage that a considerable amount of information is already available on automation, its requirements and its beneficial and adverse effects; but on the other hand, the country may experience unique problems because of the composition of its labour force. There is, for example, the question of the trainability of the Bantu and his adaptation to automation. The problem of redundancy also has very important social implications.

The Institute is presently making only a modest start in this field of investigation. One project involves the development of aids for training adult Bantu in the specific skills required for working with information (which is usual in automated plants) rather than with objects. In order to place in perspective, when it arrives, the effects of automation on the South African labour force, the current manpower situation has been analysed and short-term projections have been made of certain aspects. A staff-member, as a member of the Manpower Subcommittee of the South African Council for Automation and Computation, participated in a sample survey to estimate the future demand for manpower to handle automated equipment.

Vocational guidance

A small section of the NIPR provides vocational guidance, both in Pretoria and Johannesburg, mainly for young people who have completed their secondary schooling and for university students.

Since its inception there has always been a heavy demand for this service. By employing ex-members of staff on a part-time basis it has been possible to see 968 clients in the past year compared with 374 in 1968. Despite this, it is still not possible to give guidance to all those who request it.

To improve the service further, questionnaires were sent out during the year to determine what was expected of the service and whether these expectations were being met. The Institute also hoped to establish from this survey whether clients had difficulty understanding test results in the reports issued to them.

Psychological attributes and proficiency of truck-drivers

In a study sponsored by the National Institute for Road Research the psychological attributes and proficiency of White and Bantu male truck drivers were investigated.

The aims of the investigation were to test the hypothesis that there are no differences in driving proficiency between White and Bantu drivers of heavy vehicles; to investigate, by using a test battery, the value of certain predictors of driving ability; to develop a criterion of driving proficiency; and to obtain information for use in the training, selection and employment of heavy-vehicle drivers.

The study was carried out in three phases : a descriptive survey was undertaken of a large sample (587) of White and Bantu heavy-vehicle drivers and their employers from the Witwatersrand area; 35 matched pairs (each consisting of one White and one Bantu driver) were selected from the above sample; the psychological attributes and driving proficiency of the matched pairs were studied and a criterion of driving proficiency was established.

Certain differences were found between White and Bantu heavy-vehicle drivers regarding both the predictive value of the tests and driving proficiency. The final report is, however, still being compiled.

Scale of authoritarian behaviour

The concept of authoritarianism or anti-democratic attitude has great relevance in the everyday working situation and, for managerial selection and development, the identification of individuals with autocratic, authoritarian attitudes is therefore important.

The Institute has developed a scale of authoritarian behaviour which has been applied to a large representative group of male students. It seems possible that the authoritarian person has some or all of the following characteristics : a tendency to worry unnecessarily; feelings of worthlessness and a disposition to react emotionally rather than rationally; pre-occupation with preservation of order with emphasis on regimentation; self-righteous moralism and a striving to do the 'done' thing; low self-esteem; tendency to be timid and withdrawn in demanding and taxing situations; unnatural concern with physical illness; uncritical acceptance of all forms of authority; exaggerated submissiveness to, and respect for, all authority figures; harsh intolerance of any form of deviant behaviour; emphasis on punishment and retribution.

The test has since been applied to 1 000 National Servicemen to verify the personality traits previously identified.

Test distribution

A small unit in the Institute physically produces and distributes NIPR tests.

The unit has had a particularly busy year as the demand for tests remained high and several innovations were made in their packaging and dispatch.

The Classification Test Battery for Bantu labourers, already referred to, was finally produced and compares favourably in format and durability with the best overseas products.

A two-day conference on psychological testing in general, the enforcement of ethical codes of conduct, and test distribution was held at the Institute. It was attended by about 150 persons, representing psychologists and personnel practitioners from industry and the universi-

ties. Papers were presented by several experts, including clinical psychologists and personnel managers.

The conference served the valuable purpose of making the Institute more aware of the everyday problems of the test-user. It also highlighted the NIPR's contribution to the alleviation of problems regarding the optimal use of available manpower.

Publications

The Publications Section produces and distributes the Institute's journal, *Psychologia Africana*, its *Annual Report*, and its *Annual Publications List*. The Section houses and distributes all contract and research reports produced by the Institute's research divisions, and assists where necessary, with the production of other NIPR publications.

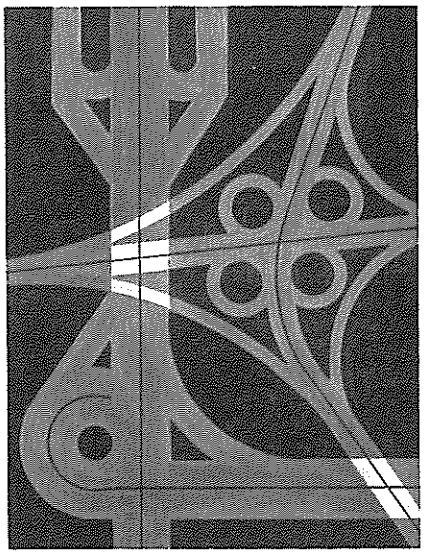
Psychologia Africana is intended primarily as a medium of publication for NIPR staff-members, but also includes contributions by outside authors on topics related to the Institute's sphere of research interests. Like the *Annual Report* and *Annual Publications List*, it has a wide circulation locally and overseas, and is sent to scientific, educational and industrial organizations as well as to individuals who are interested in the work of the Institute. (Volumes 1 to 11 of the journal, covering the years 1948 to 1967 have been reprinted by, and are obtainable from, Swets and Zeitlinger N.V., Amsterdam, Holland.)

During the year, the first part of a comprehensive list of NIPR publications, covering the period 1946 to 1968, was printed and distributed. This list contains 906 references and a subject index. Further parts, combining the *Annual Publications Lists*, will be published at five-yearly intervals. So far lists for 1969 and 1970 have appeared in which a total of 111 items are given.

Master copies of all publications listed are housed in the NIPR library. The Publications Section, however, keeps a limited supply of publications and copies are issued on request. The demand remains high and 1 305 copies were issued during the year.

Manuals used in supervisory training.

Road Research



National Institute for Road Research

Director: Mr S. H. Kuhn

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.

Heavy vehicle simulator

A heavy vehicle simulator which may be invaluable in determining the effect of prolonged heavy traffic on roads, has recently been commissioned by the Institute. The NIRR and a Johannesburg firm developed the machine over the past two years with the active support of the Department of Transport.

The heavy vehicle simulator has captured world-wide interest among road engineers because of its potential value for the rapid evaluation of design methods for roads.

Designs for road pavements have until now been evaluated either by observing the performance of roads under normal traffic conditions or by repeatedly driving heavy vehicles over test strips. However, these methods are time-consuming and expensive and there is uncertainty in the application of even proven designs if environmental conditions differ or if alternative materials are used.

The heavy vehicle simulator makes it possible to evaluate new designs rapidly in practice under all sorts of environmental conditions. In this way, the best design for a road can be established, failures prevented and repair costs avoided.

The machine can be positioned anywhere on a road and a special wheel tests a section 6 m by 1 m. This wheel can be hydraulically loaded to 70 kN, which is 75 per cent higher than the legal limit for wheel loads on public roads. The legally allowed axle load can be repeated on the test section about 1 million times in one week. This is equivalent to the effect of normal traffic on a typical road over a period of approximately 15 years. Each wheel load of 70 kN has approximately the same effect on the road as 10 heavy trucks or 150 000 motor cars.

At first mechanical difficulties were experienced with the machine but these are gradually being overcome. During the year a number of tests were completed on the new Springs-Witbank road (S12) from which valuable design information has been obtained.

National Data Bank for Roads

At the request of the Institute the CSIR decided to finance the establishment of a National Data Bank for Roads. The initial budget is R22 000 which includes about R6 000 for acquiring information besides that obtained free of charge from road authorities and other sources.

The function of the data bank is to classify and store data on road materials indicating the type of terrain in which the materials occur, so that the data can be re-used in similar terrain. For this purpose the whole subcontinent is being divided into different terrain units. This subdivision facilitates the handling of information and the definition of areas where information can be re-used for purposes of road construction.

At present it is necessary to carry out a soil survey and materials tests for each length of road constructed. This information, contained in completion plans and materials survey sheets, is seldom used again even if other roads are later constructed on almost similar terrain. Such surveys cost approximately R250 per kilometre of bituminized road and South Africa's annual expenditure on this work is estimated at R500 000. It is expected that as the terrain classification advances and the data bank becomes suitably stocked the re-use of information will reduce this expenditure.

A recent NIRR publication, *TRH 2*, deals with the proper processing of data. Some 160 terrain units were indexed during the year, 32 of which were described in detail. Field demonstrations of the methods applied are well advanced in the Transvaal, Natal, Orange Free State and the Cape Province while those for South-West Africa and Rhodesia are being prepared.

Lacroix deflectograph

One of the most important parameters governing road performance is the transient deflection of a road surface

under moving traffic. Deflection measurements are used in theoretical models for the design of bituminous overlays, in assessment of road conditions in practice and in research into materials and construction techniques. Until recently such measurements were made with various mechanical devices which required laborious manual operation. It has been shown that about 200 measurements per 1 km of road (i.e. one every 5 m), are required to design an effective overlay with a reasonable degree of accuracy. French engineers therefore developed the Lacroix deflectograph which, mounted on a specially designed, slow-moving truck, rapidly and automatically measures deflections by taking a reading every 3,8 m in both wheel paths at a rate of about 400 readings per hour per wheel track.

The Lacroix deflectograph recently purchased by the NIRR will be a valuable aid in research into both theoretical and practical methods of evaluating the performance and design of roads. With suitable instrumentation the shape of the deflection bowl and the total deflection may be measured. The Institute hopes to adapt the instrument to measure another important parameter – radius of curvature. At present deflection is recorded by means of a visual system which has the advantage that the operator can see variations in deflection as the test proceeds. Since it is often short, isolated sections of a road that fail, it is valuable to be able to distinguish quickly those sections from the homogeneous sections.

Quality control in road construction

Recent advances in the structural design of road pavements, coupled with the need for better and hence more costly roads, call for more certain guarantees of the quality of road construction. This need has arisen at a time when road authorities are finding it extremely difficult to recruit and retain skilled technical staff.

Research by the Institute has led to the development of a scheme which clearly defines the responsibilities and authority of the various persons concerned with the design and construction of roads. Procedures for translating design requirements into statistical terms, the setting of standards for process and acceptance control, the execution of the control task as well as the proper application of data are dealt with in detail. The fact that the production process with roads is different from that in manufacturing industry has also been taken into account. For example, a system of reduced payment is proposed for work not conforming to specifications in cases where it is uneconomical to improve the quality of the work. More practical aspects which also receive attention are the location of sampling points on the road, lot size and frequency of testing.

In the development of the scheme valid statistical principles were used. This means that decision criteria are expressed in quantitative terms so that it is clear on what basis quality is judged. Furthermore, the use of this statistical method makes it possible to summarize routine

The NIRR heavy vehicle simulator.

control in a few simple rules which can be followed by any suitably instructed technician. This will help to utilize the country's limited manpower better.

Fatigue of road surfacings

A thin bituminous surfacing of less than 50 mm, supported by a granular crushed-rock base is a common design for South African roads. Under dynamic traffic loading the behaviour of the surfacing is determined mainly by the properties of the supporting base and subbase layers. In an investigation into the fatigue behaviour of thin bituminous surfacing in the NIRR, laboratory fatigue tests under conditions of controlled strain were carried out on samples of the mixture usually used as surfacing.

Two bituminous surfacing mixtures from an experimental pavement, one gap-graded, the other continuously-graded, were studied. Both mixtures are commonly used on roads with heavy traffic although they differ greatly in their composition and engineering properties.

The gap-graded specimens showed fatigue failure after one million repetitions of the strain commonly experienced in practice (144 hours of testing), whereas the continuously-graded specimens, under identical test conditions, failed after only 6 000 repetitions (1 hour of testing).

A disadvantage of gap-graded mixtures is that in wet weather they present a smooth surface with low skid-resistance to fast traffic. This condition can, however, be improved by applying precoated stone chippings to the surfacing.

Skid-resistance measurement

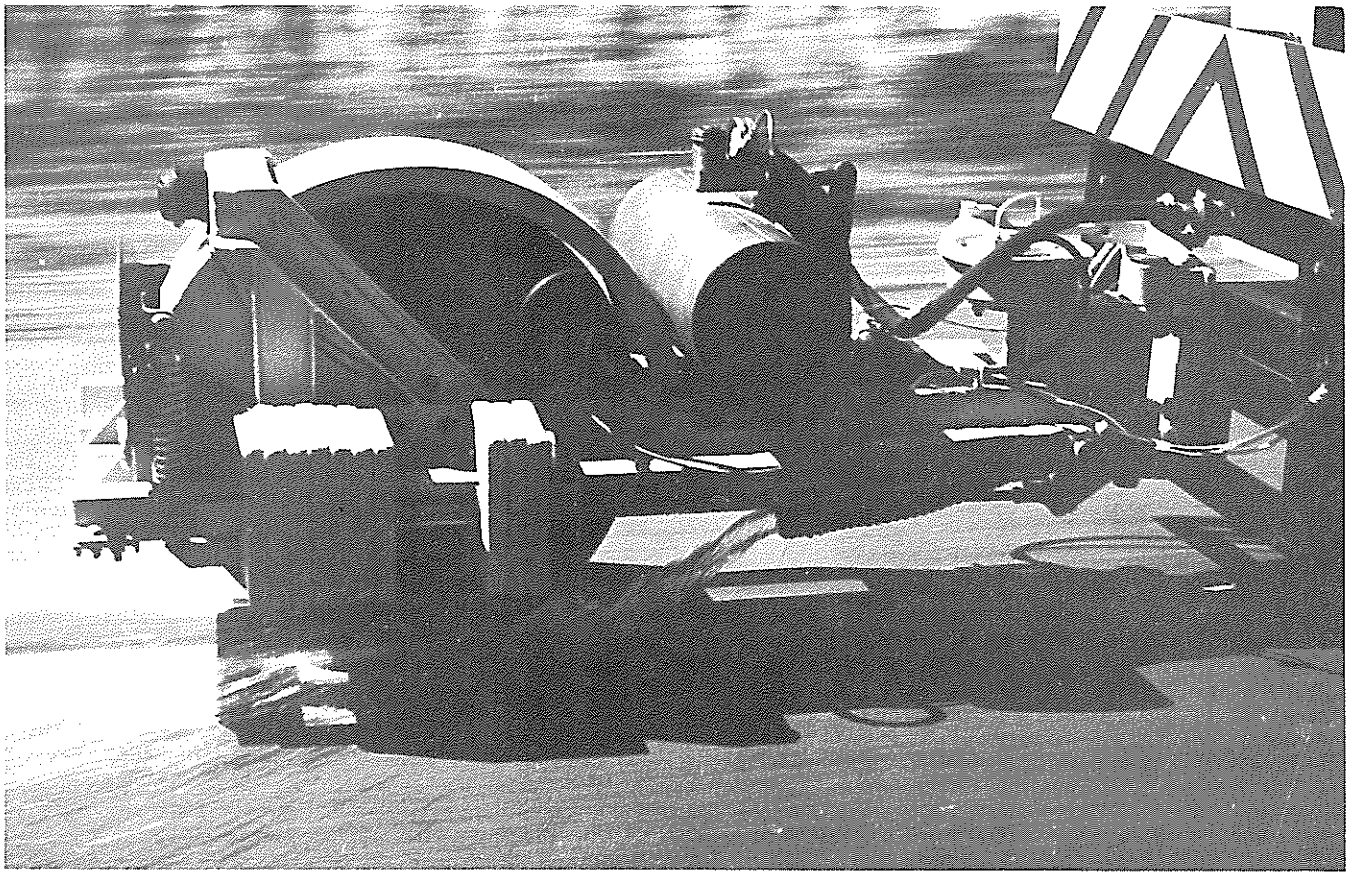
The number of skidding accidents in South Africa each year justifies planned research in this direction. Skidding is recorded as an attendant circumstance in approximately eighteen per cent of rural accidents in which people are injured. Approximately a quarter of these accidents occur on wet roads. Although as many skidding accidents occur in urban areas as in rural areas, they represent only five and a half per cent of the urban accidents.

This kind of accident can be reduced by approximately fifty per cent by improving the skid-resistance of road surfaces. The problem in practice is to identify slippery sections for treatment so that available funds can be used in the most effective way. Because the skid-resistance of a road cannot be determined visually, there is a need for a reliable measuring instrument by means of which the skid-resistance of different surfaces can be compared.

The first step taken by the Institute was the construction of a trailer to take the necessary measurements. This trailer consists of a chassis on one wheel, fitted with a treadless tyre, which is towed by a special vehicle with a large supply of water. Tests are done on safe stretches at speeds of 25, 50, 75 and 100 km/h, by locking the wheel while water is sprayed on the road in front of it.

Several series of tests were done on different road surfaces. Results showed that skid-resistance decreases as speed increases, although not equally for all surfaces. More research will be required to find a relationship between the texture of road surfaces and their skid-resistance so that specifications for improving roads with regard to skid-resistance can be made.

The trailer used to measure the skid resistance of road surfaces.



Building Research

National Building Research Institute

Director: Dr T. L. Webb

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

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

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

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

Investment in the South African building and construction industry in 1970/71 amounted to R1 700 million. The Institute's budget for this period was R1,4 million. Of this, seventy per cent was provided by the Government while the Institute itself earned the balance. An important fact is that the Institute, in dealing with technical problems, serves not only organized industry but also the community. Each year, the Institute deals with some 25 000 queries and receives approximately 6 000 formal visitors, of whom about 10 per cent are from overseas.

Building and Construction Advisory Council

The Building and Construction Advisory Council (BCAC) has appointed the Institute technical secretariat for the Standing Committee on the Use of Computers in the Building and Construction Industry. A report on the data requirements of the industry, requested by the BCAC, has been completed.

Regional offices

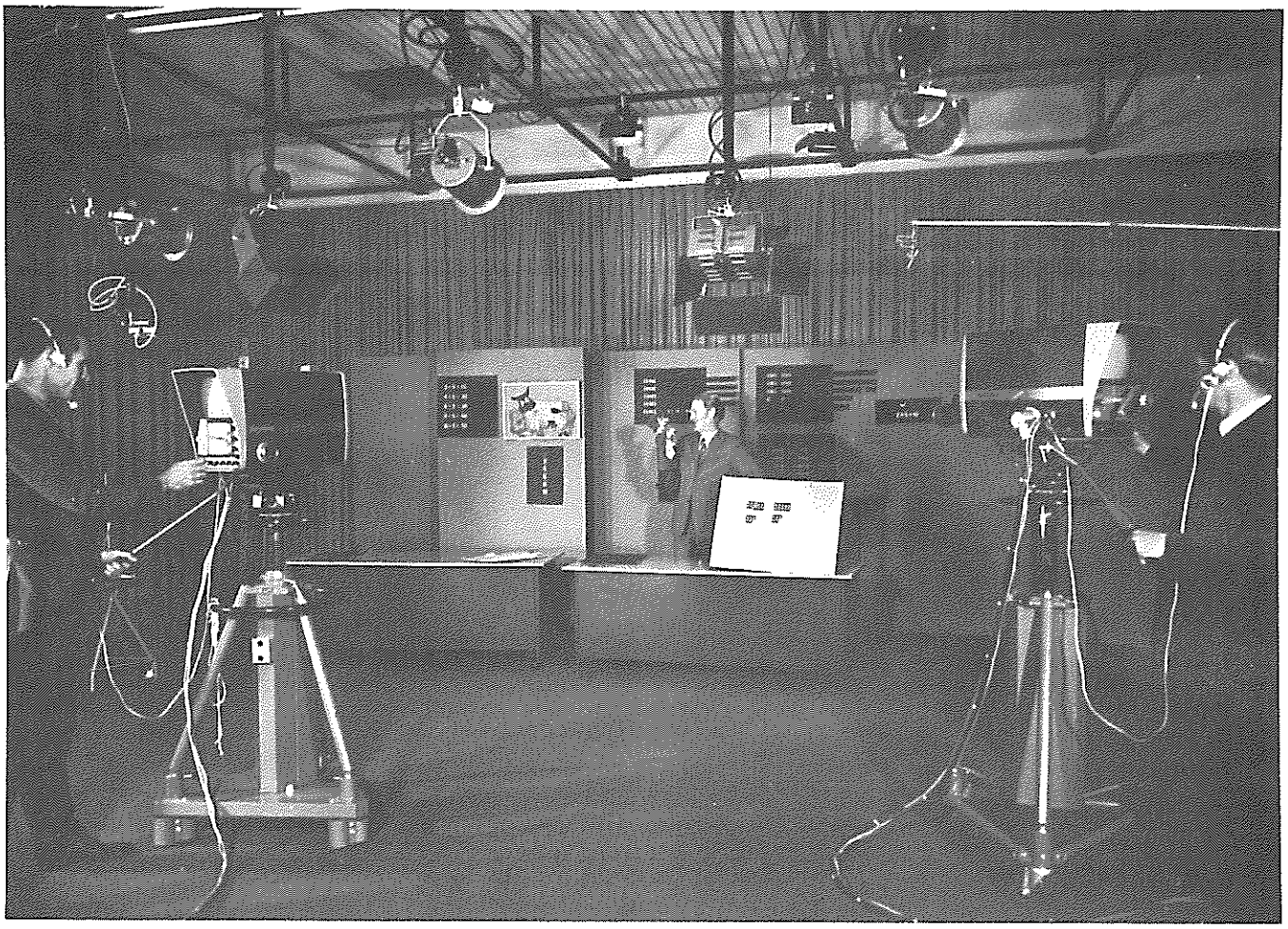
Local sub-committees of the Building Research Advisory Committee direct the work of the NBRI regional offices in Durban, Cape Town and Windhoek and guide their research into local problems. Members of these sub-committees represent different local sections of the building industry and government bodies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

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

Committees, congresses and symposia

During the year staff members of the Institute served on 138 committees which promote the interests of the building and construction industries. Members of staff delivered 32 lectures and took part in 42 local and overseas conferences at which they delivered 23 papers. Nine radio talks were given.

Two very successful symposia were organized during 1971. One, on moisture penetration in buildings, was held in Cape Town in September. In October an international symposium on the function and design of hospitals took place in Pretoria. Representatives of eleven countries attended this symposium and six of them delivered papers. The Institute, in collaboration with the CSIR's Information and Research Services, also arranged a symposium in June on the functional design of church buildings.



Investigating the use of audio-visual aids in schools.

Films

Two films were completed during the year, one on the precooked frozen food system and the other on a clean operating enclosure for hospitals.

Structural model study

Increasing precision and complexity in present-day structures give rise to problems in the field of building and civil engineering which are not easily solved by theoretical analysis. Here structural model studies are invaluable.

During the year a model investigation was completed for a 30-storey building for the Department of the Interior. A model to the scale 1:12 was completed in November 1970 and consisted of a ring-beam with eight supporting columns and two floors that fitted into the model. By February 1971 the cables had been tensioned and tested.

Solar shadowscope

An improved model of the solar shadowscope was entered in the Shell Company's competition for industrial design. It was awarded a highly commended certificate and was exhibited at the tenth anniversary celebrations of the Republic of South Africa.

Plastics in the building industry

The 'plastics age' in building industry predicted ten years ago by plastics manufacturers has not yet dawned. The two main factors preventing the ready acceptance of synthetic materials by the South African building industry are their low resistance to weathering and to fire. The Institute is investigating both these aspects.

To overcome the low resistance to weathering better compounds are being imported and the effect of parameters such as ultra-violet radiation, moisture, ozone and temperature are being studied. The low resistance to fire is a more difficult problem because criteria of acceptability are often based on subjective rather than on objective observations. Poisonous gases and fumes released when plastic dissolves at different temperatures, heating rates and oxygen/nitrogen ratios are being investigated.

Site investigations and soil mapping

By investigating sites before structures are planned expensive mistakes can be obviated.

The Soil Mechanics Division studied various methods of determining soil behaviour, for example aerial-photograph interpretation, and developed a standard approach to soil investigation.

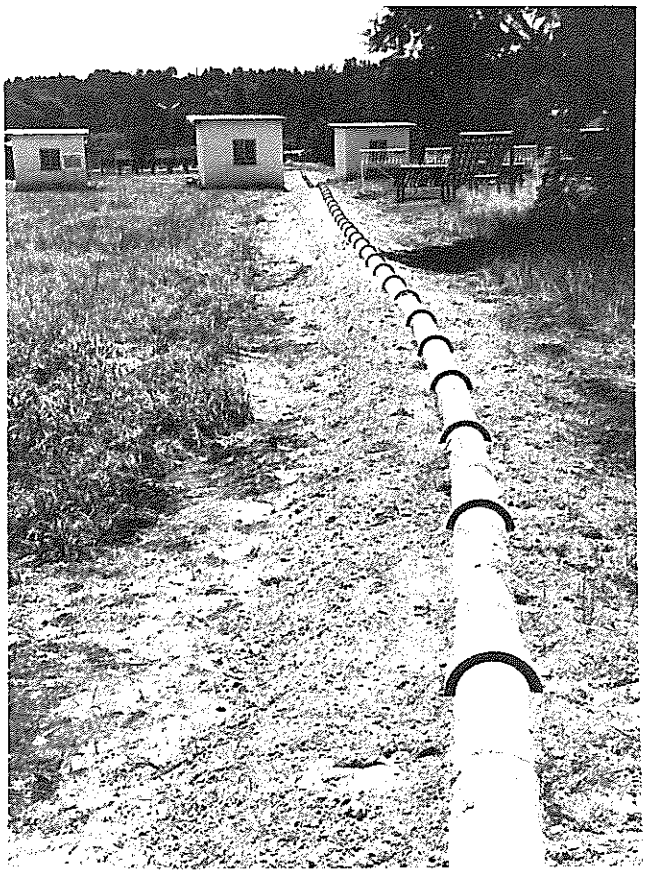
These methods are increasingly used for large projects, but unfortunately not as frequently for housing projects. It is hoped, however, that soil surveys of building sites will shortly be made obligatory.

Thermal behaviour of lightweight structures

The most important conclusions reached in connection with the thermal behaviour of full-scale experimental

houses in East Lynne, Pretoria, may be summarized as follows :

- Lightweight houses with suspended wooden floors do not comply with the thermal requirements of the Department of Health for inland mass-housing schemes.
- Excessive solar heat gains through windows in lightweight structures can cause serious indoor overheating and temperatures far above the threshold of discomfort.
- Although the thermal behaviour of heavyweight structures in inland regions is more favourable than that of lightweight structures, the opposite is true for the warmer Natal coastal area.



A full-scale working model of a curved sewer pipe on the NBRI test site.

Lightweight structures with additional mass, such as heavyweight floors and inner walls, are thermally more acceptable than brick veneer construction.

Building economics and statistics

Effective economic studies of the building and construction industry are only possible if suitable, up-to-date, meaningful, reliable and comprehensive statistics are constantly available. This is one of the biggest problems besetting South African industry at present.

The Institute is always well informed on current economic developments with an eye to their implications for building activity. A report on the data requirements of the industry has recently been completed for the Building and Construction Advisory Council.

Technical evaluations

The establishment of the Agrément Board in 1969, with the NBRI as its evaluating agency, may be seen as the creation of a formal basis for, and extension of, the work that the Institute did for years on a contract basis for those who wished to have building innovations evaluated.

In its evaluation reports for the Agrément Board or for private sponsors the Institute tries to give an objective, unprejudiced reflection of the technical behaviour of the innovation concerned, whether it is a new material, component, technique or building system. Attention is paid to behaviour in fire, rain resistance, condensation problems, sound reduction, structural strength, resistance to wear, thermal behaviour, durability, weathering, and the maintenance which will probably be necessary.

Computers in the building industry

The Standing Committee on the Use of Computers in the Building and Construction Industry, appointed by the Building and Construction Advisory Council, has nominated the NBRI the technical body responsible for the computer centre. As such, it has to undertake research, collect and disseminate information, and further coordinate training in this field.

As a start answers to a questionnaire on computer use were analysed and a report was compiled. Numerous concerns were then interviewed.

Curved sewers

In order to eliminate manholes at small changes of direction in housing sewerage systems, the use of curved sewers is being investigated. Full-scale models of curved sewers, in which standard salt-glazed pipes were used, were laid in order to study the laying technique and determine the action of cleaning equipment.

Improvements in pipe-jointing methods and in cleaning outfits have made the use of curved sewers more practicable. These sewers are especially useful in densely populated areas where changes of direction have to be eliminated, and also in hilly towns where the street layout is uneven. An experimental sewer layout in such an area in Pretoria is envisaged.

Audio-visual aids in schools

The Institute is investigating the characteristic behaviour of new audio-visual teaching aids and the development of physical parameters that will create the best environment for the educational process. It is also studying the implications of this development for the planning of schools properly equipped for these facilities.

Housing research

Housing research carried out by the Institute in the past was directed mainly towards the provision of housing for lower-income groups. It embraced separate projects for lower-income Whites, Bantu, Coloureds and Indians, as well as a project for housing for the aged. Usually preliminary surveys were made to establish the requirements, housing preferences and desires of each group, as well as whether they were able to pay for the housing. Minimum requirements for living-space and the technical behaviour of the houses were then ascertained. This procedure was adopted for Bantu housing and an operative building system was developed which made it possible to build 450 000 functinal houses during the past two decades at costs low enough to suit the incomes of the inhabitants.

Current research is directed towards reducing the cost of housing for the middle-income group by applying new

building techniques, for example the use of brick veneer with wooden framework and prefabricated brick panels. The thermal behaviour of buildings, especially under warm climatic conditions, is also being investigated.

Inorganic building materials

The most important inorganic materials into which research is being done are binders such as portland cement, blastfurnace slag, lime, gypsum, and the compounds in which they are used, as well as clay and clay products, building stone, fine and coarse concrete aggregates and sand.

At present investigations are being carried out into the use of fly-ash, a waste-product of power-stations, and of special slag from the steel industry, in cement, ceramic products and calcium-silicate building units. Work is also being done on the corrosion of concrete in harsh environments particularly as far as this affects sewer corrosion and its prevention.

Fires

An investigation into the occurrence of fires in buildings in South Africa emphasized the necessity of including measures for preventing fires in building design. The investigation included visits to the scenes of fires and a survey of fires over a number of years.

International co-operation

The Institute is an active member of the International Council for Building Research, Studies and Documentation (CIB), an international organization of which 70 countries are members. The Institute participates in the CIB system for the exchange of research programmes and abstracts of publications between building and allied organizations throughout the world. Through personal contact and the exchange of correspondence it takes part in the activities of a number of working groups and commissions. Great benefit is derived from such co-operation. Co-operation with Rhodesia and Malawi takes the form of reciprocal visits and regular lectures by NBRI personnel.

At the Golden Jubilee Congress of the Building Research Station in Britain the Director presented an address of appreciation on behalf of building research organizations in Australia, Canada, India, New Zealand, Pakistan, the United States and South Africa.

The election of the Director as a member of the Board of the CIB for a second three-year term of office, strengthens the close ties between South Africa and the CIB and also foreign building research organizations. The Institute is also represented on the Board of CIB's journal, *Build International.*

The Institute is a member of 19 international organizations. Attending international conferences and other gatherings has contributed significantly towards furthering international co-operation. At several congresses members of the NBRI staff presented papers, and participation in formal and private discussions with representatives of countries such as the United States, the United Kingdom, Australia, New Guinea, Canada, Japan, France and Sweden, proved most rewarding.

A soil survey of a site being made to determine its suitability for building purposes.

Timber Research

Timber Research Unit

Head : Dr D. L. Bosman

The Timber Research Unit (TRU) was established in 1960 to serve the needs of the wood and wood products sector and the pulp and paper sector of the Republic's forest products industry. As a multi-disciplinary, industrially oriented organization the Unit offers a wide variety of specialized research services to both producers and consumers of forest products. Timber research and development in timber technology are managed on business principles and the research process is carried beyond the development stage into the field of practical application.

The Unit consists of divisions for timber engineering, wood processing, pulp and paper, systems development, techno-economics and information and special services.

The aims of the TRU are:

- *the effective utilization of South African timber resources*
- *the development of satisfactory wood-base products resources*
- *the development and improvement of manufacturing processes*
- *the effective use of timber products.*

Stress-grading

Additional batches of structural timber were tested and analysed to obtain more data for the implementation of mechanical stress-grading in the Republic.

A simple and inexpensive stress-grading machine has been developed by the TRU which will be adequate to cope with the demand for structural timber reflected in a recent survey.

Research workers of the TRU assisted the Malawian Department of Forestry in developing a stress-grading system for locally grown softwoods.

Joints

The TRU helped the South African Bureau of Standards in an experiment to determine whether various new types and sizes of finger-joint were acceptable.

Pilot studies have been done on various aspects of nailed plywood joints including the effect on these joints of reducing the spaces between nails.

Roof trusses

The project aimed at developing and publishing a series of economical standard designs for roof trusses with nailed plywood gussets is progressing favourably.

A number of timber roof trusses of the traditional type have been tested as part of an investigation to evaluate new testing procedures and establish rational performance criteria.

Board products

Research into the durability of various types of wood-base board products indicated that where these materials are used as exterior cladding for houses particular attention should be given to construction details. The information is being used in evaluating industrialized building systems with board products as cladding.

Adhesives

A study of the effect of contamination on the gluability of timber led to a better understanding of the way in which contaminants such as greases, waxes, oils, resins, extractives and wood preservatives interfere with gluing. This information was used in recommending methods of overcoming certain problems caused by contamination in practice.

Because the durability of adhesives used in wood gluing is of the utmost importance, several investigations were made in this connection. The following conclusions were drawn :

- the durability of urea-based adhesives used in structural products is suspect, but no deterioration was observed within the first two years of long-term aging tests
- melamine/urea adhesives used as substitutes for resorcinol-based adhesives were durable if properly formulated and cured
- hot-setting adhesives made from wattle tannin were comparable with the usual outdoor adhesives as regards durability.

Delamination in glulam

Research has shown that delamination does not always affect strength of glulam critically and that much depends on the degree of delamination and certain design features. An important consideration is whether the delamination is continuing or whether it has reached a stable condition.

Timber quality

A survey of the attitudes of consumers towards the quality of graded South African softwood timbers showed that warp, which usually manifests itself as severe twist some time after grading, is the chief cause of dissatisfaction. Recent research at the TRU has shown conclusively that

twist can be reduced by half, if the timber is mechanically restrained during kiln drying. This also increases the quality of the timber. The amount of twist in restrained timber was reduced whether a high, medium or low drying temperature was used. The amount of twist was measured shortly after kiln drying.

Further research is being conducted to study the subsequent behaviour of the material during storage under cover to see whether the beneficial effect of mechanical restraint is maintained.

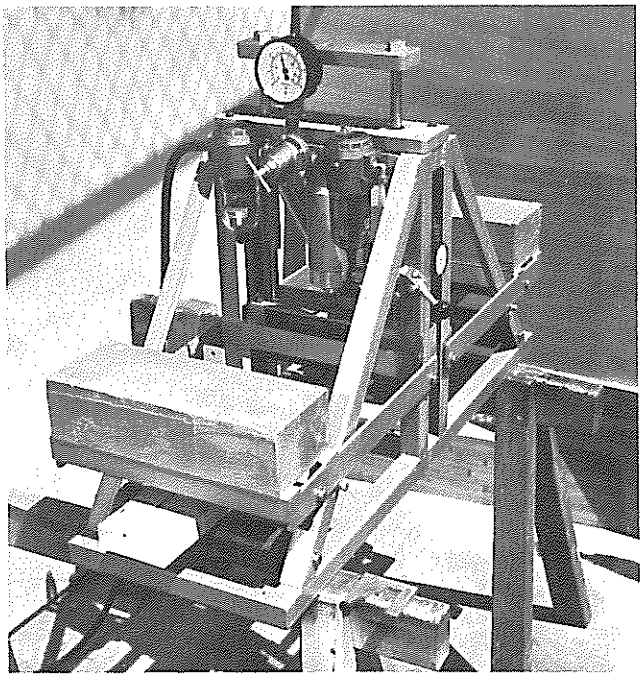
Moisture content

A method of rapidly determining the gravimetric moisture content of wood has been developed. The surface temperature, not the air temperature (as in the conventional oven-drying method), of the specimen is controlled at 102 ± 3°C. The system accelerates the drying process without the danger of the specimen charring.

Techniques for the non-destructive determination of moisture content and density of wood have been studied with special reference to radiation techniques.

Bagasse

An expected shortage of pulpwood is the most important limiting factor in the long-term development of the pulp, paper and paperboard industry in South Africa. The possibility is therefore being investigated of substituting or supplementing wood fibre with another vegetable fibre such as bagasse, a waste product of the sugar industry.



A machine for stress-grading structural timber, which was developed by the TRU.

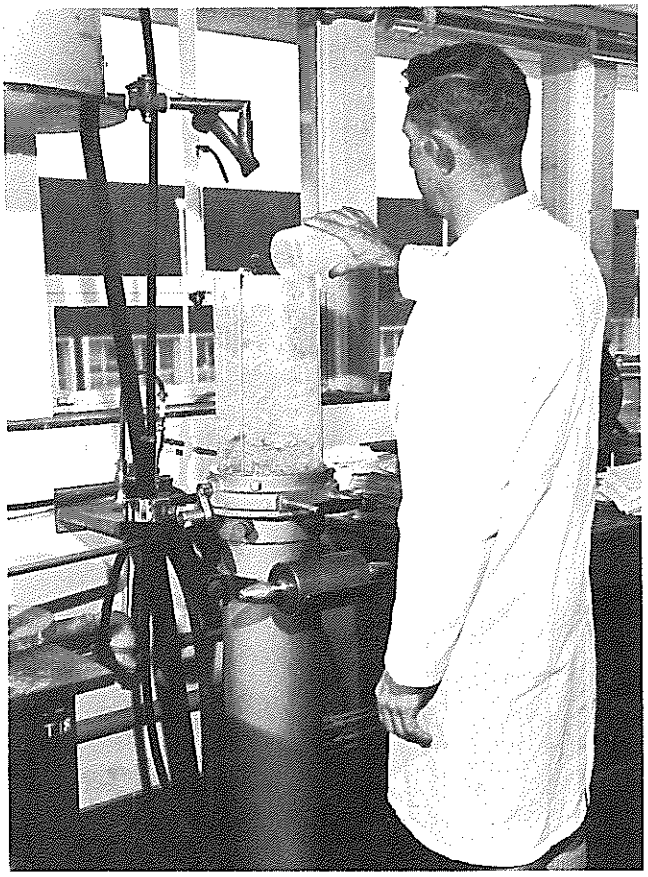
Pitch deposits

The use of resinous pine in the mechanical manufacture of pulp results in pitch deposits during papermaking which cause serious production losses. The TRU initiated a project aimed at developing an efficient method of overcoming this problem. Such a method should benefit the paper industry technically and economically.

Preservation of paper

Most documents on modern paper become unusable within a few decades owing to excessive deterioration of the paper. An investigation to determine the simultaneous influence of a number of aging factors is nearing completion.

This work will serve as a basis for further recommendations concerning the preservation of archival documents.



Equipment for making paper for experimental work.

Requirements of pulpwood

The South African paper industry finds it difficult in some cases to match the quality of imported paper. The first phase of a project aimed at laying down criteria by which to assess the quality of South African grown pulpwood is nearing completion. The Department of Forestry will use the results of this work in their treebreeding programme to produce better pulpwood.

Systems development

The Head of the Unit's Systems Development Division studied the use of systems methods in developing and applying new and improved forest products utilization practices in the United States. The knowledge gained should enable the TRU to undertake similar projects.

Stock glulam

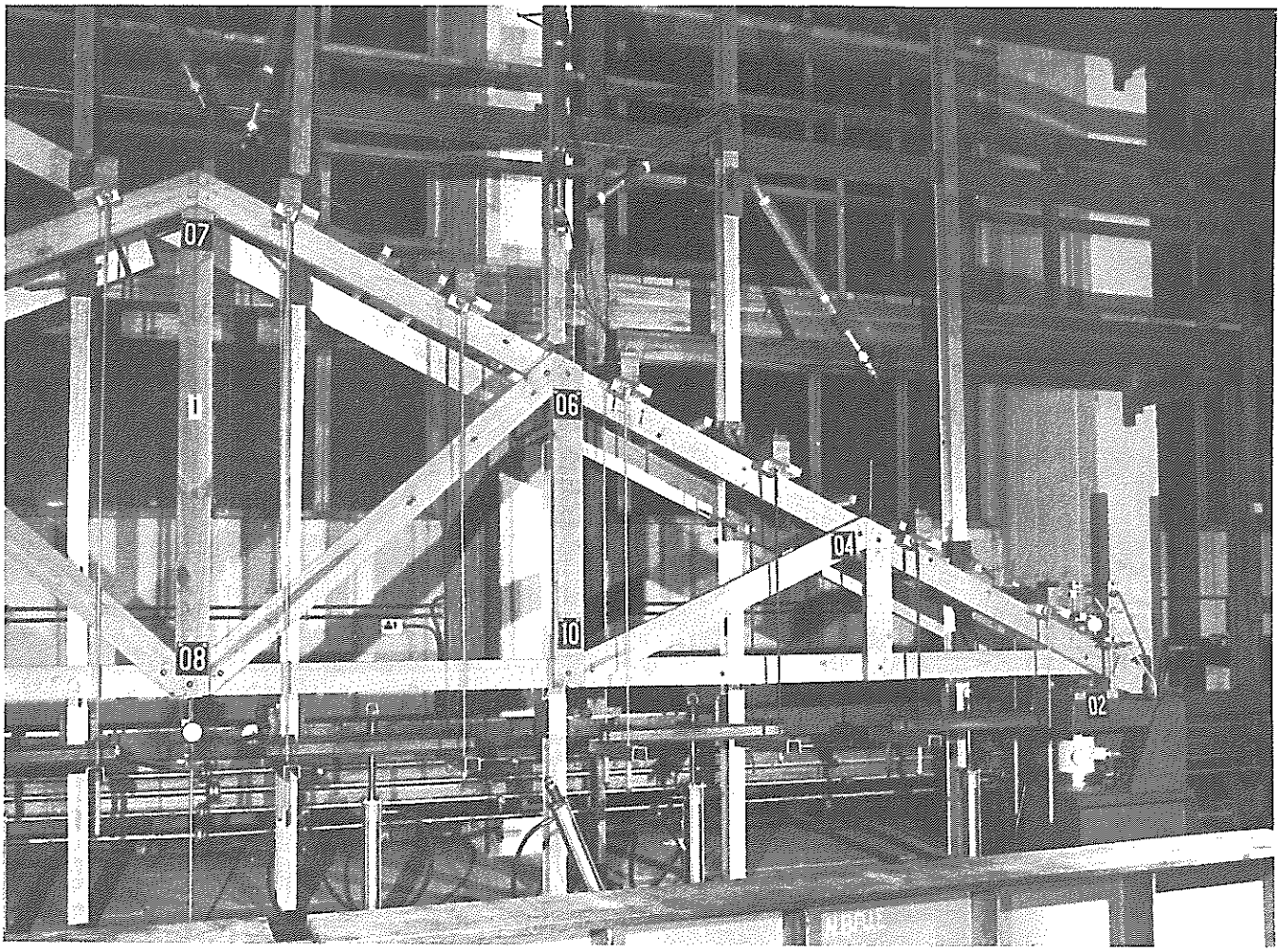
The results of work undertaken for industry and the South African Bureau of Standards indicated that the strength of most stock glulam was overestimated. This led to the inception of a new project, sponsored partly by the stock glulam industry. A project leader has been appointed and a research programme prepared.

Supply of and demand for timber

A study of the supply of and demand for softwood sawn timber in South Africa was completed during the year. This showed that, in general, consumers were not satisfied with the present system of grading timber. The TRU may be able to assist in developing a system of grading timber to meet specific needs.

An investigation into the cost of manufacturing roof trusses in South Africa has been completed. This information was required to guide the research being conducted by the TRU into new types of trusses which must compete economically with traditional trusses.

The techno-economic study of the pulp, paper and paperboard industry which was completed last year, was



A traditionally constructed timber roof truss being loaded in the TRU truss test rig to study its structural behaviour.

The study also confirmed the serious lack of general techno-economic information with which to plan effectively for the sawn timber industry. A project on short-term timber trend analysis was thus commenced to obtain information with which to design effective measures to overcome problems associated with shortages and oversupply within the industry. Reports showing the supply of and demand for timber on a quarterly basis have been published for the first two quarters of the year.

followed by a more detailed analysis of the cost and benefit of various projects in order to allocate priorities to specific research and development projects in this field.

Cost studies

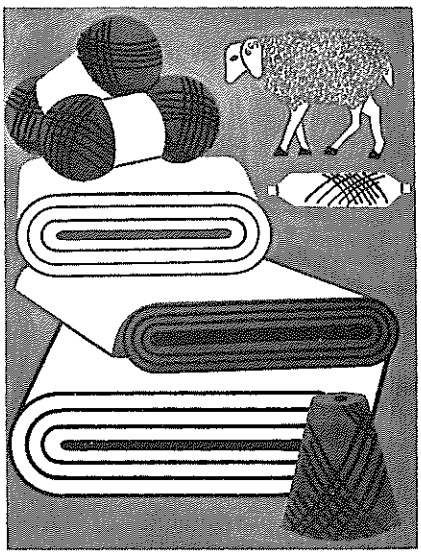
A study of the cost structure of the sawmilling industry progressed favourably. The aim is to make cost information on sawmilling available for use in various programmes of the TRU, and to develop a uniform costing system for the industry in order to provide information on cost centres where improvements can be made in efficiency and cost. A representative sample of sawmills had to be visited to obtain information on the cost structure of the industry as a whole and a basic costing system was designed.

International activities

Three research workers of the TRU attended the congress of the International Union of Forestry Research Organizations (IUFRO) in Florida and presented papers at meetings of working groups of the Union in Madison, Wisconsin. Their participation resulted in an invitation to Division 5 (Forest Products) of IUFRO to hold its next meeting in South Africa in 1973.

The TRU has assisted neighbouring states and other territories in Africa, and members of staff have visited Rhodesia, Swaziland and Malawi, and participated in a symposium in Windhoek on the *Utilization of South African pine structural timber in South-West Africa.*

Textile Research



South African Wool Textile Research Institute

Director: Dr D. P. Veldsman

The South African Wool Textile Research Institute (SAWTRI) which was established as a research institute for the industry and later incorporated into the CSIR, became a national research institute of the CSIR on 1st April 1971. One of the most important implications of this is that, whereas in the past the Institute was confined to research into the natural animal fibres (wool and mohair and mixtures of these fibres), it now does research into all fibres, including synthetic fibres. This is extremely important not only to another natural fibre, cotton, which has received very little technological attention in South Africa, but also to wool which will be investigated as a component for synthetic blends.

The fact that the CSIR regards wool and mohair research as of national importance is shown in its decision to subsidize research into these fibres on a 50:50 basis. Furthermore, the South African Wool and Mohair Boards still utilize more than 50 per cent of SAWTRI's research capacity.

Desoiling and soil-resist properties of resin-treated wool

In a previous investigation woollen fabrics were treated with chlorine to make them shrinkproof, before Hercosett resin was applied. The effect of various pretreatment conditions on the desoiling properties of fabric were investigated and the best pretreatment was determined.

Thereafter similar tests were done to test the desoiling properties of wool treated with Hercosett resin modified with thioglycolic acid (TGA). These two treatments were compared by using the two best (and probably the only useful) desoiling agents at present available for resin-finished wool. The desoiling treatment with Cassapret SR improved the desoiling properties considerably but the fabric soiled very easily. Thus although the fabric will clean easily the frequent washing necessary will shorten its practical life.

The other desoiling treatment (with Scotchguard 218) imparted good desoiling and soil-resist properties but the process was expensive.

Although the TGA-modified Hercosett had a less favourable influence on the soil-resist properties than on the desoiling properties it had specific advantages.

Dimensional stability of knitwear

Knitted all-wool fabrics were treated with Synthappret LKF, steamed in an autoclave after evacuation and finally tested for dimensional stability. It was found that both relaxation and felting shrinkage of all-wool jersey structures can be stabilized by treatment in perchlorethylene and subsequent autoclave steaming for two minutes. Chemical pretreatment of the wool is not recommended as prechlorination has a detrimental effect on the ability of Synthappret LKF to make the fabric shrinkproof.

Single and double jersey wool fabrics were made shrinkproof by applying methylolmelamine-polythylene solutions to the fabrics. The fabrics must, however, be chlorinated before the resin mixtures are applied.

Fabrics treated with acid colloid resin-polyethylene mixtures gave the best shrinkproof results. Good results were obtained with a resin addition of only 0,5 per cent (of the mass of the fabric). The handle of fabrics treated with acid colloid did not deteriorate significantly.

Solvent dyeing of wool

Further investigation into dyeing wool in a solvent medium led to the discovery that by adding glycerol to the charge a greater number of reactive dyes could be utilized. It has also been found that glycerol cannot replace water, but of some one hundred reactive dyes investigated, 90 per cent could be successfully dyed to a depth of 5 per cent by adding 15 per cent glycerol to the charge. At 100°C the dyeing took only 20 minutes.

The dyed wool had depth of shade and wet-fastness properties similar to those of wool dyed in an aqueous medium and slightly higher covalent fixation values.

Bleaching with hydrogen peroxide in an organic solvent

Wool can be successfully bleached with hydrogen peroxide in perchlorethylene. The degree of whiteness obtained depends on the peroxide concentration, the time of reaction, and the temperature.

Bleaching in a solvent system is superior to the usual aqueous bleaching. With perchlorethylene it is possible to obtain the same degree of whiteness in 25 per cent of the time required for standard aqueous bleaching, using less than one tenth of the quantity of peroxide.

Solvent bleaching of wool does not impair the cloth's physical properties such as abrasion resistance and breaking strength more than an aqueous bleach does. Felting may, in fact, be reduced by solvent bleaching which may therefore be used to treat knitted fabrics as well as loose wool.

No additives such as stabilizing or activating agents are necessary in this method. Emulsifying agents which do not dissolve in the solvent, may be used to facilitate the application of higher concentrations of peroxide, but those used in the investigation were not active in the actual bleaching.

Airflow method of determining fibre diameter of mohair

It was realized some time ago that the mean fibre diameter of mohair could be determined by means of the airflow method but the residual variance was so great even after a regression line had been fitted that the method was impractical. A means of overcoming this high variability has now been devised.

A test cell was constructed with the cross-sectional area as specified by IWTO standards, while the height was increased to give a clearance of 32 mm between the cell and the plunger base. The dimensions of the plunger cap as well as the size, dispersion and number of perforations of cell and plunger base were all as specified by IWTO standards.

Merely by interchanging two cells, therefore, an airflow apparatus for testing wool can be adapted to test mohair. A standard error of 0,5 microns (compared with previous errors of 1,6 microns) and a correlation coefficient of 0,986 were obtained, thus providing a suitable calibration for determining the mean fibre diameter of mohair.

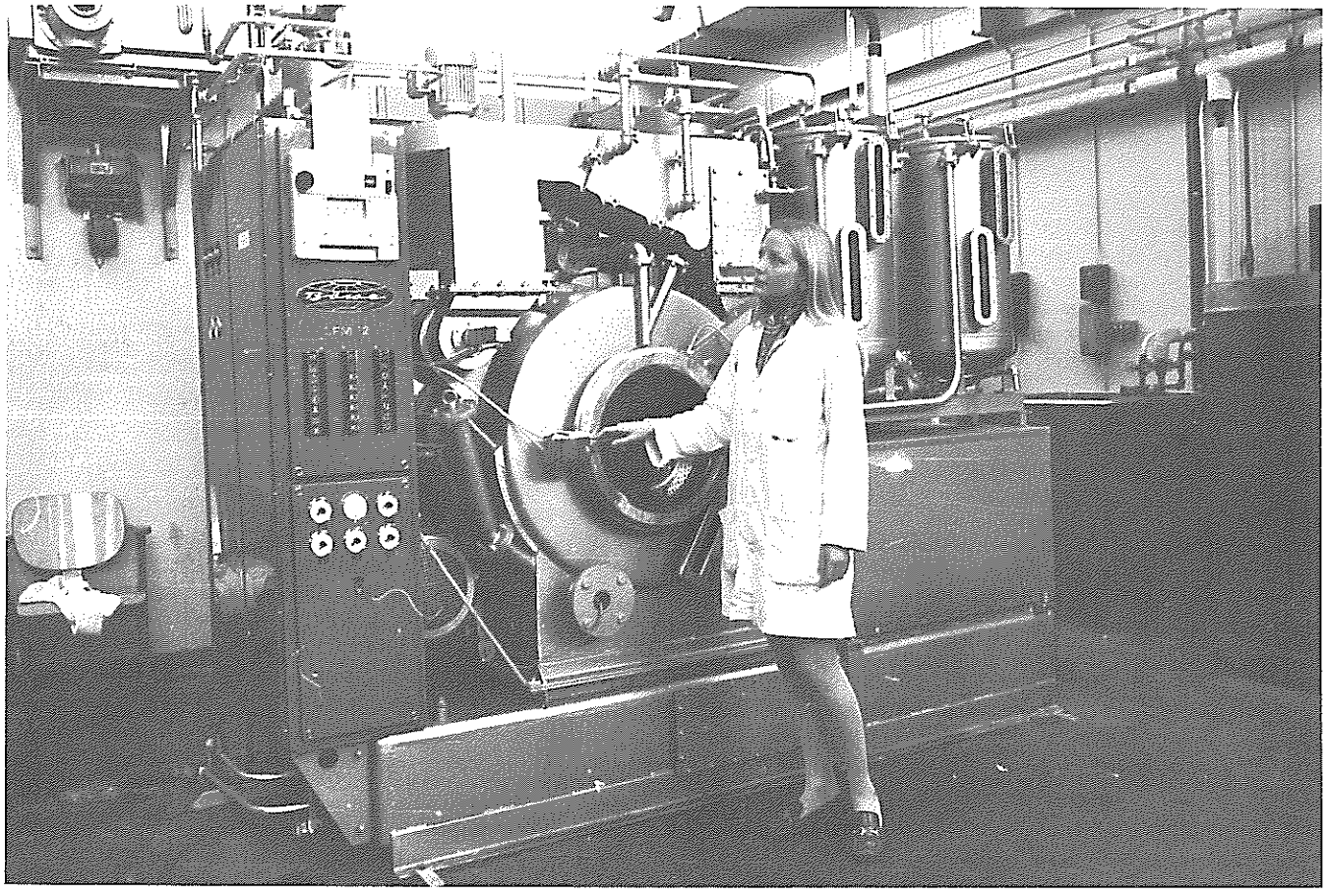
Mean fibre-length tester

SAWTRI has developed an instrument which requires only a few minutes to measure the mean fibre length of a wool top. This instrument measures the maximum force necessary to draw a tuft of fibres from a sliver through a comb, as well as the work done to complete the withdrawal. The mean fibre length can be calculated from the values of these parameters. Results compare favourably with the mean values obtained with conventional instruments. Factors such as the addition of a lubricant do not affect measurements significantly.

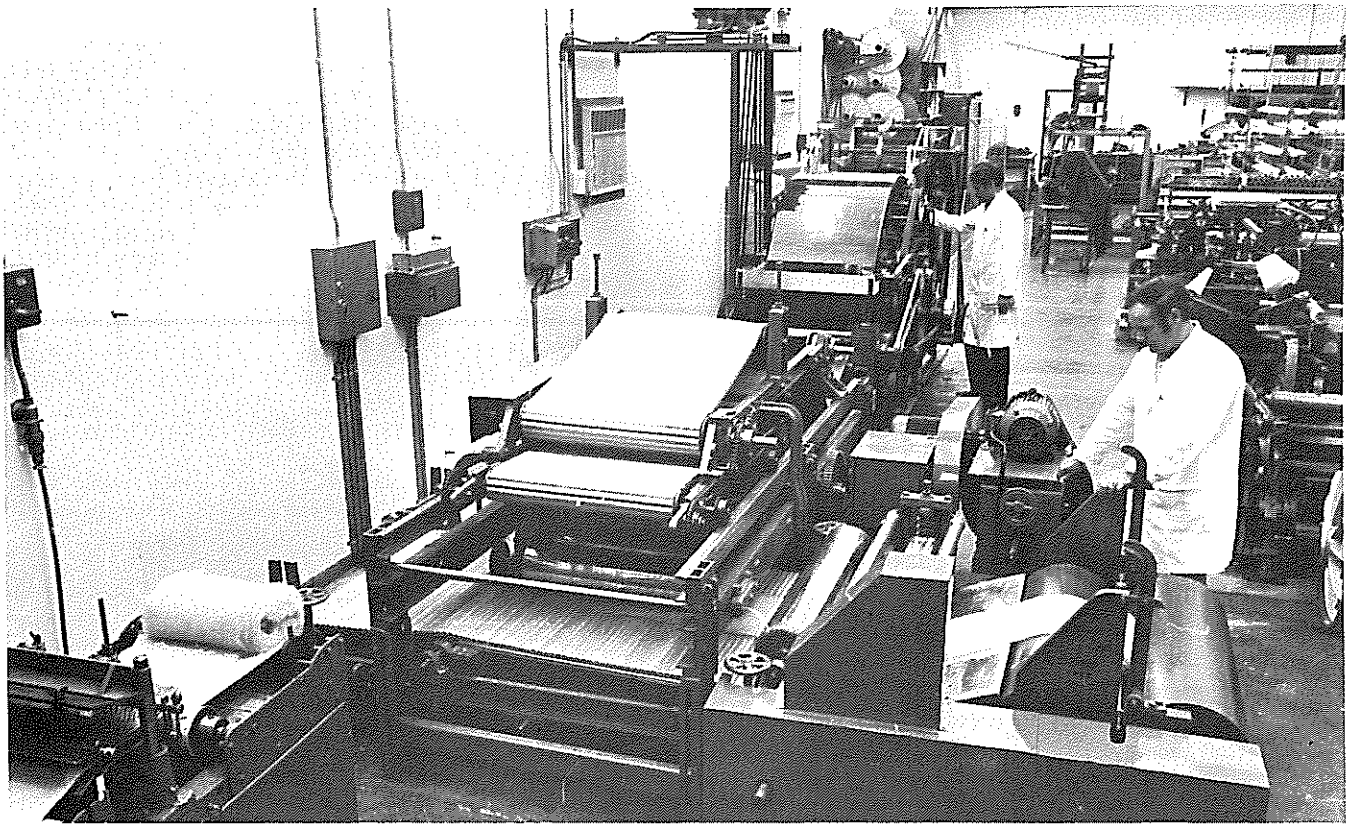
The instrument is simple and robust and easy to operate. A reading can be taken within one minute and five readings are sufficient to give a satisfactory average. A method of calibration was devised from which a table was compiled giving the mean fibre length for different values of the force required to withdraw the tuft and the total work done to complete the withdrawal.

Twist variation of single wool worsted hosiery yarns

The standard deviation of yarn twist as determined on an automatic twist tester was found to have a low but significant correlation with yarn irregularity as determined on the Uster evenness testing equipment. Twist variation is therefore considered a rough measure of yarn irregularity. A low but significant correlation was also found between the coefficient of variation of twist and



SAWTRI's new machine used for research on the solvent dyeing of wool.



A circular knitting machine used for the manufacture of lightweight knitted fabrics.

that of yarn linear density as calculated from the masses of one-metre lengths of yarn. The correlation was, however, too poor to be of any practical value. Empirical relationships between yarn twist and linear density were also derived from the results obtained with commercial worsted hosiery yarns.

Variation in doubling twist of wool worsted hosiery yarns

Changes in the doubling twist of a range of twofold worsted hosiery yarns were determined at different gauge lengths and average values for the coefficient of variation of doubling twist were obtained. At gauge lengths of 25, 50 and 100 cm, average values of 9,3, 9,0 and 5,8 per cent respectively, were obtained for the coefficient of variation. These values were independent of yarn count and the mean doubling twist. At gauge lengths of 2,5 cm and 5,0 cm, however, the coefficient of variation of doubling twist appeared to be a quadratic function of the mean doubling twist.

Card clothing and carding performance

The 150 cm-wide FOR worsted card was used to study card clothing. The forepart of the machine was clothed with metallic clothing and the clothing of the two swifts and doffer was changed and various combinations were used, viz. a double swift with fillet clothing; a single swift with metallic clothing; a double swift – the first with metallic clothing and the second with fillet clothing; and a double swift with metallic clothing. A long wool of 64's quality was used throughout the experiment.

The single swift with metallic clothing carded as well as the double swift with fillet clothing, formed fewer neps and broke fewer fibres. As a result there was less noil.

The use of double swift with metallic clothing improved the carding but more fibres were broken, which increased the noil.

Fillet clothing removed seed effectively but formed more neps.

For the particular wool used the single swift with metallic clothing gave the best results.

Effect of moisture on carding and combing

The effect of moisture on the carding and rectilinear combing of wool was investigated. The performance of the rectilinear comb was improved by combing at regains of at least 22 per cent. Practical values for relative humidity during gilling and combing appear to be between 68 and 80 per cent.

Carding scoured wool at regains of above 25 per cent resulted in larger amounts of noil. Applying an antistatic agent before carding at low regains was beneficial provided water was added during gilling to maintain the optimum regain for combing.

Performance of French comb

A new type of comb cylinder, the two segments of which are covered with metal clothing similar to that used in carding, was compared with a conventional cylinder suitable for 64's wool. Results showed no difference in the combing performance of the two types of cylinder

but the former has definite advantages such as longer life and the fact that impurities do not accumulate in the pin beds.

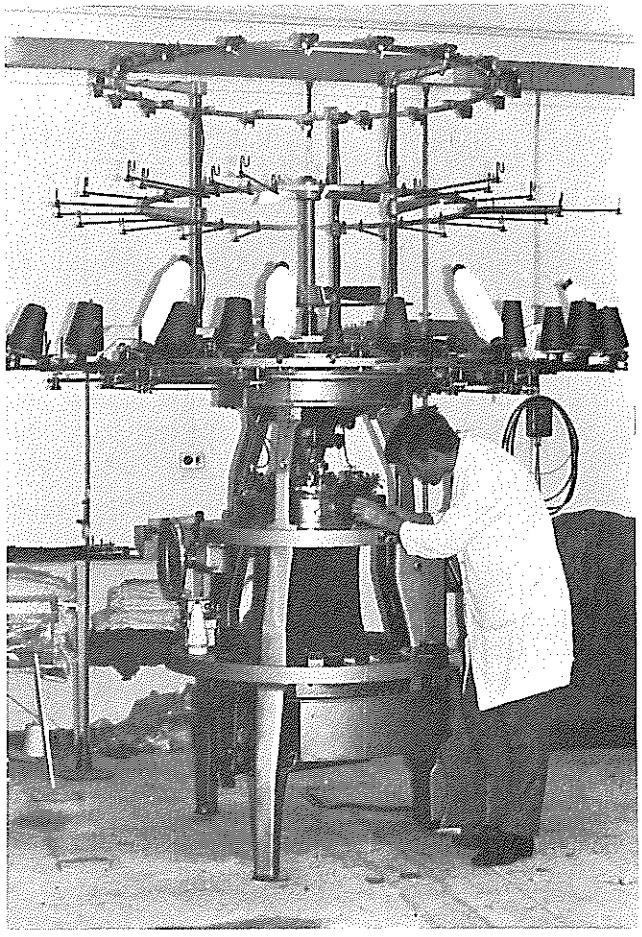
Further studies of the French comb revealed that its performance is strongly affected by gauge setting and gill feed. Although it is generally accepted that impurities in the top decrease as gauge settings increase it was found that this is true only for seed particles. Fewer neps were formed with increasing gauge setting only when a top comb (e.g. 28 pins per cm) giving optimum combing performance was used. The use of top combs (e.g. 25 pins per cm) which do not give optimum or near optimum performance does not cause any decrease in nep content and in certain extreme cases there is even an increase in neps at higher gauge settings.

The influence of gill feed is far more complicated. It was found that there is an optimum gill feed, giving minimum percentage noil, for all gauge settings between 26 and 34 mm. At higher gauge settings the effect of gill feed on percentage noil increases and the optimum value becomes better defined. At lower gauge settings (22 to 28 mm) the number of seed particles in the top is proportional to the gill feed. With increasing gill feeds there is practically no change in the number of seed particles but there is a decrease in nep content for all gauge settings above 24 mm. As gill feed affects the ability of the comb to remove neps and vegetable particles, optimum gill-feed values should be used when combing at gauge settings above 26 mm.

Core spinning of wool with texturized filament

As an experiment wool was spun around a core of 20 denier texturized multifilament nylon. For satisfactory results the filaments had to be stretched more than 20 per cent before they were spun. The physical properties and the knitting performance of the core-spun yarns were considerably better than those of pure wool yarns. Samples knitted from the core-spun yarns were also better than those knitted from the pure wool yarns as far as pilling and abrasion resistance were concerned. Core-spun yarns were stronger and more resistant to pilling than intimately blended yarns but the latter had better abrasion resistance.

SAWTRI's new horizontal crosslapper, coupled to a small card (background) and which is used to prepare fibre layers for final processing on the needle punching machine (bottom left).



Plating synthetic filaments with wool yarn for double jersey fabrics

A technique for manufacturing double jersey fabrics with a low synthetic content has been devised. With this technique the synthetic filament is plated with wool yarn and practically concealed. By using the plating technique and introducing a low percentage of polyamide flat filament into wool fabrics during knitting, the knitting performance of the yarn and fabric performance under wash-and-wear conditions can be improved, while the handle and aesthetic qualities unique to wool are retained.

In the initial investigation of the technique the aim was to determine the regions where the most yarn breaks in a Punto-di-Roma structure were likely to occur and to feed the machine in these regions with filament carrier yarn. It soon became apparent however, that the machine knitted better if it were fed at every feed region. In order to limit the synthetic content of the fabric a 40 denier filament carrier yarn and a 1/36's (24 tex) pure wool yarn were used. This produced a Punto-di-Roma fabric with 82 per cent wool and 18 per cent synthetic yarn and a yarn count of 1/31's (29 tex).

In general it was found that structures knitted with synchronized timing at a tension ratio of about 2 and appropriate feeder settings, gave the best results. The occurrence of holes in tight knitted structures suggests that the knitting performance of the wool yarn can be considerably improved by using the plating technique.

Wool/mohair blends in fully-fashioned knitwear

Different blends of wool and mohair were knitted on a 24 gauge fully-fashioned plain knitting machine to investigate the influence of yarn friction, linear density, the amount of paraffin wax on the yarn, re-waxing, knitting speed, and yarn input tension on the stitch length and the variation in stitch length. The effect on stitch length of changing from an unwaxed to a waxed worsted yarn (and *vice versa*) and of the warming up of the machine after different periods of stoppage were also investigated.

Stitch length and variation in stitch length are independent of the mohair content of the yarn provided yarn friction remains constant. Both stitch length and coefficient of variation of stitch length depend on yarn friction. Generally the coefficient of variation of stitch length increases with an increase in yarn friction while the opposite applies to stitch length. Stitch length has a tendency to decrease as the knitting speed increases.

Optimum knitting conditions for pure wool yarns can be obtained by waxing the yarns twice with paraffin wax to a wax content of approximately 0,6 microgram per cm, although almost identical results can be obtained by applying the same amount in one operation. These conditions are similar to those required for optimum yarn friction.

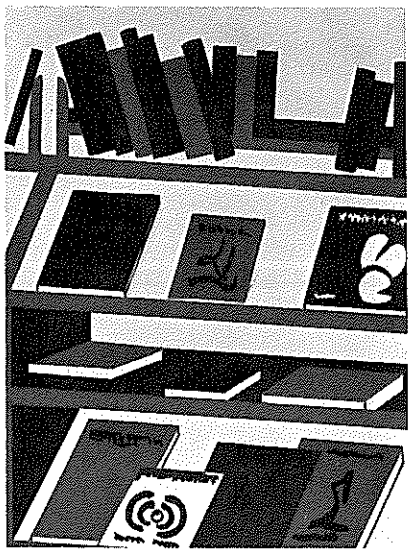
It was also found that the coefficient of variation of stitch length increases with an increase in yarn input tension, which is obtained by using heavier pretensioning weights.

CO-WE-NIT men's wear

Men's wear was the field into which the CO-WE-NIT machine was originally introduced, but unfortunately manufacturers have had little or no success. From previous experience with curtaining, SAWTRI considered that enough knowledge of design techniques had been acquired to attempt to show that cloth for men's suits could be made on the CO-WE-NIT machine. The machine was converted to 48 gg and experiments with fine-count yarns showed that cloths as light as 12 oz per yard could be made. Structures such as cords, 'plains', herring-bones, glenchecks, zig-zags as well as stripes have been made in mixtures of natural and synthetic fibres.

(*Note* : The use of proprietary names does not in any way imply that such products are recommended, or that there are not substitutes which may be as good or even better.)

Information and Research Services



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

The aims and functions of the CSIR's Information and Research Services can be grouped under the following main headings:

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

Library services

The extent of the services which the CSIR's central library provides to the CSIR's own laboratories and institutes and to other organizations, industries and individuals throughout the country, is apparent from the following statistics:

Year	*Publications used and photocopies provided*	*Books and pamphlets ordered*	*Periodicals received*
1967	44 995	3 704	3 136
1968	52 450	4 440	3 413
1969	53 845	5 605	3 457
1970	52 755	4 958	3 410
1971	49 107	5 117	4 000

In this connection it is worth mentioning that the increasing use of telex equipment by libraries in this country has speeded up inter-library loans.

As in previous years the library and information services handled numerous enquiries of a diverse nature; *inter alia* they advised several industrial undertakings on the establishment of internal library and information services.

During the year an illustrated booklet was published containing information about the services offered by the CSIR library and suggestions on how to make the best use of them.

Source guides

Steady progress was made with the preparation of the second edition of *Periodicals in South African Libraries* (the union catalogue of serial titles in South African libraries published in collaboration with the Human Sciences Research Council). By the end of the year under review the parts under the letters A to D had been published (about 11 500 titles), while the parts from letters E to H (about 4 700 titles) were almost ready for the press. It is expected that all the parts will have been published by March 1973.

The *Register of Current Scientific Research at South African Universities* is no longer being published as the information it contained will in future be included in a national register of research projects compiled by the office of the Scientific Adviser. The *Register of CSIR Projects* was discontinued for the same reason.

The investigation into the adequacy of literature resources available to research workers in South Africa continued, in collaboration with the Human Sciences Research Council and on behalf of the National Library Advisory Council.

Foreign language information

The potential, language coverage as well as volume of work, of the service which supplies information from foreign language sources has been increased by more effective use of free-lance translators and of overseas translating agencies. The most important languages as far as volume of work is concerned, are still German, French and Russian.

Interpretation and liaison work in foreign languages has also been extended, especially in connection with scientific and technical co-operation with Portuguese territories in Africa.

Non-conventional documentation techniques

Investigations continued into the use of non-conventional techniques for handling information and the mechanization of library procedures.

Dr C. v.d. M. Brink, President of the CSIR, presents a copy of the book **Marion and Prince Edward Islands** to Mr B.J. Schoeman, Minister of Transport.

A considerable amount of preparatory work was done on feasibility studies in connection with the selective dissemination of information on a national basis with the aid of magnetic tape data bases (indexes) which are available from large indexing and abstracting services overseas.

Attention has also been given to the possibility of using on a national basis machine readable cataloguing records (MARC) in the form of magnetic tapes.

Work on the latter two projects is undertaken in collaboration with other bodies and at the request of the National Library Advisory Council.

The development work done on behalf of the State Library in connection with a computerized system for preparing the *South African National Bibliography* has almost been completed. This system is based on one originally developed for this purpose in West Germany. A similar system is being developed to prepare the catalogues for the South African Library for the Blind.

The current-awareness service in the field of water research (*Current Literature on Water*) is being developed further. *Inter alia* the format of the KWIC indexes (indexes with keywords in context) was changed to make it more readable. The fact that the system has also been applied to other services in the CSIR proves its usefulness.

Progress has also been made with the programming for a computerized system to process data for the *National Register of Research Projects in South Africa.* This is being done on behalf of the office of the Scientific Adviser.

Work is also being done on the programming for a system to sort and print English and Afrikaans terms for a dictionary in the field of textile technology which the CSIR is compiling.

Liaison in the field of documentation

The CSIR was represented as a national member of the International Federation of Documentation (FID) by the Director of Information and Research Services at meetings of two FID committees held in Tel Aviv in September on the occasion of a conference on new developments in the field of documentation.

During his overseas visit the Director of IRS also attended the annual conference of the Association of Libraries and Information Bureaux (ASLIB) in Darmstadt, West Germany.

The CSIR was also represented at a conference on training problems in documentation held in November in Rome. This was done especially with a view to short courses in documentation which the CSIR is to offer at the request of the South African Library Association.

Liaison with industry

To promote contact between the CSIR and industry industrial undertakings were visited regularly. The stationing of a technical information officer at Bellville in the Western Cape has considerably improved liaison between the CSIR and manufacturing industry in the Western Cape.

In collaboration with the South African Wool Textile Research Institute a technical information officer was also appointed in Port Elizabeth during the year.

An experimental current-awareness service has been established for industry. For the present the service is provided to about 50 chosen firms in the metal industry and if it is a success it will later be established on a permanent basis and extended.

The preparation of the monthly bulletin *TI - technical information for industry* took up a considerable amount of time and a start was also made with compiling further editions in the series *Technical Pocket Books* which are meant mainly for use by technical personnel in industry.

An important contribution was made with the arranging of a successful technological display exhibited during the Republic Festival in Cape Town. The purpose of this display was to give the public in general and youth in particular an insight into technological development in this country.

Progress was made with a survey of the present state and potential development of automation in the Republic. The survey is being undertaken on behalf of the Scientific Adviser of the Prime Minister and the South African Council for Automation and Computation.

Promotion of industrial research

Besides undertaking research on behalf of industry in its own laboratories the CSIR also endeavours to encourage and support research by industry itself. During the year the Advisory Committee for the Development of Research for Industry (ACDRI) which advises the CSIR in this respect, considered giving financial aid for the next five years to develop the South African Foundry Research Foundation, the South African Paint Research Institute and the Sugar Milling Research Institute.

For this purpose techno-economic surveys of the foundry, paint and sugar industries in this country were carried out. The Committee also considered the possibility of imparting incentive schemes to South Africa to promote the innovation process.

As part of its programme of techno-economic surveys of specific industrial sectors to determine research needs, and as an aid to compiling research programmes, surveys were done of the Bantu beer industry, the phosphate products group in the chemical industry and the saw-mill industry.

Besides these surveys of national scope industrial marketing surveys and feasibility studies of projects with a high technological content were done on a contract basis for specific undertakings.

Planning for research

Research is continually done into the application of various techno-economic techniques as aids in the planning of research and development, *inter alia* extrapolation, trend correlation and the Delphi technique of opinion survey. A member of staff worked at the Programme Analysis Unit, Harwell, England, for six months to gain experience in these techniques.

In the sphere of techno-economics there is close cooperation with other establishments concerned with research into industrial economics, such as the National Productivity Institute, the Council for Commerce and Industry and research units at universities. It is hoped that industry will become more and more involved in this co-operation and that regular discussions about work programmes will be held.

During the year work continued on the survey of expenditure on research and development in South Africa. A report was compiled in which the total expenditure of the CSIR for the financial year 1968/69 was analysed in detail. Two reports on the expenditure on research and development and other scientific work of four autonomous industrial research institutes supported by the CSIR, were completed for the finincial years 1968/69 and 1969/70.

In addition a fourth report on the research work and other scientific activities of organizations in the business sector was completed for the financial year 1968/69. This

report will be sent to the organizations concerned as soon as approval has been obtained from the Minister of Planning.

Bursaries and research grants

A considerable decrease in the number of students applying for bursaries for post-graduate study in the scientific field is causing concern and steps should be taken to avoid a serious shortage of trained manpower in this field.

The CSIR also had financial problems in this connection as its budget for this purpose had to be cut because of financial restrictions.

In spite of financial problems however, it was possible to begin two new schemes. Under the one scheme a limited number of special merit bursaries of between R2 500 and R3 000 are available for full-time doctoral study at South African universities. One of the bursaries was granted during the year. The other scheme concerns the granting of research bursaries to active research units and groups at South African universities to enable them to obtain recognized scientists from overseas to work for periods of six to twelve months in the Republic. Only one of these bursaries was granted during the year.

At the end of the previous year under review two research units were closed – one because the director had reached the age of retirement and the other because the director had accepted a post overseas. Current projects which fell under these units are still supported on an *ad hoc* basis.

A unit for flavanoid chemistry was established at the University of the Orange Free State, while the Council also decided to make an annual block grant to the Institute of Fresh Water Studies at Rhodes University. Several research groups have, with the aid of *ad hoc* support, reached the stage where they can soon claim support as units with full status.

International research programmes

The intial work was done on the development and co-ordination of a national research programme within the framework of the international programme which is being launched under the leadership of the Scientific Committee for the Preservation of the Environment (SCOPE) of the International Council of Scientific Unions (ICSU). The scientist responsible for co-ordinating this programme, attended the first general meeting of SCOPE in Canberra in September. A start will be made with this programme as soon as the national programme of activities for the International Biological Programme has been completed.

A national programme within the framework of the International Geodynamics Project of ICSU's International Union of Geological Sciences (IUGS) is also being developed.

The CSIR arranged the meeting of the International Union for Biological Sciences (IUBS) held in Cape Town in October. The meeting which was a great success was attended by, amongst others, the Secretary-General of ICSU, Professor F.A. Stafleu. It was the first meeting of this kind to be held in South Africa.

The progress made with Antarctic research programmes by research groups attached to universities and other research bodies under the leadership of the South African Scientific Committee for Antarctic Research (SCAR), created the need for a medium of publication. It was decided to publish a new journal for this purpose and the first edition of the *South African Journal of Antarctic Research* appeared in June 1971 and was well received. The CSIR's Publishing Service is responsible for the editing and distribution of this journal which is published under the auspices of the above Committee with financial support from the Department of Transport.

The Department of Transport, which also finances and directs the Antarctic programme, made funds available during the year under review for the resumption of a biological research programme under the leadership of Prof. E.M. van Zinderen Bakker of the University of the Orange Free State.

It may also be mentioned in this connection that the summarized scientific results of the biological and geological expedition of 1965/66 to Marion and Prince Edward Islands were published during the year in the form of a monograph.*

Publicity and liaison in general

The CSIR always endeavours to make the implications of research known at all levels. Besides its own publications such as the journal *Scientiae* and regular press releases, other media such as the radio and film are also used.

During the year the filming of a new documentary in the series *Science in your service* was completed. This film, with the title *Walk our land* is about the role of science in the critical relationship between man and his environment and will probably be released for general distribution by the middle of the new year. In addition two short news-reels have been made in collaboration with a South African film company and the film unit of the South African Broadcasting Corporation.

The CSIR is also gradually preparing to use the medium of television to make its work known in wider circles.

*Van Zinderen Bakker, E.M., Winterbottom, J.M. and Dyer, R.A. (ed.) *Marion and Prince Edward Islands*, Cape Town, A.A. Balkema, 1971.

Scenes from the visit by Members of Parliament to the CSIR.

A visit to Scientia was arranged for cabinet ministers, members of parliament and senators to give our legislators the opportunity of making acquaintance at first hand with CSIR activities.

The Central Conference Secretariat, in collaboration with research institutes of the CSIR and other professional bodies, arranged eleven successful symposia and conferences during the year.

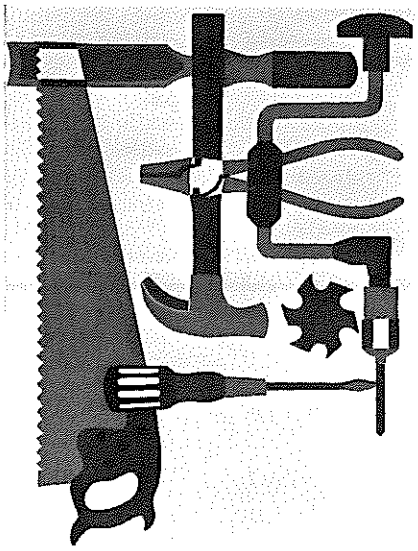
Representation overseas

The four overseas scientific offices maintained by the CSIR continue to provide valuable services to South African scientists.

At the beginning of the year under review Dr W.T. de Kock assumed duty as head of the office in Cologne and his predecessor, Dr P. le R. Malherbe, returned to the CSIR in Pretoria to assume responsibility for the co-ordination of international scientific liaison, the co-ordination of national programmes as part of international programmes (see above) and the support of university research.

Mr H.J. van der Merwe departed for London in September where he will take over as head of the science office at the beginning of 1972 from Mr C.G. Hide who returns to Pretoria to assume broad responsibility for the development of industrial research.

Technical Services



Technical Services Department

Director: Mr J. van der Staaij

TECHNICAL SERVICES DEPARTMENT

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

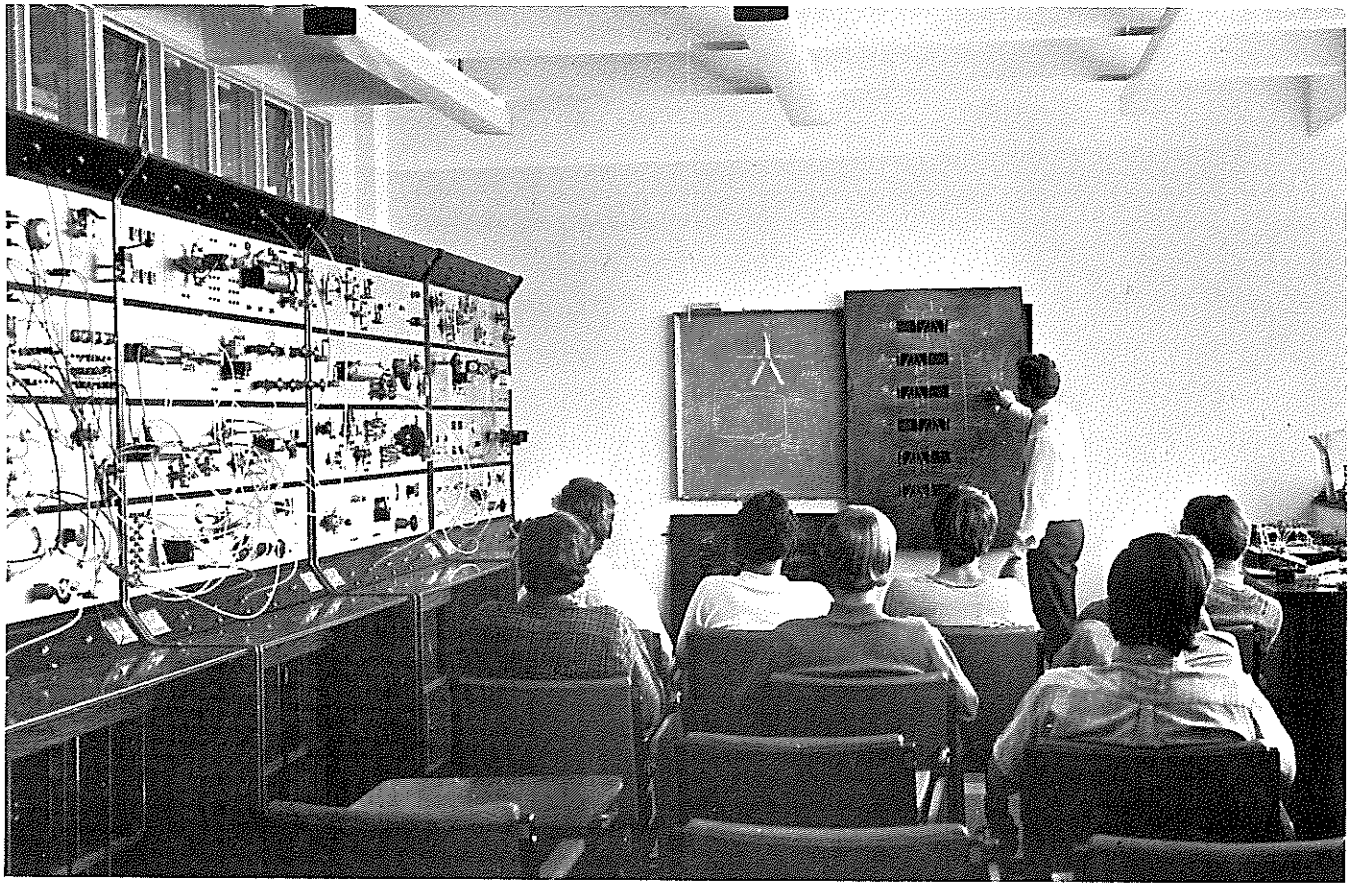
The Department also undertakes work on contract for other bodies and industry if it cannot be undertaken anywhere else in the Republic.

Extension of facilities and services

The section responsible for the manufacture of printed circuit boards is, except for undelivered equipment for multilayer boards, fully equipped to undertake very accurate work for research and industrial establishments. Since the inauguration of these facilities printed circuit boards have been manufactured for research and industrial organizations which previously, because of high accuracy requirements, had to have them made overseas. With the success thus far achieved it is expected that the demand for these services will increase, especially when the equipment for multilayer boards is taken into use early in 1972.

The Advice Centre for Low Cost Automation began operating in September 1971. The activities commenced with a basic and an advanced course in low cost automation presented by a senior lecturer, a specialist in this field, from the Heriot-Watt University. The courses were attended by lecturers from South African universities, a lecturer from the Department of National Education and several technicians from industry. In collaboration with the National Development and Management Foundation, seminars have been presented in Pretoria, Johannesburg, Durban, Port Elizabeth and Cape Town. The activities were widely publicised with emphasis on the ad-

Courses for lecturers and technicians were arranged by the Advice Centre for Low Cost Automation.



vantages which this labour-saving technique offers to industry. Several universities and the Department of National Education are thinking of incorporating this subject in their syllabi for engineers and technicians. To assist these organizations and the large number of industrialists who have requested further courses, three basic courses for the first half and three advanced courses for the second half of 1972 have been arranged. Advice and assistance will also be provided for individual industrialists who request such services.

With the experience gained in the field of numerically-controlled machining it was possible, in collaboration with the National Research Institute for Mathematical Sciences, to advise and assist several industries with programming for the manufacture of complex components. The rendering of these extraordinary services has also made outside organizations aware of the activities of the Technical Services Department and demands for advice and services related to manufacturing will probably increase considerably in future.

Training

Visits by groups from the Department of Defence, universities, teachers' training colleges, colleges for advanced technical education, secondary schools and industry to the Training Centre for Instrument Makers stimulated interest in the tuition methods and the training programmes used by the centre. The success achieved with the training methods is illustrated by the fact that over the past four years an average of 92 per cent of the apprentices passed the national trade test for instrument makers.

Training is at present based mainly on research and development work. To provide for industry's increasing demand for instrument mechanicians to maintain process control instruments, an extension to the present facilities is being considered.

Projects

Of the numerous projects with which TSD design and workshop personnel assisted research institutes and other bodies, the following merit special mention :

- Preparation of the electrical shark barrier at Margate for the National Physical Research Laboratory.
- Mobile water desalination unit for farming purposes in South-West Africa for the National Institute for Water Research.
- Apparatus for measuring manganese dioxide activity for the Chemical Engineering Group.
- Wind and rain simulator for the National Building Research Institute.
- Apparatus for testing concrete samples for the National Institute for Road Research.
- Microtome for the dissection of brain samples for pathological investigations.
- Foot gauges for footwear issues to army personnel.
- Dosing apparatus for veterinary research.
- Improved stamps for grademarking carcasses, with a lower replacement cost, for the Meat Industries Control Board.

Co-operative Industrial Research

Leather Industries Research Institute

Director: Dr S. G. Shuttleworth

The Leather Industries Research Institute (LIRI) developed out of research work begun in 1936 in the Chemistry Department of Rhodes University. It has remained closely associated with the University although financially independent. Through collaboration with University departments the Institute has helped to bridge the gap between the theoretical and applied aspects of science and has drawn graduates into the arena of industrial innovation and development – which is vital to South Africa's future prosperity.

The Institute serves the research and training needs of its four main partners, the hides and skins industry, the wattle industry, the tanning industry and the footwear industry. These industries have steadily expanded their investment in the Institute over the past thirty-five years. During the current five-year cycle the Institute will spend over one million rand on research, development and training in these spheres of the industrial economy.

The benefits of sponsoring industrial research by collaborating with industry were underlined in several instances during the year under review.

An example in this connection is the development of alternative outlets for wattle extract. These are urgently required to offset shrinking world demand for vegetable tannins used mostly in the manufacture of outersole leather. Through research in collaboration with the Institute knowledge of the structure of tannins and the chemical properties of the components of the extract has been accumulated over the past thirty-five years. This has resulted in the development of new timber adhesives for which there is a vast market. The wattle industry and a major timber adhesive user have formed a company to exploit these products.

Another interesting development, also of benefit to the wattle industry, is that major United States tanneries have adopted a ten-year-old process of tanning sole-leather developed by the Institute. Local tanneries use this process on a large scale. This tannage has wattle extract as a base, whereas United States and Canadian tanners relied mainly on other tanning materials. The wattle industry has invited tannery directors and management personnel from various United States and Canadian tanneries to visit South Africa and has sponsored visits by the Director and senior staff of the Institute to US and Canadian tanneries. The interest in the LIRI process is due to the fact that it helps solve the problem of tannery effluent. The largest sole-leather tannery and the largest harness and saddlery tannery in the world would have been forced to close had they not been able to introduce the LIRI process.

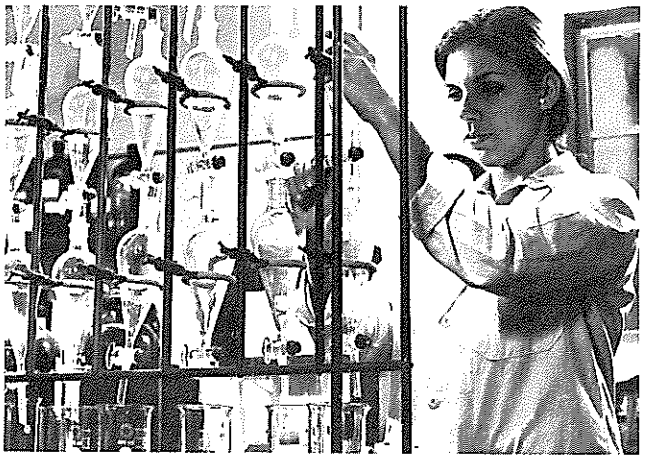
Incidental benefits to the local tanning industry include the study of American 'know-how' and particularly the latest overseas methods of purifying tannery effluent.

With the technical knowledge it has accumulated the Institute is helping its subscribing groups to solve the labour and supervisory staff crisis which is currently one of South African industry's major headaches. A post-graduate one-year university diploma course is offered, and the Institute also encourages tanneries to appoint staff members who can be sent to the Institute for intensive training. There are also three-year correspondence courses in leather technology which include in-factory guidance. Periodic short block-release courses are offered for the staff of the hides and skins industry, and for tannery and footwear factory staff. For factory workers in-factory training is preferred, while the Institute trains the instructors and instructresses. Finally there is a three-year correspondence course for footwear factory supervisors and managers. At present it has an enrolment of over 250 from 20 countries and is recognized as the best all-round course offered anywhere.

Hides and skins

The bacteriology of hide and skin curing being studied at the Institute, in collaboration with the Department of Botany and Microbiology of Rhodes University, has taken on even greater significance with the enforcement of stricter control of water pollution. The brine effluent from curers must therefore be eliminated in a closed circuit system or a preserving agent other than sodium chloride must be found. The bacteriological knowledge acquired at

Analysis of leather lubricating oils.



the Institute over the years is being used to find new preserving methods. Isolation of collagenolytic bacteria from hides and skins has shown that initially collagen is rapidly digested by these bacteria. This is important both technically and commercially as it emphasizes the necessity of curing hides and skins quickly and soon after animals have been slaughtered.

The Institute, in collaboration with the Tick Research Unit, Rhodes University, is studying the esterases present in tick strains which are sensitive or resistant to the organo-phosphorous insecticides in cattle dips. The elimination of ticks is important to the leather industry since they affect the condition of animals and damage hides and skins. Several technical reports and publications have resulted from this work.

Protein research

Fundamental studies on the disturbing effects of polar organic solvents on protein structure have been extended. Activity and dependence on structural and functional features of solvents, similar to that noted in soluble collagen, have been observed in precipitated acid-soluble collagen and in mature insoluble collagen. That the effects of the aqueous solvent are general is also apparent from similar solvent activity found in a variety of non-protein systems. These findings provide further support for the concept proposed previously of a predominantly polar mechanism of solvent interaction. This work has been published in a M.Sc. thesis and in several overseas biochemical journals.

Wattle-based adhesives

During the past year a research team of the Institute has collaborated closely with a large chipboard manufacturer to develop and market wattle-based adhesives. Recently the wattle industry formed a company to co-ordinate the effort. Achievements during the past year have been the improved formulation of wattle-based chipboard adhesive and the development and patenting of a high-quality waterproof cold-setting adhesive for finger jointing, laminating and general carpentry use. An improved wattle-based high-quality thermosetting adhesive for plywood was also developed. Local sales of this adhesive exceed 1 000 tons per annum and there is considerable overseas interest.

Oil-well drilling

A new laboratory has been equipped to continue the rheological studies of wattle-based mud thinners for oil-well drilling. The chrome-wattle complex, Kr6D, developed by the Institute has been in commercial use at two sites in the Cape Province for approximately a year and there is a good deal of overseas interest in the product. However, the emphasis in oil-well drilling compounds is moving from mud thinning to drill-hole stabilization and water-loss inhibition. While the Institute is still evaluating further chrome-wattle complexes work is also being done on the use of fractions of gum-rich wattle extract complexed with metal ions.

Tannin metal complex ions

In view of the potential use of wattle extract in oil-well drilling, ore flotation and as a soil conditioner to combat trace-element deficiencies, the chemistry of the complex molecules formed by wattle tannins with a wide range of metal ions is being studied extensively. This work forms a valuable background for exploring the use of wattle.

Chemistry of wattle tannins

The Institute's Wattle Research Section contributes to the work in this field by close collaboration with a research team of the University of the Orange Free State. This team has successfully worked out the structures and stereochemistry of dimeric, trimeric and tetrameric tannin units. The latter comprises very large molecules previously considered impossible to resolve.

Vegetable leather tannage

After giving technical aid to US and Canadian vegetable leather tanners who experienced effluent problems, the Institute carried out investigations aimed at adapting the LIRITAN no-effluent sole-leather process to other types of vegetable-tanned leather such as harness, saddlery, bag, case and upholstery leather. It has developed a flexible four-day pit/drum no-effluent process which has been adopted by two South African tanneries to make a range of leathers from sole leather to bag and case leather. In this process the final stage of the system is adjusted.

Leather finishing

The increasing use of synthetic materials instead of genuine leather upper materials in footwear manufacture has emphasized the need for leather to retain its popular appeal by being in the forefront of fashion. The Institute has already evaluated a wide range of modern finish formulations, some of which are not yet commercially available to the leather industry.

Water and air pollution

As a result of overseas visits the Institute has set up laboratory and pilot-plant experiments to study the purification of tannery effluent. Large-scale trials of these results are already being planned. Over the past decade the Institute has worked closely with officials of the Department of Water Affairs to solve the difficult problem of air and water pollution by tannery effluent. Pollution remains the major tannery problem throughout the world.

Comfort factors in footwear

In order to compare old and new variations in leather with new solid and poromeric synthetic and reconstituted leather, a considerable part of the Institute's work for the footwear industry has been devoted to batteries of tests and practical wear trials. The use of extension cycling tests on an Instron machine has been a novel and revealing feature of this work and has aroused overseas interest. The Institute's shoe-making facilities have been extended so that test footwear can be constructed at the Institute instead of by the courtesy of busy factories.

Systems engineering

A new management science known as systems engineering is gaining repute overseas. In this the factory organization is viewed as a total concern, its objectives are properly defined, and a suitable planning system is introduced. The Institute is introducing systems engineering techniques to the footwear industry and is at present carrying out its first full-scale practical application in a factory.

Fishing Industry Research Institute

Director: Dr R. J. Nachenius

The Fishing Industry Research Institute (FIRI) is affiliated to the University of Cape Town and is located on the University campus. A field laboratory, staffed from headquarters as the occasion demands, is maintained at Walvis Bay.

FIRI is financed by voluntary contributions from the fishing industry, and subsidized by the CSIR. Firms with an indirect interest in the fishing industry can become associate members of FIRI. The total annual income of the Institute is currently about R201 000.

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

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

More edible fish

Most whitefish processors have recently installed machines which recover a high percentage of edible material from filleting waste and undersized fish normally converted to fish meal. The use of this minced or shredded fish as a base for a variety of frozen, canned and dried fish products for human consumption is being investigated. It can, for instance, be turned into frozen fish cakes ready for frying; homogenized and seasoned it can be used to make a canned fish loaf suitable for serving with salads.

It has also been found that one of the steps in the fish meal process can serve as a source of de-boned, gut-free pilchard or mackerel flesh suitable for human consumption. Stabilized with anti-oxidant and dried, this material is currently being tested as an ingredient in the diet of mine labourers.

Disinfection of sea water

The purification of water used in the food industry usually involves flocculation, clarification by sedimentation, filtration and chlorination. This system cannot be applied to sea water used in fish canneries as the higher relative density of the water and the presence of traces of oil from factory effluent makes sedimentation difficult. Chlorination cannot be used as it taints the canned product.

It has now been demonstrated that residual traces of oil in water render clarification by flotation much more effective than clarification by sedimentation. The water is clearer after flotation and as the process takes less than a quarter of the time required for sedimentation, the capacity of the water treatment plants at Walvis Bay can be substantially increased without major modifications.

Although clarification by flocculation and flotation markedly reduces the bacterial load, some form of bactericidal treatment is essential. As an alternative to chlorination, ultra-violet irradiation of clarified water is very effective. It is important that the source of radiation is kept clear of the water, as the UV tube or its glass guard would rapidly be covered by a film of scale which absorbs most of the lethal energy.

Several fish canneries at Walvis Bay and a number of rock lobster packers along the Republic's west coast are currently installing UV water disinfection plants in consultation with FIRI.

Gas chromatography of amino acids

The use of gas chromatography to determine the amino acid contents of fish meal protein has reached the stage where its potential advantages over ion exchange chromatography are obvious. More sophisticated equipment is however necessary in order to perfect the method and make it suitable for routine analysis.

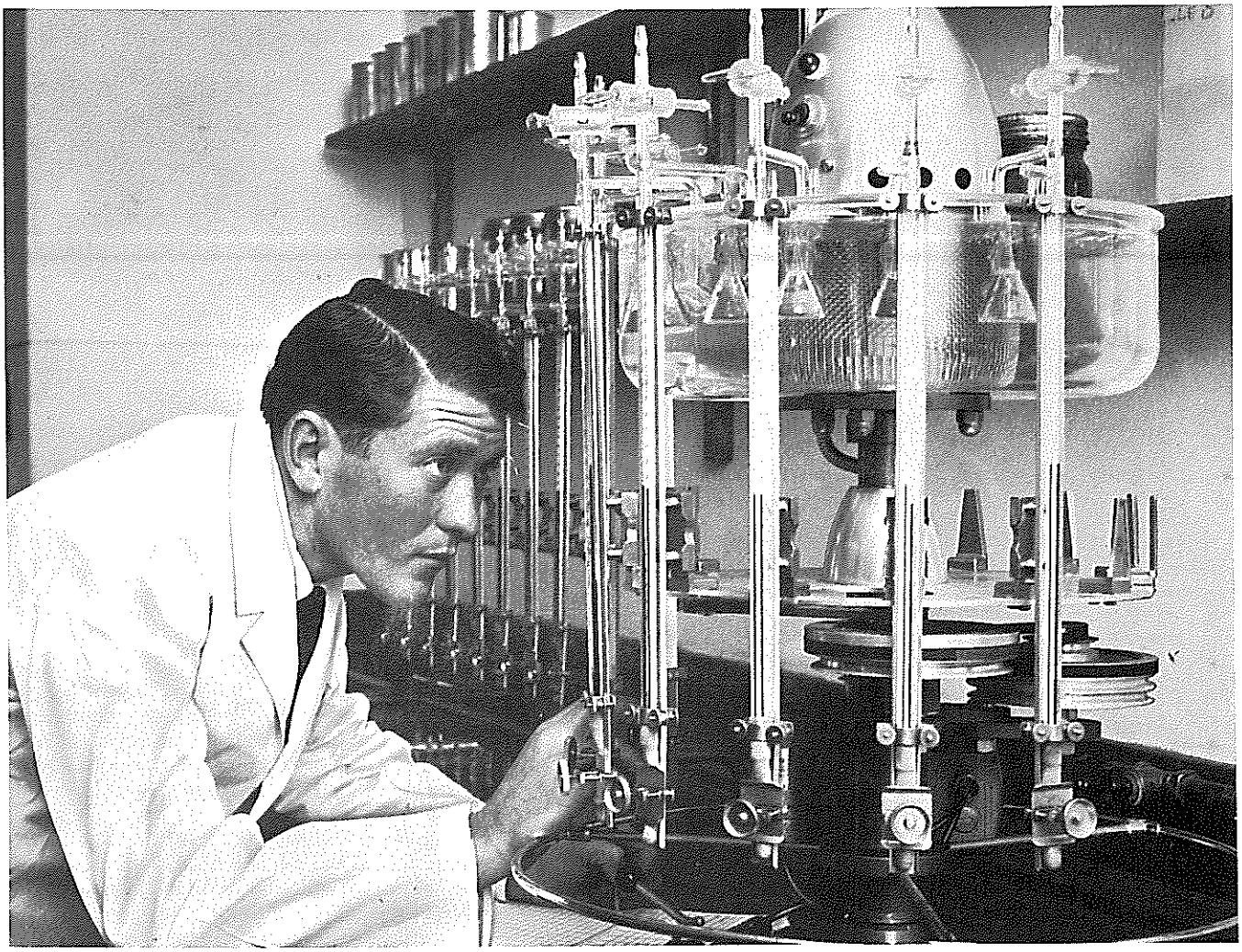
Trace elements in fish products

Following reports that some of the fish products distributed in the United States contained excessive amounts of mercury, a wide range of South African fish species and fish products was analysed. In all cases the mercury content was well below the maximum accepted in the United States.

A comprehensive survey of desirable and undesirable trace elements in fish meals made from different South African species is under way. The role of certain trace elements, e.g. selenium, in poultry diets is under investigation. It is expected that buyers of fish meal will pay increasing attention to the trace element contents of the product.

Freezing whole rock lobster

There is a lucrative export market for frozen whole rock lobster. However, during storage, even at the lowest practical temperatures, autolysis of the digestive tract and enzymatic breakdown of the anterior section of the tail occurs. This deterioration of the product, which becomes serious after about four months of storage, is undesirable,



Oxygen absorption rate of fish meal being measured.

and tests to prevent it are in progress. Factors studied include purging of the rock lobster before freezing, encasing the fish in ice (which also makes it visually attractive), and chemical suppression of the enzymatic action responsible for the defects.

Analytical methods

Modifications to the standard methods of determining the hexane and chloroform-methanol extracts of products such as fish meal have cut down the time necessary for these analyses. Instead of determining the total extract in each sample, the sample and the solvent are equilibrated by refluxing and the composition of part of this is determined.

Analytical methods are also being developed or adapted for total volatile acids in canned fish, histamine and benzoic acid in raw fish, hydroxyproline in fish bone, and disodium ethylenediaminetetra-acetate in ice.

Protein quality tests

The method for determining fluorodinitrobenzene-available lysine in fish meal has been refined and standardized in collaboration with the originator. The presence of FDNB-available lysine is widely accepted as an indication of nutritional defects in fish meal. FIRI does these tests regularly as part of an investigation into production and storage factors which may influence the nutritional value of fish meal.

A microbiological method in which the growth rate of the protozoan, *Tetrahymena,* is used to determine the protein quality of fish meal is also being tested. The use of the metabolic rate of the organism rather than physical counts to determine the growth rate is being considered.

New fish meal process

Factory ships on which whitefish are frozen at sea seldom have enough space to install machinery for converting filleting waste, undersized fish and fish unsuitable for human consumption into fish meal. In the conventional fish meal process the raw material has to be cooked and the rotary dryers are heavy and bulky.

FIRI has tested a new system on a pilot scale, in which the uncooked raw material is flash-dried and passed through a specially designed hammer mill in a single step. The process can possibly also be adapted to process rock lobster bodies, the disposal of which is a problem for those who pack rock lobster tails on a small scale. The plant is being further developed in collaboration with a local engineering firm, and has aroused considerable interest in the fishing industry.

Sugar Milling Research Institute

Director: Dr M. Matic

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

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

The main functions of the Institute are:

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

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

Juice clarification

To place cane juice clarification on a more scientific basis the physico-chemical factors involved are being studied. The surface nature of cane juice colloids is of primary interest. The stability of a colloid system is related to the magnitude of the electrostatic forces at the particle surface. In the case of cane juice particles these forces were examined by measuring the colloid electrophoretic mobility.

The electrodes of the instrument used in these measurements were modified so that very low current densities could be used. This also eliminated unwanted side-effects created by the conventional system. A palladium (H_2 saturated) cathode and molybdenum anode were used with success. The very high particle density of an average juice sample makes it difficult to determine mobility directly. The particle count has therefore to be reduced considerably by centrifugation and ultra filtration methods. However, the resultant system is not very stable and prepared samples must be placed in the electrophoresis cell as soon as possible. The small voltage which the system demands creates particle mobilities of a low order but results were reproducible.

Chloride balance

From the beginning of the 1970/71 season an attempt was made to establish a chloride balance for the whole factory at Jaagbaan in order to determine whether a complete recovery of chloride could be achieved over a period of time. If this were possible chloride ions could be used as tracers in the detection of sugar losses at various stages in the process.

The factory balance was calculated in the usual way. Chloride determinations were made on four-hourly composite samples of mixed juice and filter cake, and on daily composites of sugar and final molasses. An undetermined chloride loss occurred which rose from 0,9 per cent after four weeks to 1,3 per cent at eight weeks and 2,3 per cent at twelve weeks. At this stage the experiment was discontinued.

Because of the very high proportion of chloride eliminated in final molasses, even a small error in molasses mass affects the accuracy of the chloride balance. The work was therefore discontinued until it was possible to check weigh the molasses. Although a 100 per cent balance was not achieved it is felt that useful information can be obtained by carrying out chloride balances at various stages in the factory. For example, the percentage of chloride in non-sugars before and after clarification could be used to determine whether the clarifier is removing non-sucrose. This and other possibilities will be investigated further.

Colour measurement in raw sugar

For years there has been a difference of opinion as to the most suitable wavelength of light for the measurement of raw sugar colours. South Africa has tended to favour the use of 560 nm (ICUMSA method 2) rather than 420 nm, for two reasons:

- The measurement at 560 nm is thought to be closer to the visual appearance of the sugar, owing to the sensitivity of the eye to the green end of the spectrum.
- The higher colour intensities of raw sugars at 97,5 per cent pol are more reproducible at 560 nm than at 420 nm, owing to the higher transmission at 560 nm. Readings at 420 nm, using a 0,5 cm cell or less, often lie below 20 per cent transmission.

Those favouring 420 nm point to the greater sensitivity at this wavelength, particularly when evaluating the efficiency of colour removal in refinery products.

During the past season all shipments of export sugar were analysed for colour at both wavelengths. The improved quality of South African export raws has meant that very few unaffinated sugars exceeded an attenuation of 0,3 at 560 nm, whilst affinated sugars were sometimes as low as 0,06. Seventy-eight pairs of results were obtained and these were submitted to simple regression analysis as there appeared to be a straight line relationship. It was found that there were a number of points with higher colours which deflected the straight line from a really good fit. Values at 560 nm greater than 0,3 were therefore excluded. The regression equation then had a correlation coefficient of 0,998. There is thus a very close relationship between colour measurements at these two wavelengths, provided the colour level is low.

Air pollution

At the request of SASMAL a Smoke Study Group consisting of engineers representing the major milling groups and SMRI was established. This group work in close collaboration with the mills and the chief Air Pollution Control Officer to reduce the emission from sugar mill stacks to the permissible level of 150 mg/ std m^3, within the framework of the Atmospheric Pollution Prevention Act of 1965.

Several meetings of the Smoke Study Group were held during the year. Technical information obtained from the Sugar Research Institute in Mackay was discussed and assessed in relation to local conditions.

South African Paint Research Institute

Director:
Prof. G. M. Hamilton
Prof. D. W. S. Evans

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

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

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

Facilities are provided for outside and accelerated-weathering studies of paint films, and a sea raft is maintained for assessing the effectiveness of marine paints and anti-fouling compositions. Both are available for testing members' products.

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

Hydroxyl value of resins

In order to facilitate the rapid determination of the hydroxyl values of resins, two prototype infra-red instruments (one with differential optics) have been designed.

The Institute is also studying the correlation of hydroxyl value with electrical conductivity and dielectric constant. For a given resin mix dielectric constant is linearly related to hydroxyl value. The effects of temperature variation and foaming are being studied. An accurate micro-conductivity bridge and sensitive (1 pF) capacitance meter with digital readout are used for this work. The process could be automated by mounting the cell in a plant resin kettle or in a heated by-pass sample loop.

Identification of raw materials and paint products

The present infra-red instruments at the Institute are being replaced or supplemented by more up-to-date models. The series of three books on spectra already distributed to member firms, will be extended to cover other materials of interest to paint manufacturers. The use of extended-range infra-red will increase the usefulness of these rapid identification spectra to industry.

Ion permeation through paint films

This is particularly relevant to corrosion studies as rusting and surface staining of paint films are directly related to residual film polarity and hence to ion transport through the film. It is hoped to delay transport by incorporating large or branched organic dyes. A graduate has been engaged to work in this field.

Polyesters

Methods are being developed for overcoming the difficulties of identifying and analysing polyester resins. They include chemical, ultra-violet and infra-red techniques.

Solvent retention by paint films

As much as 10 per cent of solvents may be retained during the useful life of a paint film. After the initial rapid solvent loss, their concentration at the paint/air surface approaches zero, but near the paint/substrate interface they cause increased plasticity or inhomogenity, depending upon whether or not they are true solvents for the particular system. The effects of this on film adhesion and cohesion are being studied, and methods are being developed for the quantitative assessment of loss and retention of common solvent mixtures. Pyrolysis and gas-liquid chromatography are the main processes used.

Polyol mixtures

A liquid-liquid chromatograph has been purchased to further the study of methods of separation and quantitative identification of polyols, and for the separation of polymer mixtures.

Attenuated total reflectance

The ATR unit obtained has already proved useful in identifying paint top coats rapidly by their reflectance characteristics. It can also be used for the non-destructive examination of both sides of a paint flake.

Financial Statements

Balance sheet

as at 31 March 1971

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

	General Fund R	Building Fund R	1971 R	1970 R
ACCUMULATED FUND				
Balance – 31.3.70	19 990 458,95	13 114 377,78	37 305 677,11	33 104 837
Inter-fund transfers	(–) 182 000,00	182 000,00		
SUB-TOTAL	19 808 458,95	13 296 377,78		
CAPITAL RECEIPTS				
Parliamentary grants :				
CSIR	1 649 500,00	750 000,00		
Grants	98 400,00			
Donations :				
CSIR	74 995,89	5 022,98		
Grants				
Interest		175 487,86		
Sale of assets written off :				
CSIR	30 295,50			
Grants				
Investigations and services	839 524,14	28 533,33		
SUB-TOTAL	2 692 715,53	959 044,17		
ADD :				
Excess income	752 485,91			
Adjustment previous years	36 500,00			
LESS :				
Nett value of phys. items transferred/received	15 416,30			
Cost of assets written off :				
CSIR	213 281,41			
Grants	11 207,52			
SUB-TOTAL	3 241 796,21	959 044,17		
TOTAL	23 050 255,16	14 255 421,95	37 305 677,11*	33 104 837
Current liabilities				
Advances for investigations and services			445 130,58	1 804 700
Sundry creditors and credit balances			1 510 583,29	1 423 975
TOTAL			1 955 713,87	3 228 675
GRAND TOTAL			39 261 390,98	36 333 512

Notes – *Contractual obligations against the General and Building Fund as at 31 March, 1971, was R1 361 257 and R841 679 respectively.

†Value of assets transferred : *To* U.S. Public Health Services (R15 112,31), Medical Research Council (R6 189,55); *From* Desert Ecological Unit (R3 805,56), National Trading Co. (R1 500,00), Printing Machinery Services (R580,00).

S.M. Naudé, *President*

J.H. Visagie, *Secretary/Treasurer*

PRETORIA 19.8.1971

	1970 / 1971 Nett Additions					
	Grants R	CSIR R	Written off R	Phys. assets transferred† R	1971 R	1970 R
FIXED ASSETS (at cost):						
Land and buildings	—	701 664,50	—	—	13 423 754,54	12 722 090
SUB-TOTAL	—	701 664,50	—	—	13 423 754,54	12 722 090
Laboratory and workshop equipment	102 517,82	2 674 176,40	134 491,86	9 211,72 (–)	17 112 599,17	14 479 609
Furniture, fittings and office equipment	662,00	163 478,37	16 743,08	893,50 (–)	1 161 117,05	1 014 613
Vehicles and cycles	27,76	108 310,42	70 743,99	2 221,99 (–)	755 598,57	720 226
Books and journals	1 223,43	108 364,52	2 510,00	3 089,09 (–)	1 000 293,84	896 305
Prefabricated structures	—	1 464,20	—	—	10 920,63	9 456
Shares in S.A. Inventions Development Corporation	—	—	—		140 000,00	140 000
Stores stock	—	10 522,51	—	—	391 861,33	381 339
SUB-TOTAL	104 431,01	3 066 316,42	224 488,93	15 416,30(–)	20 572 390,59	17 641 548
TOTAL	104 431,01	3 767 980,92	224 488,93	15 416,30(–)	33 996 145,13	30 363 638

Current assets			
Saleable stock		106 522,30	3 765
Sundry debtors and debit balances		694 490,78	1 269 311
Investigations and tests in progress		525 941,58	1 220 229
Advances and deposits:			
Research grants	503 665,15		
Other	62 459,70	566 124,85	608 292
Investments		3 180 849,21	2 738 271
Cash:			
At S.A. Reserve Bank	166 377,03		
Petty cash imprests	24 940,10	191 317,13	130 006
TOTAL		5 265 245,85	5 969 874
GRAND TOTAL		39 261 390,98	36 333 512

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.

24.9.71
PRETORIA

W.D. de la Rey,
Acting Controller and Auditor-General

Operating account

for the year ended 31 March 1971

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

Expenditure	1970 / 71 Grants R	CSIR R	Total R	1969/70 R
Salaries, wages and allowances	62 503,07	12 417 565,99	12 480 069,06	10 933 888
Consumable stores and services	10 065,12	4 594 902,63	4 604 967,75	4 669 730
Subsistence and transport	7 158,42	645 615,95	652 774,37	559 980
General expenses	26 666,76	1 858 463,08	1 885 129,84	1 607 343
Subsidies : Research by industry	—	307 549,87	307 549,87	278 629
Grants	729 558,12	—	729 558,12	598 313
SUB-TOTAL	835 951,49	19 824 097,52	20 660 049,01	18 647 883
LESS :				
Income for internal services	2 330,40	2 532 637,10	2 534 967,50	2 145 540
SUB-TOTAL	833 621,09	17 291 460,42	18 125 081,51	16 502 343
Balance transferred to Accumulated Fund	84 609,18	667 876,73	752 485,91	520 310
TOTAL	918 230,27	17 959 337,15	18 877 567,42	17 022 653

19.8.71
PRETORIA

S.M. Naudé, *President*

Income	1970/71 Grants R	CSIR R	Total R	1969/70 R
Parliamentary grant	917 300,00	9 955 200,00	10 872 500,00	9 621 200
Investigations and services	—	7 317 587,69	7 317 587,69	6 744 939
Contributions to CSIR projects	—	614 679,65	614 679,65	575 043
Publications	930,27	10 353,30	11 283,57	13 577
Sundry	—	61 516,51	61 516,51	67 894
TOTAL	918 230,27	17 959 337,15	18 877 567,42	17 022 653

J.H. Visagie, *Secretary/Treasurer*

CSIR Budget 1971/72

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 . . .	15 598 447	5 339 963	629 038	596 814	—	1 415 966	(–)3 000 069	20 580 159	10 952 300	9 627 859
Grants and subsidies	232 560	14 550	26 460	33 100	1 373 994	52 710	(–) 67 174	1 666 200	1 645 200	21 000
Total	15 831 007	5 354 513	655 498	629 914	1 373 994	1 468 676	(–)3 067 243	22 246 359	12 597 500	9 648 859

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 . . .	99 805	1 810 178	85 540	60 180	—	1 780 000	3 835 703	2 523 100	1 312 603
Grants to universities etc.	500	152 293	100	—	—	—	152 893	144 200	8 693
Total	100 305	1 962 471	85 640	60 180	—	1 780 000	3 988 596	2 667 300	1 321 296
						Grand totals	26 234 955	15 264 800	10 970 155

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