

CSIR

annual report 1970

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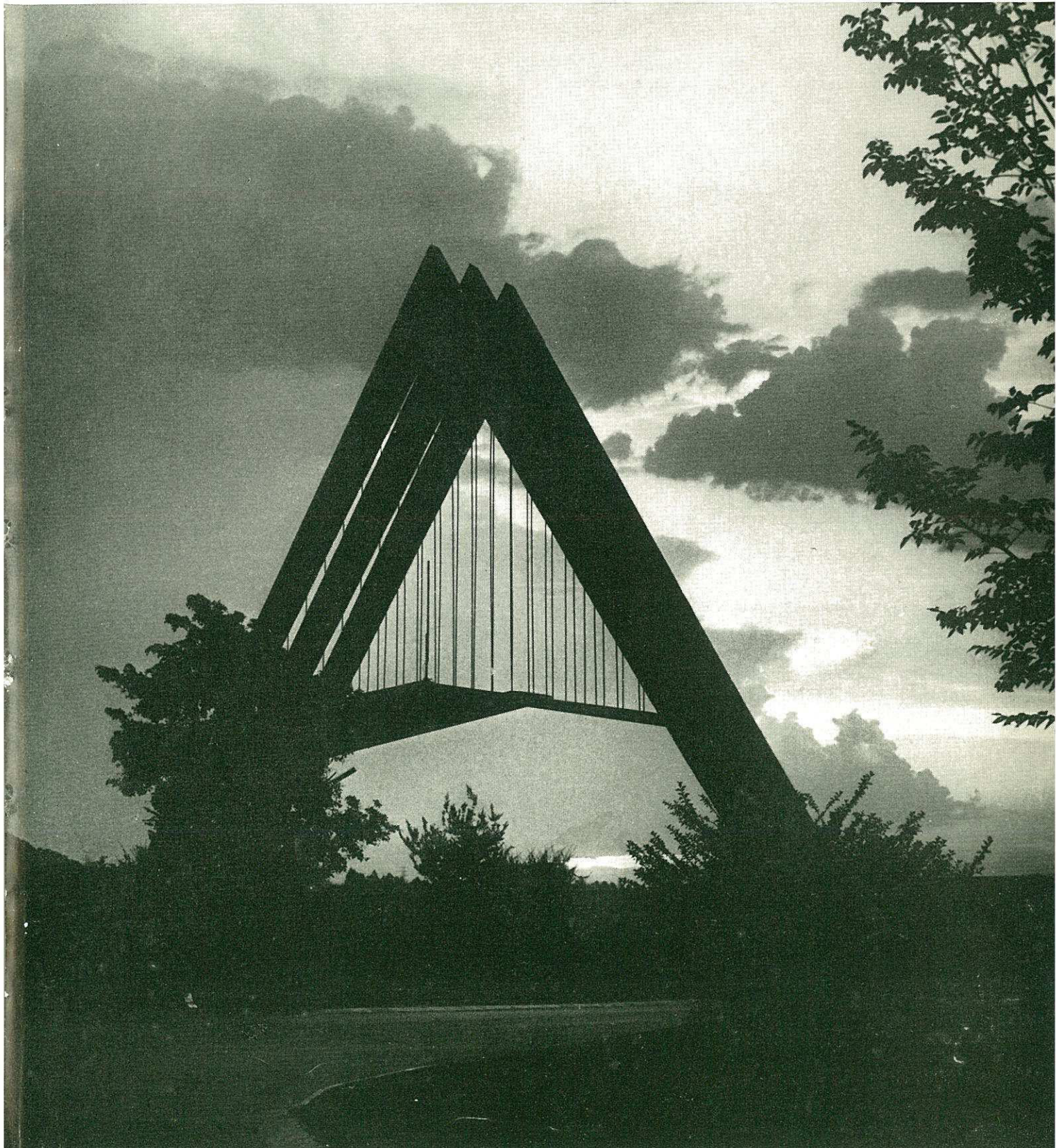
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Contents

Introduction	3
National Chemical Research Laboratory	5
National Physical Research Laboratory	8
Magnetic Observatory	11
Republic Observatory	13
National Research Institute for Mathematical Sciences	14
National Institute for Telecommunications Research	17
National Mechanical Engineering Research Institute	19
National Institute for Water Research	23
National Food Research Institute	26
Air Pollution Research Group	28
National Institute for Personnel Research	29
National Institute for Road Research	32
National Building Research Institute	35
Timber Research Unit	39
South African Wool Textile Research Institute	41
Information and Research Services	43
Leather Industries Research Institute	46
Fishing Industry Research Institute	48
Sugar Milling Research Institute	50
South African Paint Research Institute	52
Technical Services Department	53
Financial statements	i
Selected publications	vii
Subject index	xiii
CSIR periodical publications	xvi

**South African Council
for Scientific and
Industrial Research**

Twenty-sixth Annual Report 1970



Members of the Council for Scientific and Industrial Research 1970

Dr S. M. Naudé, *Chairman*
President of the CSIR

Dr H. J. van Eck
Chairman, Industrial Development
Corporation of South Africa Ltd
(deceased 18.2.1970)

Prof. R. L. Straszacker
Chairman, Escom
(retired 20.11.1970)

Prof. S. F. Oosthuizen
President, South African
Medical and Dental Council
(retired 3.10.1970)

Dr F. G. Hill
Technical Adviser, Rand Mines Ltd
(retired 3.10.1970)

Prof. C. A. du Toit
Professor of Zoology,
University of Stellenbosch

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

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

Dr J. N. van Niekerk
Head, Basic Research Division
Research Department, Iscor

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

Mr G. C. V. Graham
Managing Director, Fine Wool Products
of South Africa Ltd, Uitenhage

Dr B. Gaigher
Member, Board of Trade and Industries

Prof. A. J. Brink
President, South African
Medical Research Council
(as from 4.10.1970)

Dr G. S. J. Kuschke
Chairman,
Industrial Development Corporation
(as from 4.10.1970)

Mr J. W. Shilling
Director,
Anglo American Corporation of S.A. Ltd
(as from 4.10.1970)

Executive of the CSIR



*Dr S. Meiring Naudé,
President.*



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



*Dr F. J. Hewitt,
Vice-President.*



*Dr P. J. Rigden,
Vice-President.*

P.O. Box 395 Pretoria
1st May, 1971

Sir,

I have pleasure in presenting to you the Twenty-sixth Annual Report of the Council for Scientific and Industrial Research. This Report covers the period 1st January, 1970 to 31st December, 1970.

Balance sheets and statements of income and expenditure for the financial year ended 31st March, 1970, certified by the Controller and Auditor-General, are included.

Yours faithfully,

S. M. NAUDÉ

President: Council for
Scientific and Industrial Research

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

Introduction

The year 1970 has been a memorable one for the CSIR. On the 5th October 1970 this organization celebrated its 25th anniversary and stopped for a moment to look back over the period in which it grew from humble beginnings to a comprehensive organization covering practically every sphere of science and technology.

That the CSIR came into being at the beginning of a period of tremendous industrial development in this country was no coincidence. On the occasion of the anniversary celebrations at Scientia, the State President and the Minister of Planning paid tribute to those to whom the organization owes its establishment—the then Prime Minister, the late General J. C. Smuts, and the founder and first President of the CSIR, Dr. B. F. (later Sir Basil) Schonland. As far back as the early forties General Smuts realized that South Africa would have to be able to hold her own in the technological sphere in order to cope with the expected rapid development of the post-war years, and Dr. Schonland created the kind of organization which could help fulfil this need.

The statutory instructions of the new Council were to undertake and develop scientific and industrial research and to advise the government on matters related to the utilization of the country's natural resources and on the proper co-ordination and application of research for the advancement of industrial development, and to co-operate with educational and other authorities in the teaching of science and the training of research workers and technologists. The Council was also instructed to create the necessary facilities for research and for the collection and dissemination of information in the scientific and technical spheres and to effect liaison with international and other overseas organizations in these spheres.

In his first annual report (November 1946) Dr. Schonland was able to report considerable progress in the 'setting-up and staffing of certain national laboratories and research services, the organization and carrying out of a programme for the encouragement and support of research in universities and similar institutions, the organization of industrial research associations, and the establishment of committees to advise it on future developments which are needed'.

How these services have since expanded is clear from the survey of the Council's activities given in this annual report.

During its jubilee year the Council suffered a great loss with the death of one of its founder members, Dr. H. J. van Eck, who from October 1945 until his death served as a council member. The Council wishes to pay tribute here to the memory of a great South African who contributed tremendously

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to the promotion of industrial development in South Africa. His help and guidance through the years have been invaluable to the CSIR.

Three new council members were appointed during the year to replace the late Dr. van Eck as well as Dr. F. G. Hill and Professor S. F. Oosthuizen who retired at the end of their terms of office. They are Dr. G. S. J. Kuschke, Chairman of the Industrial Development Corporation, Mr. J. W. Shilling, a director and Manager of the Anglo American Corporation of S.A., and Professor A. J. Brink, President of the South African Medical Research Council.

In the previous annual report the resignation of the Deputy President, Dr. N. Stutterheim, was mentioned. During the year under review Dr. C. van der Merwe Brink was appointed Deputy President in his place. Dr. Brink had been a Vice-president of the CSIR since 1967, and was previously professor of Organic Chemistry at the University of the Orange Free State.

Another appointment to the Executive was that of Dr. P. J. Rigden as a Vice-president. Dr. Rigden was Director of the National Institute for Road Research from its establishment in 1955, and has been succeeded in that capacity by Mr. S. H. Kühn.

The appointment of Professor J. F. Kemp as third Vice-president (with effect from 1st January 1971) was also announced during the year. Professor Kemp was until recently professor of Mechanical Engineering at the University of Stellenbosch.

Towards the end of the year under review the establishment of a new research institute was announced. This institute, the National Electrical Engineering Research Institute, was created out of the Electrical Engineering Research Department of the National Research Institute for Mathematical Sciences.

Mr. J. D. N. van Wyk was appointed Director of the new institute which will cover research in both the light and heavy current fields.

In September 1970 it was made known that the CSIR and the Science Research Council of Great Britain had agreed on a joint astronomical venture. This

involves *inter alia* pooling the resources, in both manpower and equipment, of the Republic Observatory in Johannesburg and the Royal Observatory in Cape Town, for a new institution to be known as the South African Astronomical Observatory, with a new observing station near Sutherland in the Karoo where conditions for observing are very favourable. The world-famous astronomer Sir Richard van der Riet Woolley, has been appointed the first Director of the new observatory as from 1st January 1972 when the observatory will officially become operative. This development is of great importance to astronomical research in South Africa, as progress in this sphere has been seriously impeded in recent years by the deterioration of observing conditions at the existing observatories in the big cities.

An important international scientific meeting—the Second International Symposium on Gondwana Stratigraphy—was held in South Africa in July. This symposium, attended by experts from many parts of the world, was organized by the CSIR under the aegis of the International Union of Geographical Sciences. The first sessions were held in Cape Town and were followed by field excursions through the Karoo and parts of the Transvaal and Natal where visitors had the opportunity of seeing the rock types of the Karoo System and the fossils they contain. The symposium ended with sessions in Johannesburg. A milestone in the efforts to preserve South Africa's water supplies was reached in November with the official opening by the Minister of Water Affairs of the Stander Water Reclamation Plant at Pretoria's Daspoort sewage works. The plant was named after Dr. G. J. Stander, Director of the National Institute for Water Research, and leader of the team of scientists who developed the process for reclaiming potable water from sewage effluent. It can produce 4 500m³ of potable water of the highest quality from sewage effluent daily and is an improved version of the reclamation plant which was previously commissioned in Windhoek. This experimental plant will serve as a model in the planning of large-scale schemes for water reclamation in South Africa.

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



National Chemical Research Laboratory

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

The Laboratory is organized into divisions of organic chemistry, biochemistry, 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

Though the total amount of Bantu beer brewed by municipalities has continued to increase, the rate of increase has dropped sharply in recent years. In some places poor quality beer may be the cause, but indications are that the pattern of consumption is changing. The Department of Bantu Administration and Development has set up an *ad hoc* committee, on which the Laboratory's Bantu Beer Unit is represented, to study the needs of the industry from a national standpoint. The Unit has assisted in practical investigations and has prepared two reports.

In its research work, the Unit has made two important advances in brewing practice in the past year. One is an easy method for measuring modification of malts, and the other an improved souring technique.

Corrosion

As in the past, the Corrosion Group at the Laboratory has been concerned mainly with assisting and advising various bodies. This included work on nineteen major projects as well as dealing with enquiries from Malawi and New Zealand.

Fundamental work has been carried out on galvanized steel pipes in hot-water systems, as it has been claimed that electrode potentials of steel and zinc are reversed at temperatures over 70°C. Potentiostatic studies have been made of the corrosion of a number of metals and alloys under the influence of alternating current. A number of studies on dezincification of brasses have been completed. A thorough review of work on microbiological corrosion has been widely requested.

Substances with pharmacological activity

An agreement has been reached between the Botanical Research Institute of the South African Department of Agricultural Technical Services and the United States

Department of Agriculture for provision of samples of dried plant materials to be tested for anti-tumour activity. Chemical work on substances showing activity will continue in the Laboratory. Work on seven plant species is in progress.

Further steroidal derivatives have been made in the search for substances with hormone properties. The raw materials for these came from members of the cucumber family. The Horticultural Research Institute has cultivated a species with a high yield and has developed hybrids.

Synthesis of modified nucleosides with possible anti-tumour properties continued, and a new method of attaching branched chains to the sugar moiety has been worked out.

Toxic metabolites from fungi

The Laboratory's work in this field is well known internationally, and two of its leading workers have completed review articles for a monograph at the request of Academic Press. Structures of new metabolites have been elucidated, and the precursors of ochratoxin have been identified.

Insect pheromones

This work requires collaboration with entomologists of the Department of Agricultural Technical Services, and as the project on ant trail substances has been terminated by the Department, further work has ceased. New projects on a moth which is an agricultural pest and on the gregarization pheromone of locusts (very successful work was done on the latter by the Department of Zoology at the University of the Witwatersrand), have been commenced.

Bilharzia

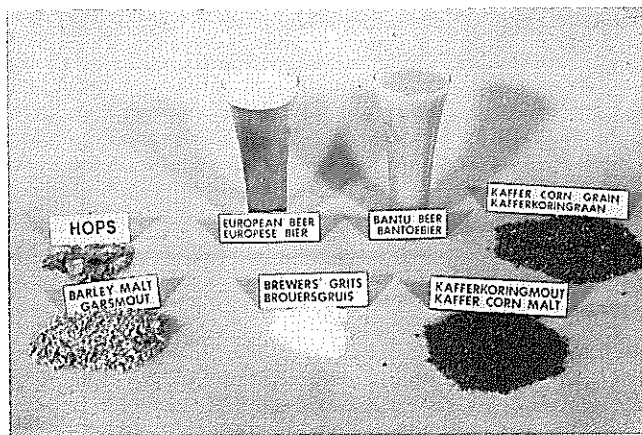
Work on the uptake of a group of molluscicides by snails has stopped. It was found that the substances are concentrated by the snail, but that they are taken up by dead snails to the same extent as by live snails, only more slowly. Thus the phenomenon seems to be one of simple adsorption by the tissues. The substance exuded by snails as a miricidal attractant appears to be a carbohydrate.

Digestion and metabolism in ruminants

The group dealing with this project has made good progress on long-term studies of the implications of earlier findings but has not yet reached the stage of definitive findings. It has been shown that certain branched-chain volatile fatty acids are formed from amino acids and are essential to activity of cellulolytic bacteria. Conditions governing the formation of these when urea is used as a supplement are being studied, particularly the effect of simultaneous starch additives. More fundamental studies by continuous culture methods are also under way.

In studies of urea supplements, it was found advisable to use a lick containing some sodium sulphate to ensure an adequate supply of sulphur in the rumen.

The value of biuret as a supplement instead of urea has been established. The way biuret is used in the rumen is not clearly understood but a step forward has been the discovery that the microorganisms responsible are mainly on the surface of coarse solid matter in the rumen, not in ruminal fluid.



Ingredients for brewing European beer and Bantu beer.

Cancer biochemistry

It was previously reported that, shortly after they were administered, dyes producing liver cancer could be found in the nuclei of liver cells. During the past year, it was established that the dye is taken up primarily by the protein part of a fraction known as inactive chromatin. Chromatin, a complex formed by proteins closely bound to nuclear DNA, is usually insoluble, and the success of the experiment depended upon developing a technique to obtain it in soluble form. A method was also developed to split off the protein part of the soluble chromatin and to separate it. A further finding is that if the dye is attached to the protein of chromatin its bonding to DNA is weakened.

The importance of techniques for fractionation of cellular components is evident from the above. An officer has spent a year in the USA studying this specialized field.

Protein chemistry

The amino-acid sequences have been established for several more of the numerous toxins isolated from cobra species, including the Cape cobra, ringhals and mamba. The positions of sulphur bridges or cystine linkages have been established. Interesting relationships between the various structures were discovered and the work was reported at an international meeting in Israel. Biochemical studies have begun and immunological work, carried out in collaboration with the South African Institute for Medical Research, is being extended.

Studies of a proteolytic enzyme from puff-adder venom have progressed, but have been made difficult by the fact that the enzyme, which appears to have a minimal molecular weight of 22 000, very readily associates to as much as ten times this molecular weight.

Structural studies are now being made of phosvitin from yolks of hens' eggs. A comparison has been made with turkey eggs and duck eggs, which show significant differences in composition. They are similar, however, in that they contain the same two slightly different components.

A new project, in collaboration with the Microbiology Research Group, is the study of the enzyme L-asparaginase, using various strains of bacteria as the source. The enzyme is important in controlling certain types of cancer.

The research group seconded by the South African Wool Textile Research Institute to the NCRL has continued successfully isolating pure peptides from wool and mohair and determining their amino-acid sequences. Wool laboratories in other countries showed great interest in this when it was presented by the officer concerned at the Fourth International Wool Conference at Berkeley, California, in August, 1970.

Analytical chemistry

Further analytical separations have been based on the comprehensive studies of the use of ion-exchange columns carried out in this Laboratory. The leader of the group concerned has been asked to prepare a thorough review of this field for a monograph on modern analytical chemistry. A scheme worked out for silicate analysis has been successfully applied in the standardization of six South African rock samples. The method was presented at an international conference in Europe, and as a result this Laboratory has been asked to participate in analysis of samples which are to become international standards.

Pneumoconiosis

A preliminary finding was published recently that silica can cause macrophages to produce an agent which induces the synthesis of fibrous tissue. This could account for the fibrotic nodules in silicotic lungs. Confirmatory evidence has been found and further studies are in hand.

Human growth hormones

These have been obtained in a very pure form but the supply of human pituitaries is limited. The passing of the Anatomical Donations and Post Mortem Examinations Act of 1970 has not, as was hoped, improved the situation. Useful clinical products could be prepared if the supply were adequate.

Chemistry of gold and platinum

Through the Chamber of Mines, most of the main producers of gold and platinum have agreed to support fundamental work on the chemistry of these metals for the next five years. This should speed up the progress of the research programme. The platinum metals are of industrial importance and are very versatile. Many interesting modifications of their properties can be obtained by forming organometallic complexes. This makes them an ideal basis for catalysts. One of the objectives of the study is to discover exactly how and to what extent various groups bonded to the metal affect its behaviour. For instance, iridium compounds can take up oxygen or carbon monoxide spontaneously, and it is planned to ascertain their relative affinity for the two. Catalysis of the conversion of nitrogen to ammonia is of great practical importance.

The mode of bonding in organometallic compounds is a vital topic in modern inorganic chemistry, and an extensive review written on request by a member of the research group concerned was published in England. Also by request the leader of the group spent a year in the USA to guide a group of research students.

Heat exchangers

The computer programme for the optimum design of air-cooled heat exchangers has been widely used in industry. The programme has now been modified to reduce computer

time. Studies have been published of variations in the heat transfer coefficients used, and further experiments are being carried out on correction factors for these in multipass cross flow. Other studies have been carried out on pressure drops for flow through turbulence promoters in parallel plate arrangements.

Particle technology

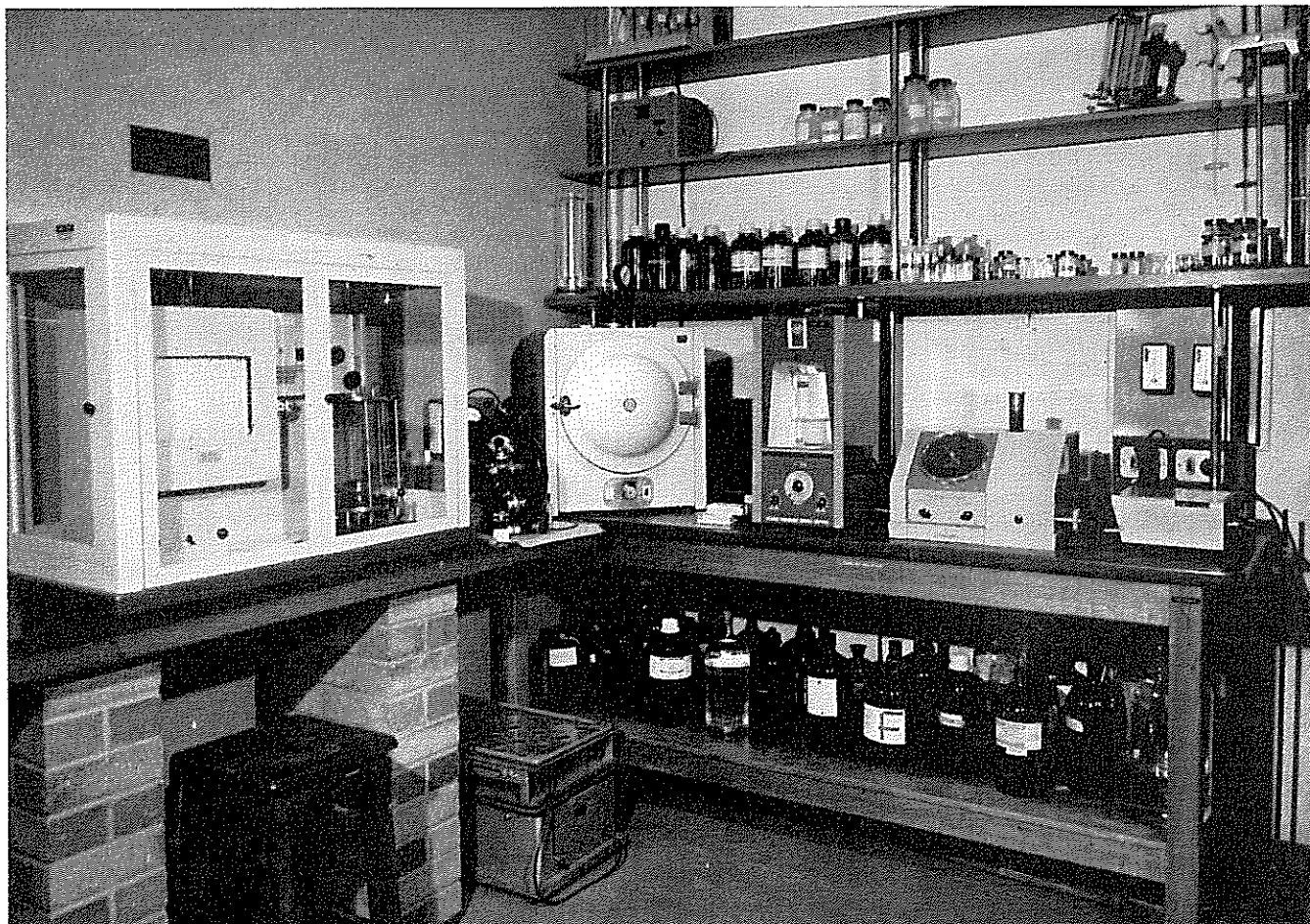
Radioactive tracer techniques have been used to follow flow

patterns of both solids and liquids in full-scale thickeners under normal load. For liquids, such techniques are not sensitive enough over the main part of the area where velocities are low.

Computer programmes suitable for desk top computers have been compiled to measure particle size by sedimentation.

Effects of floc formation in filtration have shown that existing theories are inadequate and that flocs which are suitable for thickening are not necessarily effective in filtration. Practical studies for industry are also being undertaken and special equipment has been purchased for this purpose.

Equipment for particle size determination.



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



National Physical Research Laboratory

The main function of the National Physical Research Laboratory (NPRL) is to contribute to the development of physical science in the Republic through research aimed at the adaptation of existing knowledge as well as the discovery of new facts for the solution of technological and industrial problems of national importance. In addition the NPRL has statutory responsibilities for maintaining national standards of physical measurement for mass, length, electricity, radiation, etc. The facilities at present at the NPRL cater for the most essential needs of the Republic in the sphere of the physical sciences and, within the NPRL, groups of research workers from nuclei of research man-power in the following fields: optics, nuclear physics, solid state physics, acoustics, spectro-chemistry, infra-red spectroscopy, electron microscopy, geophysics, electron spin resonance, geochronology, oceanography, high pressure physics and natural isotopes.

It is important for any community of scientists and engineers to take a periodic look at itself and to identify its task within the society it strives to serve. During the past year the scientists of the Laboratory have given thought to how they can best serve the future industrial needs of the country in the field of physics and the related fields of research and development. With this in view the activities of the Laboratory have been combined under groups for industrial physics, earth physics, material sciences and nuclear sciences. It is hoped that within these groups joint research tasks and individual projects of a high standard and of value to the national economy will be undertaken.

Apparatus

Instrument for noise analysis—When investigating noise problems it is always necessary to analyse the noise into frequency bands in order to decide what methods and materials to use to reduce it. An instrument has been designed and built that analyses the noise into one-third or whole octave bands and records the results on a strip of paper, all in less than one minute. This new apparatus is more accurate and versatile than the very expensive commercial equipment.

High-resolution radar—Studies of hailstorms and lightning in the vicinity of Pretoria and Johannesburg will be boosted considerably by the recent acquisition of a high-resolution radar. Detailed reflectivity profiles of storms will be correlated with observations of surface patterns of hailstorms, cloud photogrammetry, lightning and hailstone structures. Storm models will be derived from this information. Objectives are to be able to predict the behaviour of hailstorms and, ultimately, to develop techniques for the prevention of damaging hail.

Proportional counter for natural tritium—In addition to the facilities available for determining the natural carbon-14 isotope (radiocarbon dating), apparatus to measure tritium

in rain and ground-water has been installed. A programme for the investigation of tritium concentrations in nature could thus be initiated.

Important research results

Radio techniques in tracking—In collaboration with the National Institute for Telecommunications Research and the National Research Institute for Mathematical Sciences, miniature radio transmitters and associated receivers and antennae were developed to track animals where the nature of the terrain makes visual observations impossible. Four projects are using this system.

At Ndumu the role played by the vervet monkey in the life cycle of a particular virus is being studied by the South African Medical Research Council and the Department of Zoology of Pretoria University. At the Hluhluwe and Umfolozi Game Reserves, the Natal Parks, Game and Fish Preservation Board is studying the behaviour of black and white rhinoceros. The transmitter and the loop antenna are embedded in the posterior horn and protected by a layer of glass fibre. The Transvaal Division of Nature Conservation is studying the movements of impala in the Sabi-Sand Reserve. As in the case of the monkeys, the transmitters are built into neckbands.

At the request of the Department of Transport the possibility is being investigated of developing similar lightweight equipment for locating lost persons in the rugged and inhospitable regions of Gough and Marion Islands manned by the Weather Bureau.

Anti-shark research—The research into electric shark barriers is coming to an end at the St Lucia Estuary. Different electrode systems have been investigated and a practical system has been designed. The major problems of manufacturing suitable cables have been overcome and a pilot system is to be installed at Margate on the Natal south coast.

Hail research—The results of seven years of observations of hailstorms in the Pretoria-Witwatersrand region have been summarized. Subjects discussed include areal hail frequency, seasonal variations, onset time and duration of hailfalls and the occurrence of soft hailstones.

An extensive, illustrated report was produced on the sizes, shapes and internal structure of natural hailstones. Large numbers of hailstones of all shapes and sizes from many storms were studied over a period of ten years. It is now possible to make certain generalizations about hailstones.

Dating of Stone Age in Southern Africa—By means of radiocarbon dating, it has been established that the Later Stone Age in Southern Africa dates back more than 23 000 years. This culture is thus more than twice as old as hitherto assumed.

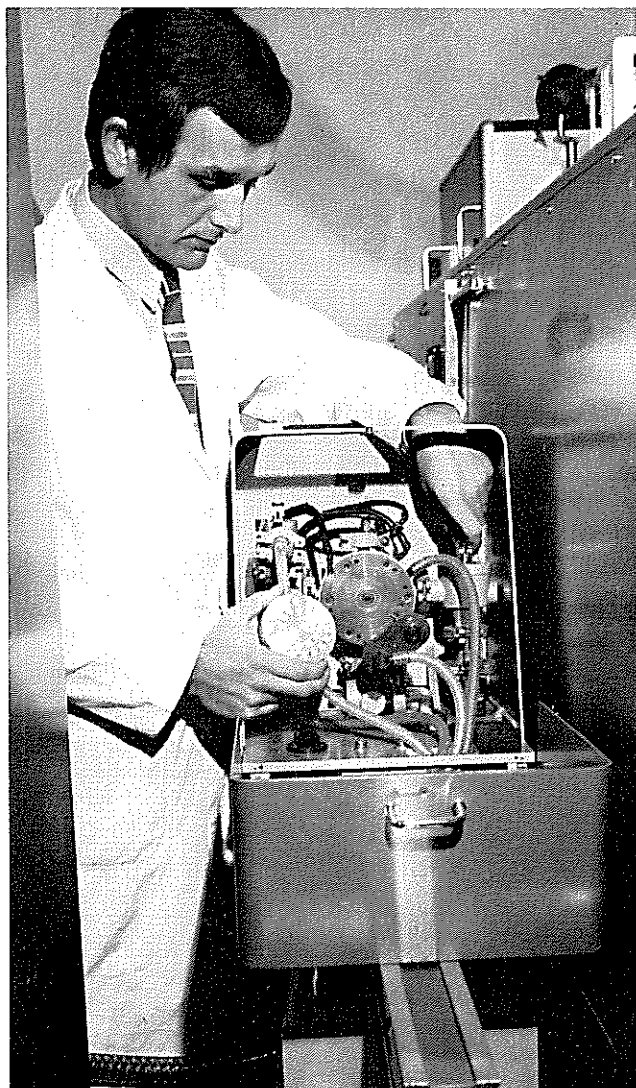
Age of ground-water—Carbon-14 analyses of about one hundred ground-water samples indicate that ages of more than 30 000 years are not at all unusual in Southern Africa. In these instances the recharge must be extremely slow.

An investigation of the ground-water in the southern Kalahari undertaken in collaboration with the Department of Water Affairs, showed two continuous water bodies with very slow flow rates of two and four metres per year in a westerly direction.

Deuterium content of organic material—The hitherto unknown deuterium concentration in organically-bound hydrogen was investigated by measuring the D/H ratio in wood, peat, coal, oil, natural gas, etc. All these materials contain less deuterium than ocean water and the observed concentrations appear to be of a systematic nature. Organically-bound hydrogen in wood contains about 3 per cent less deuterium than the water on which the plants grew. In peat the deuterium content decreases with increasing degrees of coalification. Coal shows no further dependence on the grade, but the deuterium content is characteristic of the deposit and can be used for correlation purposes. The same is true for oil deposits. Water and plants from the Last Ice Age contain less deuterium than contemporary samples, a result of the change in climate.

Ultra-deep electrical soundings—The results of ultra-deep soundings at Pofadder and Dealesville indicate that the classical idea of a chemically-layered crust may be erroneous. The electrical results indicate that the upper and lower portions of the crust are probably of the same composition, but that the lower crust is physically different due to high-grade metamorphism and dehydration.

The glow discharge source used for analysing metal samples.



Fischer-Tropsch waxes at high pressure—It was found that Fischer-Tropsch waxes at high pressure behave as if their carbon numbers increase. This makes it possible to study the properties of industrially important waxes which would otherwise be difficult to obtain in a narrow composition range.

Structure of phragmalin—An X-ray analysis of the structure of phragmalin, a complicated natural product, revealed a marked resemblance of the molecule to limonin, a well-known bitter principle of citrus fruit, the presence of a norbornane skeleton, which was not expected, and an ortho-ester linkage across a cyclohexane ring, which has never before been found in this class of natural product.

Volatile lanthanide chelates—Some hydrated β -diketonates of the lanthanides were investigated crystallographically. The belief that co-ordinated water causes hydrolysis of these compounds on heating was found incorrect in the cases of some fluorinated ligands. The structural results obtained previously of the complexes of 2, 2, 6, 6-tetramethylheptane-3, 5-dione were analysed in terms of an ionic model and good correlation with their known thermodynamic properties was obtained. The most important finding was that monomeric species show little variation in properties through the series, whereas marked gradation occurs in dimers. This is due to a variation in the energy of dimerization. Enhanced chromatographic separation can be induced by the synthesis of dimers which occur for all the lanthanides.

Oceanography—Measurements of currents near Durban have been fitted to a model consisting of a steady system of currents flowing parallel to the coast with moving anti-clockwise eddies superimposed. These anti-clockwise eddies accompany the atmospheric pressure cycles that move northwards along the coast and occur at regular intervals.

The model helps to explain phenomena such as the apparent movement of the Agulhas current towards and away from the coast, on-shore and off-shore currents, variations in surface temperature and localized enrichment of the water by up-welled nutrients.

A measuring programme at Richards Bay is aimed at constructing a similar model for this area and development of a universal model applicable to the whole Natal coast.

Glow discharge source—A new type of light-source unit known as the glow discharge source was developed recently in Germany. The simplicity of the source and its operation make it ideally suited for industrial use. The Laboratory acquired one of the first commercial units and has conducted several valuable analytical projects for South African industry.

One of these was the development of a rapid and accurate analytical method to determine the silver, copper and lead content in raw gold. It is possible to detect impurities and to determine the gold content very accurately using this method.

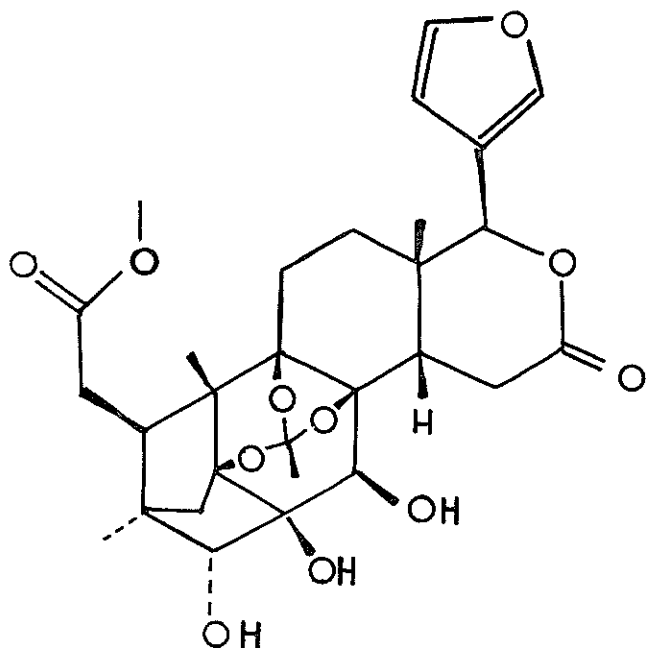
The source has also been successfully used to analyse brass and bronze. Not only is it possible to determine all the constituent elements directly, but a set of analytical curves set up from brass standards may be used for bronze metal analysis. The source can also analyse metals with different metallurgical histories, i.e. cast, drawn, or rolled metal.

Many requests have been received from industry to explore the possible uses of the source.

Spark mass spectrographic studies—A spark mass spectrograph installed some time ago is a valuable asset and has been used for trace characterization of South African gold, trace characterization of acid lavas and determination of their relationship to the chronological sequence of effusions from the mantle and isotope ratio determinations in inorganic materials.

Routine services to industry

Acoustic consultations—A considerable number of requests had been received for assistance in the planning or improvement of the acoustics of churches, schools and halls, and several investigations into noise problems were undertaken by the Acoustics Division.



The structure of phragmalin.

The acoustical planning of the new SABC studios in Johannesburg is the Division's largest single contract. Apart from this the opera houses in Cape Town, Pretoria and Johannesburg are still receiving attention. A new contract concerns the acoustical planning of the Randse Afrikaanse Universiteit.

Requests for advice show that large sums of money are spent on buildings which prove to be near-failures because the problems of acoustics, ventilation and lighting were not considered during the design stage. To draw attention to this an article on the subject was written in collaboration with the National Building Research Institute and made available to all church magazines. Enquiries have since been received from all over the Republic and from neighbouring territories.

The existing facilities for teaching music in schools and colleges are inadequate. Very little information on the design of teaching and practice rooms was available, even in technical journals, and a preliminary guide was therefore written and sent to interested parties for comment. The reaction was so satisfying that a more comprehensive treatise on acoustical considerations in the design of music rooms was prepared.

Advice is given on noise reduction in industry and on how to design buildings to exclude noise. Three staff members of the Acoustics Division serve on the Noise Abatement Committee of the Johannesburg City Council.

Geophysics—Work done in this field involved the practical application of seismic refraction and electrical resistivity methods. Seismic refraction surveys were carried out on a contract basis for Iscor and the Geological Survey, e.g. the foundation investigation of the site for the third Iscor plant at Newcastle and a similar investigation at Vanderbijlpark.

In collaboration with the National Institute for Water Research a seismic study was made of part of the Cape Flats. This is part of a research programme to determine the groundwater potential of the Cape Flats. The seismic results showed that the depth of water-bearing sand is up to 60m in places and its porosity has been estimated at about 35 per cent.

A deep electrical survey has been made of an area between Beaufort West in the west and Port St Johns in the east. This investigation was carried out at the request of Soekor to determine the nature of the Beatty Ridge. This ridge, which is about 100km wide, is a prominent magnetic anomaly which occurs across the entire land. The electrical results indicate that the ridge is not intrusive into the Karroo rocks, but that it forms part of the crystalline basement. This is important for mining exploration.

Chemical analysis—Instrumental methods of analysis are being used increasingly in South African industry. The NPRL is often consulted about the best methods and instruments. During the past year advice was given which led to the purchase of approximately R208 000 worth of instruments. Several studies were also undertaken on behalf of industrial organizations to establish the most useful and economical method of analysis. Many samples were analysed for outside organizations.

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



Magnetic Observatory

Although the activities of this well-known geophysical research station 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 continuous recordings of the geomagnetic elements, cosmic ray intensity and radio noise are often used by South African and overseas research workers in related fields of study which include space research, upper atmospheric physics and geomagnetic induction. This information finds practical application in, for example, navigation by magnetic compass and the prediction of radio reception conditions.

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 Tsumeb station was established in 1964 in co-operation with the Max Planck Institut für Aeronomie (MPI, Lindau, Germany) on the site of the Institute's 'Ionosphärischen Forschungsstation Jonathan Zenneck' and is run by the staff of the ionospheric station.

Preliminary tests have been carried out at the STADAN site of the Radio Space Research Station at Hartebeesthoek, with a view to establishing a magnetic recording station there. As magnetic disturbances are connected with ionospheric conditions the recordings at Hartebeesthoek will also be useful to the National Institute for Telecommunications Research.

Geomagnetic field-stations

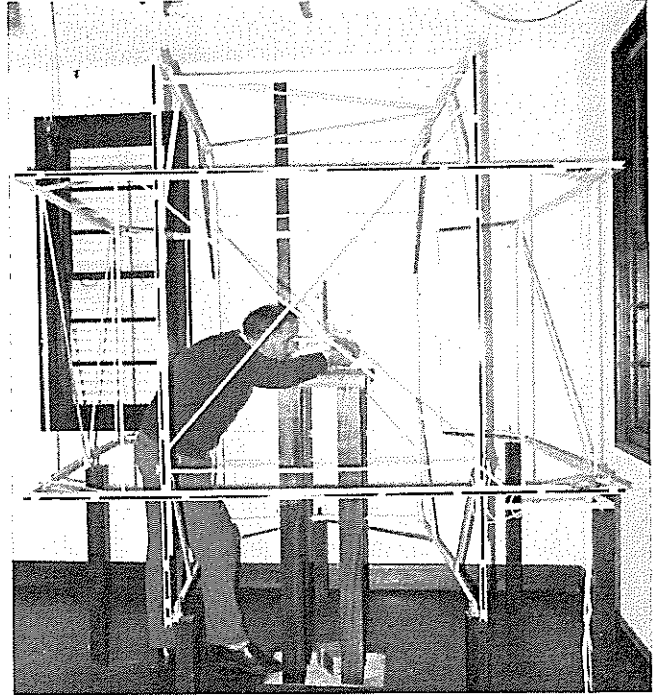
A comprehensive geomagnetic survey was carried out to determine the mean secular changes in the geomagnetic elements. The survey included observations at thirteen new field-stations in South-West Africa. With the establishment of these stations the network of primary magnetic field-stations in the Republic and South-West Africa was completed. The field workers of the Observatory travelled more than 20 000km, from Hermanus in the south to Messina in the Transvaal and Cape Fria on the Skeleton Coast. The results confirmed the change in the secular variation pattern which was observed in a recent analysis of former surveys. The data are being used to compile geomagnetic charts for the epoch 1970.0.

The Trigonometrical Survey Office assisted in setting up, co-ordinating and maintaining the primary magnetic field-stations, and will continue with the comprehensive programme of compass observation.

Automation

The standard La Cour variometers have been provided with a servo-system which reproduces the variations in the magnetic field in analogue form as variations in an electric current. A data acquisition system, developed with the assistance of the National Research Institute for Mathematical Sciences, digitizes the analogue signals and stores them on punched tape.

A computer programme which converts magnetogram scalings to absolute units and prints them in table form has been drawn up with the co-operation of the National Research Institute for Mathematical Sciences.



The double coil system used for calibrating the absolute magnetometers.

The mean hourly values of the geomagnetic elements for the last 38 years are now being stored systematically on magnetic tape for archive purposes according to the format recommended by the International Association for Geomagnetism and Aeronomy.

Cosmic rays

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

The recommendation by the Research Unit that the monitor at Hermanus be enlarged to at least four times its present size, is being considered.

Magnetic conjugate point programme

The programme of observations at the magnetically conjugate points, Hurouqué (France) and Hermanus (South Africa) was completed in March 1970.

Ozone observations

The Observatory began operating an ozone recorder for the Max Planck Institut für Stratosphärenphysik in September 1970. The immediate object of the observations is to determine

the latitude effect and time variations in the ozone content of the air at ground level. The sixteen selected observation posts lie within a narrow longitude strip from Tromsø (Norway) in the north to Hermanus in the south.

Absorption of radio waves

The 30 MHz riometer installed at the Observatory by the Air Force Cambridge Research Laboratories (Bedford, USA) in 1963 operated continuously. The records were used during the year by post-graduate students of the Potchefstroom University for research on the absorption of radio waves.

Geoalerts

The demand for the Observatory's geoalerts increased during the year. These were sent out whenever the continuous records of the magnetic field, cosmic radio noise, earth currents and atmospheric noise indicated disturbed conditions.

Magnetic activity indices

The Observatory is one of the few chosen observatories whose data are used for the magnetic disturbance indices Dst and Ks. In the monthly magnetic bulletins issued by the Observatory, the disturbances are classified and described in detail.

Auxiliary programmes

The limited seismological and meteorological programmes continued uninterrupted. To prevent the disruption of the seismological readings by a local earthquake, the optical recording system of one of the Milne-Shaw seismographs was supplemented by a special electrical recording system.

Antarctic research

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

Dissemination of data

In addition to the monthly and annual bulletins issued by the Observatory, data were supplied on request to the Trigonometrical Survey Office, the South African Air Force and Navy and numerous private bodies.

The network of primary magnetic field stations.





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

Republic Observatory

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

The principal long-term programmes of the Observatory comprise observational and theoretical research in the field of visual double stars (a field recently extended to include eclipsing binaries) and photographic observations of minor planets and comets. For half a century, the Observatory has been associated with these programmes to such a degree that they have become almost international commitments.

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

Long period variable stars

There are a number of important astronomical research programmes which tend to be neglected at many observatories. These are the ones requiring a long and uninterrupted series of observations, which is almost impossible where expensive telescope time has to be shared by a large number of observers.

One such astronomical programme, which was commenced at the Republic Observatory during 1970, is the photo-electric observation of long period variable stars (LPVS).

The long period variables form a large and inhomogeneous subdivision of the family of intrinsically variable stars. Their periods range from, say 60 days to 1500 days, but the light variations are not strictly regular. Often one can detect only a faint indication of a period, and frequently there is no period at all.

The mechanism of variability and the atmospheric conditions within the stars are still largely unknown. Detailed information about the light variations is therefore needed and the stars have to be kept under continuous observation, i.e. each star has to be observed at least once every two days, over a period of a few months.

Observations of about 50 of these variable stars were made during the winter months of 1970 in ultra-violet, blue and yellow light. Preliminary results correspond well with earlier results by other workers, but the data obtained so far are still insufficient, and the work is to be extended over many more seasons to gather statistically significant material.

Photo-electric photometer on the 20 in. reflecting telescope.



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



National Research Institute for Mathematical Sciences

The National Research Institute for Mathematical Sciences (NRIMS) is concerned with research in the mathematical sciences and electrical engineering. These two disciplines include many of the theoretical and experimental aspects of research in all scientific fields.

The Mathematical Sciences Research Department consists of divisions for mathematical analysis, statistics and numerical analysis 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 computation on digital computers.

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

MATHEMATICAL SCIENCES

Of the many basic and applied problems treated, a few examples in mathematical statistics and computing are given below.

Road traffic problems

For the intended national survey of road traffic a best choice of 98 points on rural roads was made for the National Institute for Road Research. At these points traffic counts are to be taken on a fixed day of the week four times a year. Observations began at the beginning of 1970, with the co-operation of the four Provincial Administrations.

Systematic sampling schemes were also devised for various other projects, e. g., a method of selection of road accidents for intensive study and of heavy vehicles to be tested for road-worthiness.

A statistical analysis of spot speeds of traffic measured annually at ten points on rural Transvaal roads for four years, indicated that in successive years fewer people were driving at low speeds.

An experiment was designed to determine the effects of law enforcement on the behaviour of drivers. This was measured by the rate at which traffic regulations are violated. The traffic departments of Pretoria and Johannesburg collaborated in the first phase of this experiment.

Studies of sorghum

Statistical analyses made for the National Food Research Institute included one to compare the yields obtained when sorghum is ground using a rice mill, an impact mill and a roller mill with special fluted rollers. If the flour constituents, which are obtained in addition to the grits in the impact mill and roller mill processes, are not mixed with the grits, there is no

significant difference between the yields. If, however, a portion of the flour constituents is mixed with the grits, the yield obtained by the rice mill is significantly lower than that obtained by the other two.

The object of another experiment on three cultivars (varieties) of sorghum grown in different regions, was to establish possible significant differences in yield due to the regions and also to the cultivars themselves. It was found that the yield of two specific cultivars differed significantly.

Biostatistics

Several statistical analyses were carried out for the Nutrition Clinic for Children at the H. F. Verwoerd Hospital. One involved the chemical composition of breast milk of Bantu and White women. There was significant difference between the two groups. In another investigation 68 male infants with acute gastro-enteritis were divided according to the diet they received in hospital, i.e. a high protein and a powdered milk formula.

Statistical analysis showed that the plasma potassium values of the patients who received the milk formula returned to normal more quickly than those of the other group.

The statistical analysis of results measured by the National Institute for Nutritional Diseases showed that a certain drug had a significant effect on eight biochemical variables in a group of kwashiorkor and pellagra patients.

The leg length and upper shell (carapace) length of rock lobsters collected by the Oceanographic Research Institute, Durban, were measured. After suitable statistical theory had been specially developed for the purpose, it was found that, in rock lobsters with the same upper shell length, if this is 48 millimetres or more, the legs of a male are on the average significantly longer than those of a female.

For the National Chemical Research Laboratory it was statistically established that the oxygen intake of a group of snails diminished significantly after treatment with a certain poison.

Computer centre

The more powerful computer which came into operation in 1969 was at first used for only a few hours a day, but it became necessary to introduce an overflow shift early in 1970. To cope with the growing sophistication of the daytime load, additional equipment has been ordered for 1971, including a satellite computer for the National Institute for Telecommunications Research in Johannesburg. This will be linked by telephone lines as a terminal to the main computer in Pretoria.

Use of the computer has been optimized in many respects, e.g. a better means of obtaining graphs drawn by the computer has been provided.

A television-type screen attached to the computer was used in many projects. Various new applications of computer graphics were developed, e.g. the design of electronic circuits and geometrical shapes.

Numerical control of machine tools

Further extensions have been made to the computer programs related to the numerical control of the CSIR's auto-

matic milling machine. Special attention was given to methods of defining complicated ('sculptured') surfaces mathematically. Several complex aircraft shapes have been machined for wind tunnel models. Two-dimensional parts can now be drawn and dimensioned on a cathode ray display attached to the computer.

Data processing

A good deal of work was done involving data processing by computer. It originated from such varied sources as investigations into pneumoconiosis, earth magnetism, the use of scientific literature and the distribution of hail storms.

A task commissioned by the Department of Agricultural Economics and Marketing is related to a long-term project for assessing and ultimately optimizing agricultural production. Techniques to process the monthly returns of a large sample of the farming community were developed for the preliminary stages of this project.

Programming

In collaboration with the National Mechanical Engineering Research Institute a comprehensive program has been developed for the assessment of aircraft noise disturbance near airports. The techniques and computational methods developed have received international recognition and are being incorporated in a national standard procedure.

Other programming assignments which involved significant contributions in numerical mathematics have been concerned with ionospheric studies, the eclipse of binary stars, tables of heat conduction, the simulation of process control systems, shore wave analyses, transonic flow theory, control system analysis and the design of cooling towers.

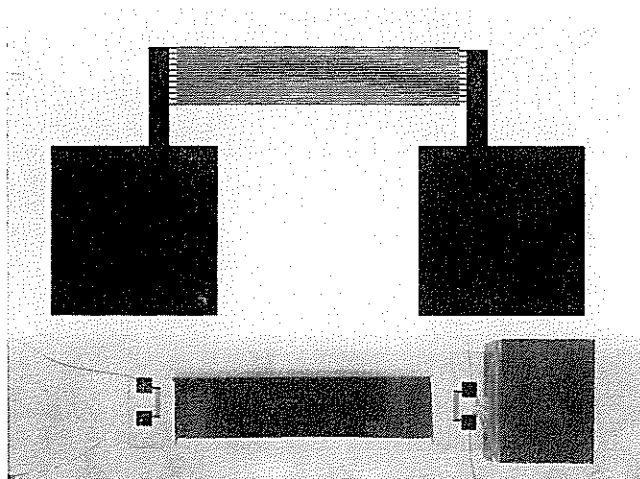
ELECTRICAL ENGINEERING

Process control

Work has continued on the simulation of the sugar refinery referred to in the previous annual report. The work related to the process part of the factory is being done in collaboration with the Chemical Engineering Group of the National Chemical Research Laboratory. Mathematical models have been derived for the milling tandem and the evaporators.

A simulation study of a gold reduction plant is being conducted in collaboration with the mine concerned and the University of Pretoria.

Pattern of an ultrasonic surface wave transducer (so-called interdigital type) and ultrasonic wave guide with transmitting and receiving transducers.



Data-acquisition systems

The Institute has for some years been designing and constructing special-purpose data-logging systems, and has on numerous occasions been consulted by outside organizations on aspects of data logging. The major activity at present is the development of a computer-controlled data-acquisition system for a high-voltage recording station, a project undertaken jointly with ESCOM and the University of Pretoria for studies on the behaviour of 400 kilovolt transmission lines.

Medical electronics

An instrument to stimulate the vagus nerve electrically in the treatment of angina pectoris was tested on a patient at the H.F. Verwoerd Hospital, with encouraging results.

An instrument for cerebral electro-therapy was mentioned in the previous annual report. A second instrument, which permits the use of current wave forms with greater peak values, was constructed this year and will replace the existing instrument, which is in regular use, when the latter requires servicing or develops a fault. It is hoped that EEG measurements during treatment will be feasible when using the new instrument, and that these measurements will make the assessment of the effects of brain stimulation more accurate.

Tracking equipment for wild animals

In the annual report for 1968 mention was made of the development of miniature transmitters for tracking monkeys and rhinoceros. Refinements were made to the receivers and transmitters initially developed in a joint project with the Acoustics Division of the National Physical Research Laboratory for tracking vervet monkeys in the Ndumu Game Reserve. Other transmitters were designed and constructed for mounting in the posterior horn of both black and white rhinoceros.

The work also includes other species of animals and altogether 5 receivers and 38 transmitters have been supplied for use in game reserves in Zululand, the Eastern Transvaal and Natal.

The considerable interest shown in this project when it was initiated two years ago, has increased, but lack of financial resources is still seriously hampering experimental work.

Electrical resistivity of soil

A very well attended symposium on earthing was held in March 1970 under the auspices of the CSIR. The discussions included earthing practices, measuring techniques, the effects of corrosion, the protection of tall structures against lightning and measures to ensure safety in domestic premises. The delegates decided that it would be advantageous to meet regularly in order to keep abreast of developments and asked the CSIR to take the initiative in arranging symposia.

Thermal resistivity of soil

Development of the small, portable, direct-reading instrument mentioned in the previous annual report has been completed. It is capable of measuring the thermal resistivity of soil within less than 15 minutes and displays the reading on a meter calibrated in resistivity. The instrument weighs 3.5 kilograms and is connected to a probe which is driven into the ground to a depth of about one metre.

Lightning

To protect overhead electric power systems against lightning, expensive equipment has to be installed. If the frequency of lightning were known, the most economical measures could be taken to ensure that the power supply would not be unduly interrupted. As an estimate of lightning density, the number of thunderstorm days is inadequate. Effective lightning ground-flash counters are therefore urgently required.

In previous annual reports the three direction-finding stations installed for carrying out lightning research were mentioned. For the second year running observations were made during the lightning season. Records were obtained

on 46 thunderstorm days out of a total of 67, and covered 51 different thunderstorms.

To calculate the ground-flash density, the effective range of the lightning flash counter must be known. This is defined internationally as that range within which the number of lightning flashes actually occurring over a long period is equal to the number registered by the counter. The preliminary value of the effective range calculated for the standard CIGRE counter was 31.5 to 34.5 kilometres. This agrees with the experimental value of 33 kilometres obtained for ground flashes by observers in Australia using a similar counter. The corresponding ground-flash density locally would be approximately 9 flashes per square kilometre per annum, assuming that no intra-cloud flashes were recorded by the counters.

Extra-high voltage

The automatic surge-recording station is now in operation, recording surges on an 11 kilovolt overhead line during lightning storms.

The research project on corona and radio interference undertaken in collaboration with ESCOM and the University of Pretoria has made satisfactory progress. The work includes corona investigations and the measurement of meteorological data, research on lightning and switching surges, and basic measurements of the currents and voltages of a three-phase 400 kilovolt line using current and voltage sensing antennae for an out-of-contact measuring system. The Institute has completed the computer-controlled data-logging system, including all the computer programs.

ESCOM has provided a site near the Apollo 400 kilovolt distribution station (near Irene) and will equip this with a control room for the instrumentation for comparative current and voltage measurements. The Institute has provided a data-processing computer and other measuring equipment, including a caravan which is used when corona measurements at other locations on the system are made.

Insulation

Following an agreement with the Rand Water Board, a project was undertaken which involved measuring insulation parameters on 19 of their induction motors, to ascertain the most significant factors which might be used to predict the life of the insulation. The motors differed widely in size and age, and included 6.6 kilovolt and 11 kilovolt machines varying in horsepower from 900 up to about 3 000. Some were as originally wound and others had been rewound locally. Insulation ages were up to 11 years. A report in which the results of 9 tests on the insulation of every motor are discussed, has been submitted to the Rand Water Board.

Thin-film technology

Standard thin-film microcircuit substrates are now delivered on demand by the Institute's own manufacturing facility. Serious problems related to evaporation are no longer encountered. In addition, experimental capacitors have been made with a capacitive area of 1 square centimetre.

In view of the technological progress and the improvements in mask making which had been achieved, it was decided to attempt to make high as well as low ohmic resistors on the same substrate. Since nickel-chromium as resistive layer is useful only up to about 300 ohms per square, the literature was studied for information on a material with a resistivity of 1 to 10 kilo-ohms per square. Amongst the materials investigated, rhenium has promising properties.

The design of a monolithic integrated circuit operational amplifier was completed, and also the initial mask designs. The purpose of the project was to determine the feasibility of designing a monolithic integrated circuit by simply following instructions issued by the manufacturers, and then sending them the mask designs for further processing and manufacture of the circuits. The project also serves to evaluate the service offered by the overseas manufacturers in terms of convenience and the limitations imposed by the rules.

Semiconductor analysis

Using metal-oxide-semiconductor dynamic shift registers, a digital memory was constructed for an oscilloscope. A similar dual-channel system was also tested. Voice pitch and amplitude extractor circuits, developed in co-operation with the Acoustics Division of the National Physical Research Laboratory, were coupled to the dual-channel memory to determine its usefulness as a speech-training aid for the deaf. Two prototype devices have been nearly completed. One instrument will be presented to a school for the deaf.

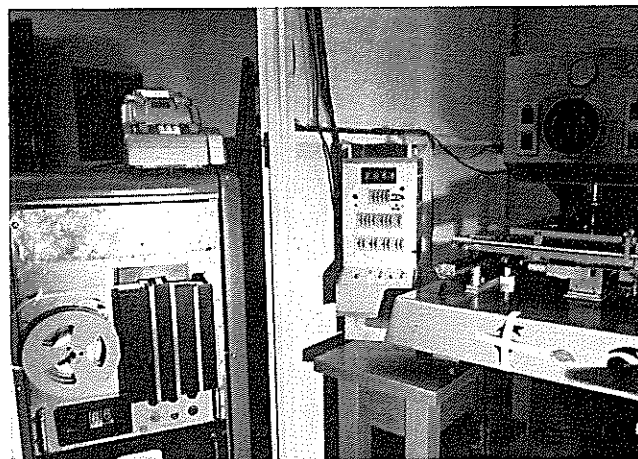
Alarm signalling system

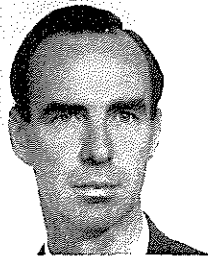
As an offshoot of a research project, an alarm signalling system was developed for the CSIR. This system will make it possible for three types of alarm to be signalled over telephone lines from any building on the site to a central alarm-monitoring panel. The system will also monitor the line for faults and indicate system failures.

Lightning damage to electronic equipment

The Department of Posts and Telegraphs has done considerable research into the protection of telecommunication channels against lightning, but the protection of electronic transistorized equipment still presents a major problem. The Institute is investigating the nature of the voltage impulses which occur in power lines and power supplies, the destructive mechanism in semiconductors and the suitability of available protective devices.

The iris photometer for measuring star sizes.





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

National Institute for Telecommunications Research

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

Ionospheric research

The Institute does research into the ionosphere and its influence on the propagation of radio waves. Monthly bulletins of ionospheric data and predictions of optimum frequencies for use in short wave radio communications are issued. The use of a digital computer in the preparation of communication forecasts has made it possible to increase the scope of these predictions and to issue long-term predictions to certain users.

Research into the various processes controlling the behaviour information which can be gained from observations of airglow, the Institute has constructed an airglow photometer of advanced design.

The Institute co-operates with numerous overseas organizations by interchanging data and taking part in joint experiments. Advice has been given to several local organizations 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 continued, and further comparative measurements of rainfall by radar and by conventional rain gauges on a small test site were carried out. Although the agreement between the two sets of measurements is generally good, this is not always the case. The radar is being re-sited and the experiment re-designed in an effort to identify and possibly eliminate some of the causes of poor correlation.

The experiment is being extended to measure rainfall over a river catchment area for a hydrological research project.

An 8mm Doppler radar, with modulation by a pseudo-noise sequence, has been developed for use in a more fundamental study of clouds and precipitation.

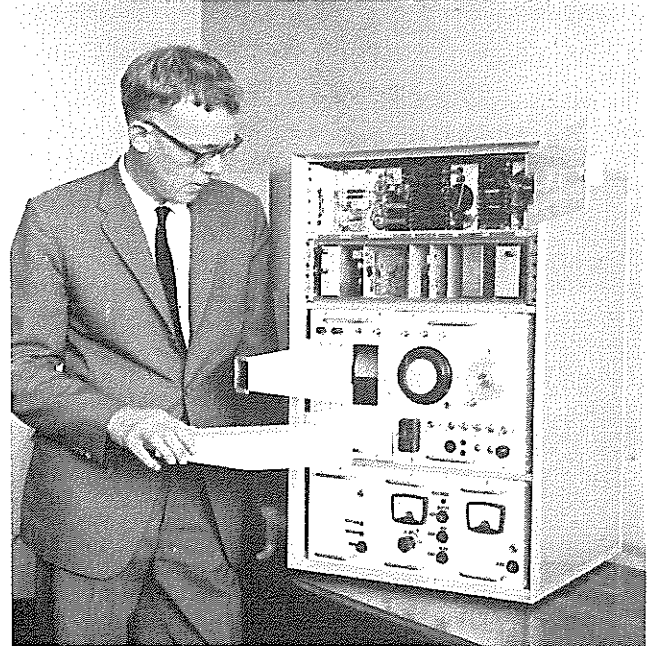
Lightning research

A VHF radio system developed by the Institute has been used to track the sources of radio noise in lightning. In this system the position of the noise sources is determined by the relative times of arrival of the noise at spaced receivers. The accuracy is about 50m in the horizontal plane, while the vertical accuracy varies from 500m near the ground to about 50m at a height of 4km.

The development of three inter-cloud strokes was studied in detail. Simultaneous observations of precipitation by radar showed that in all three cases the activity appeared to occur in regions of heavy precipitation within the clouds.

Distance measurement and position fixing

An important aspect of the Institute's work is the development of electromagnetic systems for the measurement of distance



The antenna and pedestal of the 8mm Doppler radar developed by the NITR for atmospheric studies.

An ionosonde developed by the NITR.



and determination of position. As a result of continued research and development by the Institute since the invention of the Tellurometer system of distance measurement in 1955, South Africa has maintained its lead in the production of such equipment.

An instrument to measure distance by means of a modulated infra-red beam, developed by the Institute, has been produced and marketed by a South African firm since early 1970. Cadastral and engineering surveyors have shown a great deal of interest in this instrument, which can measure distances of 10m to 2km to within 1.5mm.

The Institute operated the Omega VLF system of position fixing on board a research ship during an oceanographic investigation near Marion Island. The system proved accurate and reliable. The Institute is now investigating the operation of the system in the differential mode, in which position measurements are corrected in accordance with simultaneous measurements at a fixed position nearby.

Space research

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

The DSIF uses a 26m parabolic antenna to track and communicate with space probes to the moon, the planets and

interplanetary space. It has played an important role in most of NASA's deep space projects. Late in 1969 and early in 1970 the antenna was modified to strengthen the structure and improve the driving mechanism. The station is now being modified for the Mariner Mars project in 1971.

The STADAN station is one of a world-wide network of stations established by NASA to track and communicate with artificial earth satellites. The station, one of the busiest, is also one of the most reliable. New systems are being installed and obsolete equipment is being replaced.

The station has established a VHF radio link with the Republic Observatory in Johannesburg and receives timing signals from the satellite GEOS B, and can therefore keep time accurate to within ten microseconds.

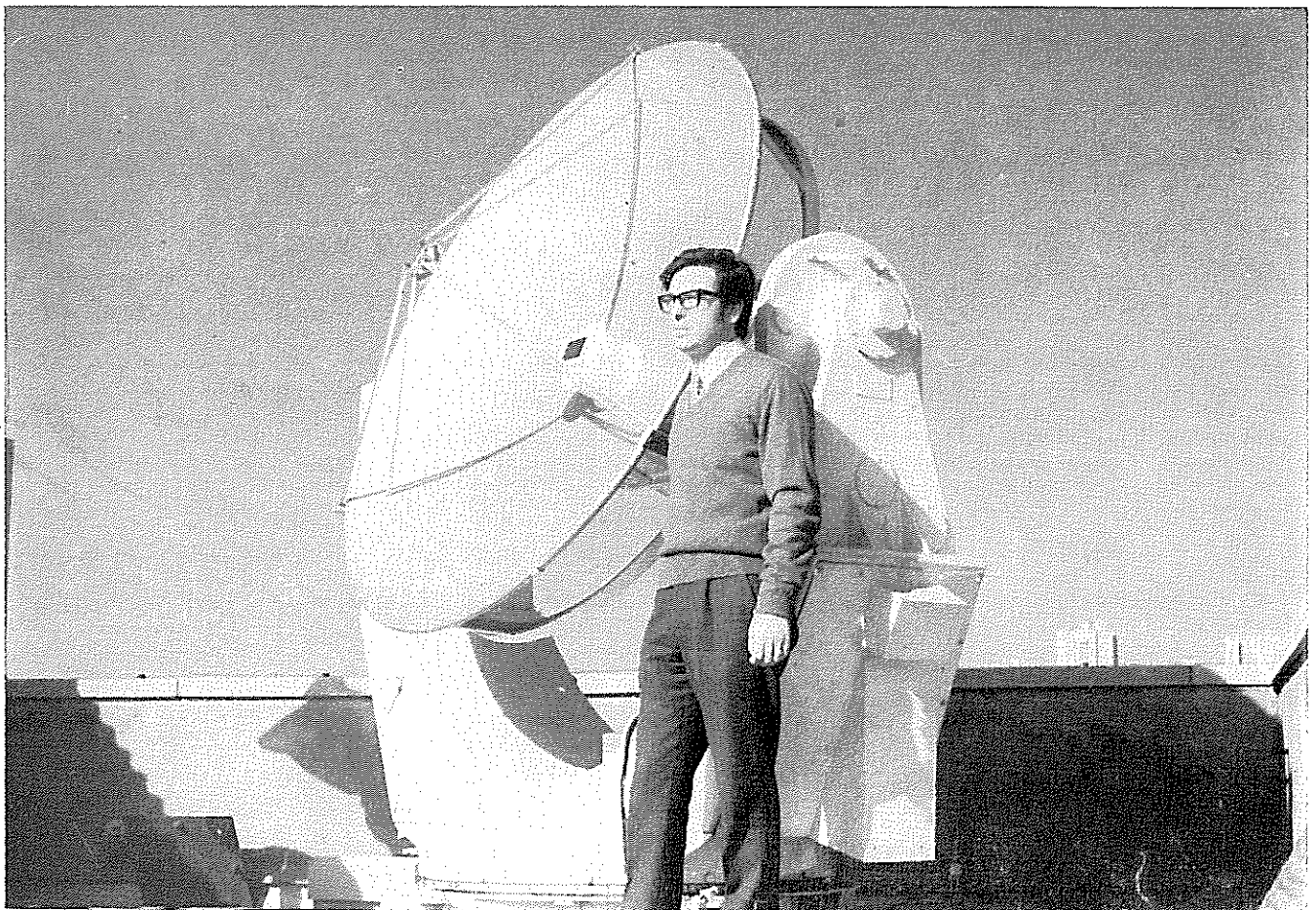
Radio astronomy

When the 26m 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 13cm was designed and constructed by the Institute. Possible methods of extending the operation of the system to shorter wavelengths are being investigated.

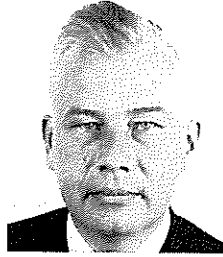
The major continuing programme is the investigation of intensity variations in extragalactic radio sources, particularly quasars. Seventy sources are being studied, thirty of which have been found to be variable.

A survey of southern radio sources has been carried out to detect uncatalogued variables for inclusion in the investigation of intensity variation.

The automatic airglow photometer constructed by the NITR.



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



National Mechanical Engineering Research Institute

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

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

The six divisions together with the Aeronautics Research Unit are situated in Pretoria, the Mine Equipment Research Unit in Johannesburg, and the Hydraulics Research Unit is on the campus of the University of Stellenbosch. The three Units are integral parts of the NMERI and are responsible to the Director of the Institute.

Materials data system for metals

A materials data system for metals is maintained by which the properties of non-ferrous as well as iron and steel materials manufactured to British specifications, and many proprietary materials not meeting these specifications, can immediately be obtained. Related American and German specifications are included in a cross-reference list. A retrieval system consisting of translucent selector cards provides a simple means of access to the stored data which are regularly updated to ensure that the latest information is available to industry.

Technological foundry problems

Activities in the field of foundry research are co-ordinated with the South African Foundry Research Foundation via a liaison officer. This ensures that attention is paid to problems of immediate interest. An investigation sponsored by the Foundation into the problem of moisture loss in green foundry sands was carried out and a report has been distributed to its members. The research is being continued.

A symposium with the theme *Designing for casting* was held in Johannesburg in collaboration with the South African Institute of Foundrymen and the South African Institution of Mechanical Engineers. The participation of overseas speakers gave this symposium an international character.

Plastic deformation

Interest in the influence of strain rates and shock pulses 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. Plastic deformation of high purity cylindrical alumi-

nium specimens was studied under impact compression loading conditions using unlubricated and lubricated specimens between flat dies. The deformation mechanism was explained in terms of work-hardening theories.

Wear testing of mill liners

Large quantities of metallic liner materials are consumed in milling the hard quartzite ores mined in South Africa. Knowledge of the wear rate of lining materials when milling different ores is important, since the ores differ widely in composition and physical and mechanical properties.

Extensive field tests on the performance of liner materials used in South African mines were carried out, but they were time-consuming and expensive. Tests to determine the wear rates of different liner materials with a laboratory device were therefore attempted and the results showed a good correlation with the results of earlier field tests.

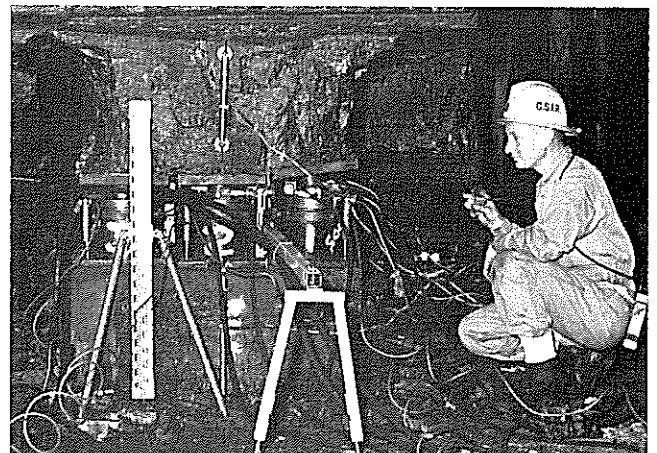
Surface quality of ferrous castings

The growing demands on the South African foundry industry, especially by car manufacturers in view of the efforts to increase local content of cars, have necessitated an increase in quantity and improvement in quality of castings. The surface quality of a casting is important and investigations into the properties (other than the expansion properties) of moulding materials and of moulding washes and their effect upon metal penetration in ferrous castings, were started.

Stress analysis and material testing

An experimental stress analysis of the roof decks of large liquid storage tanks was carried out. In addition, a wide variety of static and dynamic tests were conducted ranging from static tests on form-work panels to fatigue testing

Underground tests to determine the strength of coal pillars.



of drill rods under corrosive conditions. The most interesting current investigation is the determination of the residual fatigue life of in-service rails which are subjected to an increasingly severe loading spectrum as a result of heavier locomotives being used.

Impact properties of metals

A literature survey was started to examine the relevant aspects of impact technology and the current areas of interest in impact mechanics. While substantial advances in and sophistication of technique have been reported in several specialist fields of impact behaviour, little is known in some areas about how these can be applied in practice, e.g. the establishing of criteria for the translation of basic materials knowledge into design data or specification for structural design, and the interpretation of material behaviour in relation to test specimen geometry and method of loading.

Accumulation of fatigue damage

A project was initiated to investigate the effect of such factors as geometry, overall size and interaction between high and low stress levels on cumulative fatigue damage behaviour under various types of random loading spectra. The long-term objective is to improve the design process and to contribute to the basic knowledge of cumulative fatigue damage. A short initial programme was completed with a triangular modulation of the applied load spectrum. It is hoped that equipment will be obtained for wide-band random tests in both plane bending and axial test formats.

Rock mechanics services to industry

Industries in the Republic and abroad made use of these services which comprise a consultative service, a rock properties testing service and a rock stress measurement service. The head of the division concerned visited Italy to advise an Italian firm of consulting engineers on rock mechanics problems.

The Rock Mechanics Information Centre completed a thesaurus of rock mechanics terms for use in storage and retrieval of information. Over 1 000 articles on subjects related to rock mechanics were indexed.

A film entitled *Stressing the point in rock mechanics* was produced for general distribution. The film, 40 minutes long and in full colour, has been received very favourably in South Africa and overseas.

Stress in rock

The theory for determining the stress from measured changes in strain in either linearly or non-linearly elastic rock was published and earned comment from readers throughout the world. The project will not be continued actively since the Institute's 'doorstopper' and triaxial strain cells are adequate for measuring rock stress in most South African rocks.

Large-scale testing of rock and coal in situ

During the year ten *in situ* coal specimens were prepared for testing, two new hydraulic pump stations were built and all the equipment for the investigation was tested. The complete load-deformation characteristics of the coal specimens will be studied to provide practical data for the design of stable bord-and-pillar mine layouts. Further tests are planned for 1971.

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

Fracture mechanism of rock

An ultra high-speed camera, which can photograph at speeds of up to 1.5 million frames per second, was used to study the fracture mechanism of rock under dynamic loading conditions. This work, conducted on behalf of the Chamber of Mines of South Africa, is still in progress.

Stability of rock slopes

Finite element analysis of several problems were undertaken using computer programmes developed by the Institute.

A two-dimensional study of the stresses in open-pit mine slopes was completed. The three-dimensional stress distribution in a coal pillar was calculated.

Phormium tenax processing

The Institute was approached by the Department of Industries towards the end of 1968 to assist in developing machinery for decorticating *Phormium tenax*. As only conventional jute spinning machinery was available the coarse *Phormium tenax* fibre had to be made finer. Suitable machinery was devised for this.

A new bag mill is to begin operating in the Transkei soon and has been designed specifically to handle *Phormium tenax* fibre in its natural state. It is planned, ultimately, to be able to absorb approximately one half of the total planned production of this fibre in the Republic. The rest of the fibre produced in the Republic will be used in an existing bag mill by mixing it with jute. When the local fibre production increases, more than 30 per cent by weight will have to be used and a finer, softer fibre will be required. At present this mill is experimenting with ways of refining coarse fibre. Further investigations by the Institute may be necessary.

Further work is required on the efficient utilization of decorticators and the Institute has purchased its own decorticating unit for experimental and demonstration purposes. Most of the decorticators built in South Africa in the next few years will probably be of one type only. An order was placed for the first production model of this machine. The first experimental machine has already been tested and during the year the Institute, in close co-operation with the manufacturers, tested development models and worked on increasing output and reliability.

Conveyance of granular material

A project on the transportation of limestone slurry was successfully completed for a cement manufacturer. The results showed that it was technically feasible to pump limestone slurry at a rate of 110 tons per hour over a distance of approximately 160km. The design of the pipeline is being undertaken overseas.

Tests on a novel dredging unit showed that the unit was less efficient than the conventional jet pump. The merits of the new device however outweigh those of the conventional jet pump especially where large solids have to be dredged since there is no flow restriction, either in the suction or in the dredger unit itself.

Air-conditioning and refrigeration

Requests from architects and consulting engineers for technical assistance in the planning of air-conditioning and refrigeration facilities increased. The design and commissioning of an air-conditioning system for an operating theatre was undertaken during the year.

Basic investigations into the chilling of meat provided design data which will enable consultants to design certain components of abattoir refrigeration systems on a sound economic basis. Work is also being done on the low temperature friction coefficients and system pressure drops associated with abattoir refrigeration plants.

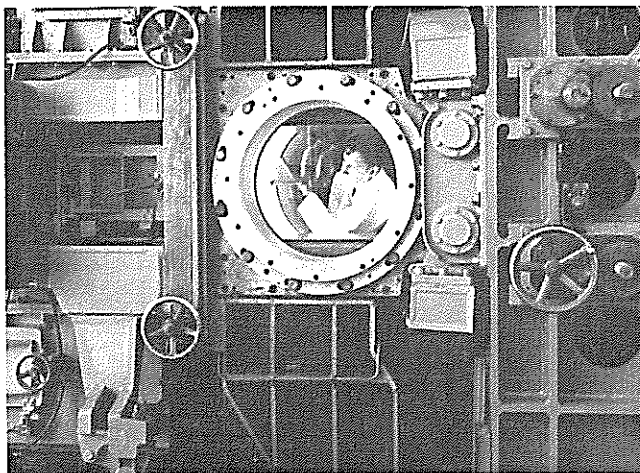
In the field of air-conditioning, a milk delivery vehicle and refrigeration plants at various city council abattoirs were tested. Practical assistance was given during the capacity testing of a liquid nitrogen freezing tunnel.

Advice or assistance was also given on the basic design of comfort air-conditioning systems and temperature and humidity control equipment in a variety of applications.

Heat exchangers

At the request of industry, performance tests were carried out on heat exchangers, evaporative condensers and cooling towers.

Theoretical work on the basic design of heat-exchanger elements for dry cooling towers in power-stations was carried



The working section of the trisonic wind tunnel.

out. Laboratory tests are in progress on the heat transfer rates and pressure drops across small scale models of heat exchangers of various geometrical shapes.

Measurement of heat loss from human body

The development of instruments for the direct measurement of convective, radiative and evaporative heat losses from a human body, as well as the design of modifications to the climatic chamber of the Human Sciences Laboratory of the Chamber of Mines of South Africa, were successfully concluded. Collaboration with the Human Sciences Laboratory will continue.

Testing of steel wire ropes and components

The Mine Equipment Research Unit fulfilled its main commitments, namely the statutory testing of wire ropes and the non-statutory testing of components, chiefly for the heavier industries. Several other tests, mainly of a routine nature, were carried out for private organizations. Extensive use has also been made of this facility by mines in Rhodesia, Zambia and other Southern African states. From October 1969 to September 1970, a total of 5 087 ropes were tested.

The new 1 000 metric ton tensile testing machine which will be installed towards the end of 1971 will increase the capacity of the existing rope test facility.

Service behaviour of winding ropes

The objective of this project is to evaluate the factors influencing the behaviour of ropes in service, in order to improve the design of ropes and hoisting installations. Rope loading and construction, depth of wind and winding speed, etc. are being examined. Design data relating to thirty selected modern high-speed winding units are being analysed. This project, which was originally intended to cover drum winders, will be extended to include Koepe winders.

Improvement of rope testing methods

A survey of methods used for the non-destructive testing of winder ropes in South Africa was completed and a report was submitted to the mining industry. This was followed by a manual on the interpretation of test records obtained from winder ropes while using electromagnetic instruments. A comparison of the various electromagnetic instruments currently used in South Africa was also completed.

Although no further work will be done on this project in the foreseeable future a committee, which includes representatives of the mining industry, will remain active to ensure that developments in this field are not overlooked.

Floating drilling platform

Wave tests on a floating drilling platform were carried out for

a firm of consulting engineers. A model of a platform was designed and built and a theoretical evaluation of a pontoon-type platform carried out. This research is related to the search for oil at present being conducted around the coasts of the Republic.

Ocean wave research

The analysis of data collected from shore stations and ships are being streamlined and computer programmes are being written and tested. At present the only coastal area without a wave observation post is the South-West Cape area because of the scarcity of suitable sites for installing instruments. A nearshore hydrographic survey at Möwe Point, South-West Africa, was completed to determine the nearshore contours and to provide information for wave refraction analysis. Work aimed at improving wave prediction techniques entailed a number of synoptic wave and weather observations from ships, in which the research vessels *F. H. Hughes*, *RSA, Africana II* and *Thomas B. Davie* participated.

Coastal design problems

Numerous enquiries were received including one about the improvement of the beaches at East London and the Wilderness, the development of a yacht harbour at Plettenberg Bay and the possibility of deflecting the Mozambique current up the west coast.

Work started on an investigation aimed at improving the beaches at Swakopmund so that the town can be developed as a major holiday resort for South-West Africa. The first stage is the collection of all field data required for a movable-bed model study.

The movement of sand in the vicinity of a sea pipeline was investigated in connection with a single buoy mooring installation off Durban.

Harbour developments at Richards Bay

Research done at Richards Bay under contract to the South African Railways requires that a layout of the new harbour be produced by mid 1971. The field team at Richards Bay has been collecting data on waves, winds and currents during the past year. A movable-bed hydraulic model of Richards Bay was constructed. In the first series of calibration tests sand was used as the movable-bed material, but some of the critical tests will be repeated using anthracite to check the reliability and accuracy of the results. A fixed-bed model using an undistorted scale of 1 in 100 was also constructed. This model, covering an area of 36m by 60m, will be used to study wave conditions behind the breakwaters and to test the navigability of the harbour entrance.

Sand dam research

The project was initiated to determine a design code for the construction of sand storage dams. The first phase of tests on a mobile-bed hydraulic scale model of the Ondekaremba sand storage dam in South-West Africa was completed. In these tests, the influence of the form of the dam wall upon the flow velocity in the dam basin and therefore upon the settlement of fine material, which is detrimental to the efficiency of the sand storage dam, was noted. A mathematical model which describes unsteady non-uniform flow is being assembled to ascertain the most desirable height increases for a dam wall at each stage. The second phase of tests on the hydraulic scale model concerns the extent to which groynes can be utilized to influence the smaller flows which may occur in the larger water conservation schemes of the future.

Marina development in Knysna lagoon

An investigation was commissioned to ascertain any possible disadvantages in developing a marina in the Knysna lagoon. A fixed-bed hydraulic scale model will be used in the investigation and also in finalizing the alignment of the canals of the marina. To determine the model contours, an aerial survey of the lagoon and surrounding area has been completed and a hydrographic survey of the lagoon bed will be conducted

shortly. Data on the water levels at strategic positions in the lagoon will be obtained from recorders.

Flight dynamics

Because of control vibration problems with the two-bladed rotor system of an experimental autogyro being developed by the Institute's Aeronautics Research Unit, it was replaced by a three-bladed rotor system. But since this system proved susceptible to severe and dangerous 'ground resonance', it was decided to study the vibration problem in the two-bladed teetering rotor system, which is safe as far as 'ground resonance' is concerned and which, because of its simplicity, should be the ideal system.

To investigate the problem of fluctuating forces acting on two-bladed teetering rotor systems, a mobile test rig was developed which consists of a piloted, flying test bed mounted on a truck and equipped with a variable geometry rotor head which can be controlled and adjusted. It has instruments to record fluctuating control forces. The rig is suitable for testing 6.5m to 7m diameter model rotor systems. Results so far obtained indicate that control vibrations can be reduced.

High-speed wind tunnel instrumentation

A new technique, using a numerically controlled milling machine, has been developed for the manufacture of high-accuracy contoured bodies of revolution. This technique eliminates the need for exacting manual labour. Further development is necessary for the manufacture of more complex winged models.

A locally manufactured digital computer, slaved to the main wind tunnel computer, will relieve the latter of a large amount of arithmetic work as well as of some control functions. Faster analysis of data and real-time control of wind tunnel parameters simultaneously with data acquisition will now be possible.

Aircraft design and construction

A design study was made of a rotorcraft configuration with two teetering rotor systems arranged in tandem. Another design study was carried out on an ultra-light aircraft, the development of which could provide a vehicle for research into special light-weight aircraft structures and high-lift producing devices on wings.

Aircraft noise

The International Civil Aviation Organization (ICAO) requested certain of its member states, including South Africa, to submit details of their national methods of assessing aircraft noise disturbance in the planning of land use. South Africa was also invited to participate in an international exercise on the calculation of noise exposure contours around a specified hypothetical airport.

The method developed earlier by the Aeronautics Research Unit was drafted in a modified form, and also used to calculate the required exposure contours. The presentation was submitted to the Department of Transport to forward to the ICAO.

Further modification of the method included a complete revision of the computer programme used for the calculations. The new programme was devised in collaboration with the National Research Institute for Mathematical Sciences, and was subsequently used in the prediction of exposure contours for eleven South African airports. The latter task, undertaken on behalf of the Department of Planning, was carried out in collaboration with the South African Bureau of Standards.

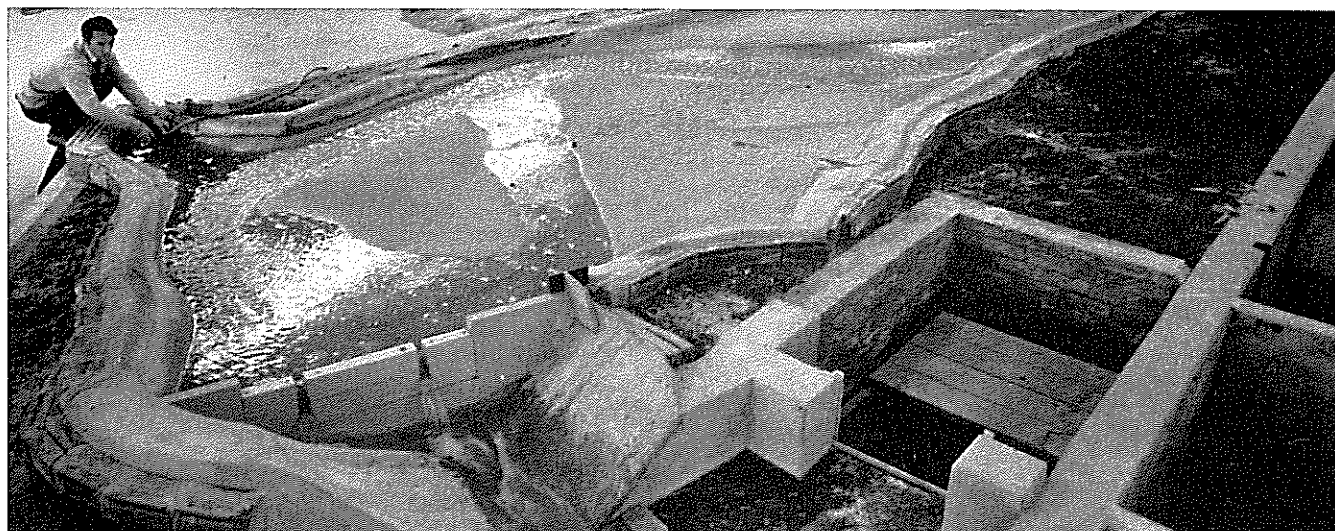
A working group of the International Organization for Standardization (ISO) met to discuss the revision, originally proposed by South Africa, of ISO methods for aircraft noise assessment. A staff member of the Institute's Aeronautics Research Unit participated in this meeting.

Gust loading effects on aircraft fatigue

As a preliminary stage in a major research project aimed at the eventual prediction of the safe life of aircraft operating under South African conditions, a comprehensive literature survey and project planning programme was started. Preliminary results suggested that the project should include various phases.

Attention was also given to the development of special recording equipment. With this equipment information on the nature of gusts and the parameters related to gust occurrence or gust strength will be continuously recorded and written on digital tape which is computer-compatible, so that analysis of the data may be greatly facilitated.

The mobile-bed hydraulic scale model of the Ondekaremba sand storage dam.



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



National Institute for Water Research

As water research covers such an extensive field the National Institute for Water Research (NIWR) is one of the CSIR's most diversified institutes. Research is conducted on a wide front and in various disciplines such as chemistry, botany, zoology, microbiology, civil engineering, chemical engineering and geology. The projects undertaken by the Institute are generally directed towards individual problems rather than specific scientific disciplines and are often dealt with on a team basis. Apart from the main laboratory in Pretoria, the NIWR also maintains regional laboratories at Windhoek, Bellville, Durban and Bloemfontein, as well as a Limnological Research Group at Rhodes University. The regional laboratories concern themselves mainly with problems peculiar to the areas in which they are situated.

Water reclamation

It is estimated that by the turn of the century the demand for water in the Republic will approach the limits of the available supplies. Reclamation of sewage effluent for domestic and industrial use could play a key role in the conservation and optimal use of urban water supplies. As much as 70 per cent of urban water used ends up as sewage. As this is an important source of water which could be exploited the Institute is conducting intensive research on all significant aspects of water reclamation.

Recently the Minister of Water Affairs, Mr. S. P. Botha, opened the Stander Water Reclamation Plant at the Pretoria sewage works. It is a large-scale experimental plant based on a pilot plant which the Institute operated for about four years. The plant has a capacity of about 4 500m³ per day and will serve as a prototype in the planning of large-scale reclamation schemes in the Republic. It will also serve as a display window for promoting the idea of water reclamation with the public. The research conducted at this plant is aimed mainly at improving the economics of water reclamation. The possibility of reclaiming various types of raw water will also be determined. It has for instance been established that the reclamation process could be successfully applied to raw sewage without any preliminary purification. The influence of shock loads of certain toxic effluents on the quality of reclaimed water will also be investigated.

Water reclamation model at Rand Easter Show

A working model demonstrating the purification of sewage effluent to a point where it complies with drinking water standards was exhibited at the Rand Easter Show this year. This model formed part of the Republic's water exhibit in celebration of the Water Year.

In addition to technical problems which have to be solved before water can be reclaimed on a large-scale for domestic purposes there is also the problem of public prejudice. The Rand Easter Show which is attended by such a large number of visitors was seen as an excellent opportunity for introducing the concept of water reclamation to the public in an area where reclamation is most likely to be practised on a large scale in the future. The public response was most favourable in that the majority of visitors, after they had the opportunity

of seeing the process in operation, indicated that they supported the idea of reclaiming water from purified sewage effluent for domestic and industrial use.

River research

In 1967 a series of three comprehensive reports on the quality of water in Natal rivers was published by the Institute in collaboration with the Natal Town and Regional Planning Commission. River research is now being continued in Natal.

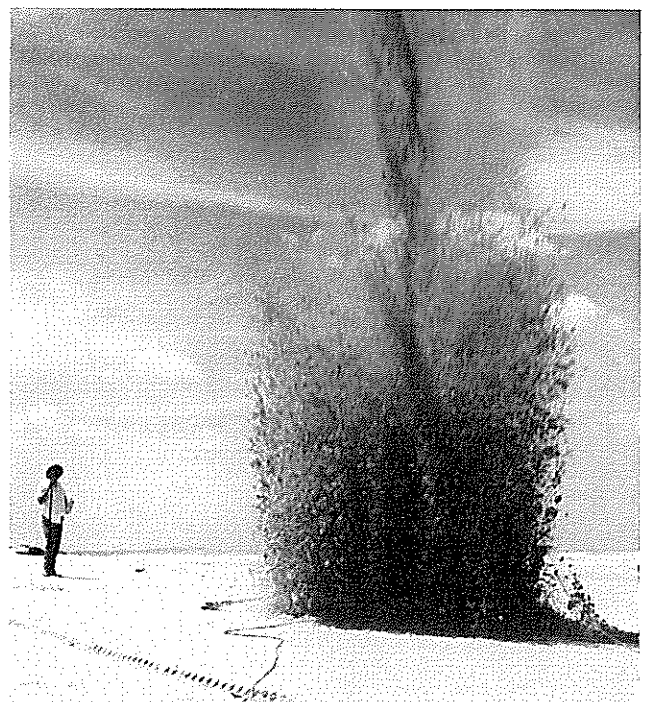
A comprehensive report has been published on a general survey of rivers in Northern Natal and Zululand. In collaboration with the sugar industry, a special study has also been made of the Nonoti, a small river which had been polluted by a sugar mill. It was established that the river quickly recovered by means of self-purification. By combining the chemical, bacteriological and biological disciplines in the study a modified and more realistic classification of rivers according to water quality was evolved.

In collaboration with the South African Sugar Association a code of practice based on the afore-mentioned investigation was compiled for sugar mills, indicating the most likely causes of sugar loss and attendant pollution as well as preventive measures.

Use of algae for removing nitrogen from purified sewage

Sewage effluent contains large quantities of nitrogenous organic compounds which are converted into ammonia,

Shock waves generated by explosives are used to gauge the depth of sand beds in the Cape Flats.



nitrites and nitrates during the conventional sewage purification process. Not only are high concentrations of these compounds toxic to human beings and animals, but algae and other organisms grow at an abnormal rate in such water, causing secondary pollution. It is therefore important that nitrogen compounds should be removed from purified sewage before it is discharged into rivers or reclaimed.

Research is being undertaken on the use of algae for the removal of nitrogen compounds from water. A pilot plant has been constructed for this purpose and so far results have been promising.

Toxicity of dieldrin to fish

In collaboration with the Department of Agricultural Technical Services research is being conducted on the toxicity of dieldrin to fish. This information would be required if dieldrin were to be used on a large scale for pest control.

Comparable groups of fish were exposed to various concentrations of dieldrin in order to determine the maximum concentration which can be tolerated by fish. At the same time the influence of environmental factors, such as temperature and the concentration of salts and dissolved gases in the water, on the resistance of fish were investigated. The assimilation of the insecticide by the fish and its distribution throughout the body were also studied.

Various species of fish were used and the toxicity limits varied from 0.01 to 0.316mg/l. Fish were more resistant to dieldrin in water at a normal temperature and their resistance weakened as the temperature rose or fell. Fish exposed to dieldrin were also less resistant to cold than usual.

Storing reclaimed sewage water in sandbeds

Because of the rapid socio-economic development in the Western Cape existing water resources are being overstrained and severe water restrictions have been necessary. Particular interest is therefore being shown in the optimum use of water, the re-use of purified effluents and methods of water conservation. A survey of sewage flow in the Cape Peninsula indicated that 60 per cent of the approximately 2 600 000m³ of water used daily is potentially available for re-use.

The Institute is currently investigating the possibility of using the natural sandbeds of the Cape Flats for reclaiming and storing purified sewage effluent. The investigation is sponsored by the Cape Provincial Administration and is guided by a steering committee representing various government departments and other organizations concerned with the matter.

A pilot plant for the anaerobic digestion of raw sewage.



Services to provincial administrations, government departments and local authorities

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

Irrigation with mineralized industrial effluents

Certain industries have to dispose of enormous quantities of effluent daily. Some types of effluent however, cannot be discharged into public streams because of mineral pollution and another solution has to be found. Some tanneries and textile factories irrigate pasture-lands with these effluents without harming the plants.

The NIWR is experimenting on this subject. Various grasses, mixed grazing and lucerne are being irrigated on test sites with highly mineralized water (more or less similar in composition to the effluents from tanneries, textile factories and paper mills) at a rate of 1 250mm (50 inches) per year. The water contains among other things, large quantities of sodium which is detrimental to soil-structure and plant-growth.

So far, after an experimental period of four years, crops are flourishing and in each successive year there is a considerable increase in crop yield. The success of the experiments may be partly ascribed to the use of soil ameliorants such as gypsum and ferrous sulphate which sustain the drainage capacity of the soil and thus counteract waterlogging.

The interaction of soil, plants and water is studied in lysimeters. Seepage water is collected, measured and analysed. The moisture lost through evaporation and transpiration is also accurately measured. The contents of the lysimeters are analysed in order to determine what percentage of the salts added have been used by the plants.

These experiments are carried out to determine whether large-scale irrigation with industrial effluents would be feasible. The results are favourable and in this way a liability could be turned into an asset.

Pathogenic bacteria, viruses and parasites in water

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

Treatment of water for low and medium pressure boilers

No natural water is absolutely pure, particularly our underground water which often contains high concentrations of dissolved salts which make it unsuitable for use even in low pressure boilers. Even in surface water some undesirable constituents (e.g. those causing hardness) may remain after conventional purification and the water should be treated further before it is used in boilers.

The Institute has compiled a guide to provide the operators of low and medium pressure boilers with information on the basic principles applicable in the selection of a method of water treatment in specific cases.

Marine pollution and the disposal of effluents into the sea

After a comprehensive report on the marine disposal of effluents off the Natal Coast was published in 1969 in collaboration with other CSIR Institutes, the NIWR continued its research on the subject, under contract to the Natal Provincial Administration.

The aims of the research are to establish more specific parameters in connection with the pollution of beaches and shallow water along the coast, to measure sea currents in the vicinity of Richards Bay with a view to the possible disposal of effluents, and to study the factors influencing the dispersal of effluents near the coast.

Anaerobic digestion of raw sewage

The two basic methods for the biological treatment of organically polluted water depend on the degree of pollution. If the pollution is severe anaerobic treatment is applied, otherwise aerobic treatment is used.

In the conventional biological purification of raw sewage, solids are concentrated for ultimate anaerobic treatment, while aerobic treatment is applied to the residue. However, in experiments conducted in collaboration with the Durban Municipality it was found that anaerobic treatment of the entire raw sewage flow holds great promise. This work was continued in Pretoria and after extensive laboratory experiments a small pilot plant was erected at the Daspoort sewage works. The results obtained at Durban were more or less confirmed.

Because of the nature of raw sewage and the increase in

the rate of treatment, the flow pattern of the conventional anaerobic units had to be modified. A pilot plant with a capacity of 5m³/h is now being planned in order to determine whether this new approach of anaerobic digestion of raw sewage is feasible in practice.

Fish production

Experimental research, performed at the Lowveld Fisheries Research Station of the Transvaal Provincial Administration, has produced information which will enable the culture of freshwater fish in farm dams in South Africa to be based on fundamental scientific principles. New methods have established the consumption and the nutritional value of the food assimilated by the fish, the growth potential of artificial foods and the effect of environmental conditions upon feeding habits, reproduction and growth. The data obtained may be used to increase fish production in fresh waters.

It is hoped that the commercial possibilities of freshwater fish culture in South Africa will be realized in the near future. The experimental fish used in this study was the 'kurper' *Tilapia mossambica* which is an excellent table fish. Freshwater fish could also be used as a basic supplementary protein in feeding the growing population of South Africa.

The Stander Water Reclamation Plant, Pretoria.



Mr J. P. de Wit, Director
of the National Food
Research Institute.



National Food Research Institute

The activities of the National Nutrition Research Institute developed in widely diverse fields from its inception in 1954 to November 1969, when its medically-orientated functions were handed over to the South African Medical Research Council. The Institute was then re-named *National Food Research Institute (NFRI)*. Its main objectives are the study of foods, their handling, processing and utilization and their role in the diets of South Africans and to improve and augment the nation's food supply by technological development and application. A further objective is to assist South African manufacturers by providing research and process development facilities.

The CSIR Microbiology Research Group is housed in the same building and is administered by the Institute. This arrangement is very convenient because of the growing importance of micro-organisms in biological food-processing and the deleterious effects of microbiological contamination of foods.

Composition of South African foods

Research on the edible wild fruits and plants of Southern Africa continued.

The unidentified fatty acids in the oil of the mangetti nut were identified as α and β forms of eleostearic acid which are isomeric with linolenic acid. Eleostearic acid imparts the property of a drying oil to the mangetti oil.

The active compound in the root of the witgatboom (some Bantu tribes use the root to extend the 'fresh' life of milk and butter) has been identified as methyl-iso-thiocyanate. The bacteriostatic and fungistatic properties of this compound are known, but the substance has apparently not yet been used as a preservative in the food industry. Little is known about its toxicity.

The fatty acid composition of samples of butter from different regions in the Republic, produced during winter, summer and autumn was determined, but little difference in the composition was found. The average oleic and linoleic acid contents were respectively 22, 24 and 26 per cent, and 1.5, 2.4 and 1.5 per cent. The ratio of unsaturated to saturated fatty acids in these samples was almost constant at 1:2.

Flavour chemistry

Groundnuts are usually cured by leaving the plants stacked in heaps on the ground after they have been removed from the soil. The quality of the nuts thus cured is very dependent on climatic conditions during the curing period, and inclement weather can result in poor quality and mould contamination.

The investigation to determine optimal conditions for the artificial curing of South African grown *Natal Common* groundnuts, which was conducted for three seasons in widely different growing and natural-curing conditions, was completed.

It was shown that controlled artificial drying could produce high-quality groundnuts. Slow drying at 35°C to 40°C yielded nuts of excellent quality. The most satisfactory and economical large-scale curing procedure would probably be to reduce the moisture content of 15 per cent in a moderate flow of air at 35°C to 38°C and then to complete the drying process by reducing the moisture content to less than 8 per cent, either in

the dryer using air at ambient temperature or by exposure to the atmosphere in a thin layer.

Changes in composition that may take place during curing and roasting were also investigated. Only minor changes were noted and neither the oil content, the fatty acid composition of the oil nor the amino-acid patterns could be considered suitable parameters for assessing groundnut quality or the progress of curing.

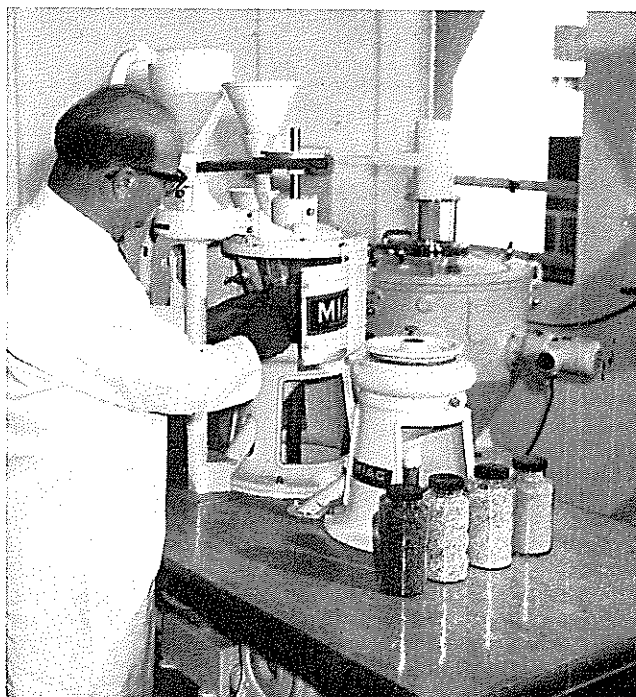
To test whether the interaction of the amino acids and sugars present during roasting affects the flavour of roasted groundnuts, small quantities of various substances such as arabinose, inositol, asparaginic acid, cysteine and threonine were added to raw nuts which were then roasted. These additions improved the acceptability of the nuts.

Volatile constituents of uncured, naturally-cured and artificially-cured groundnuts, both before and after roasting were removed under high vacuum and separated by gas chromatography. The cultural conditions and areas and the variety of groundnut influenced the patterns. The mass spectrograph was also used to identify the components isolated by gas chromatography. So far 26 compounds were identified. Investigation of the nitrogen-containing compounds present, such as amines, is continuing.

Mealies

Investigation of the enzymatic degradation of the starch in mealie grits continued. The use of a continuous cooker

Experimental preparation of kaffircorn grits by means of a conical rice mill and (in the background) a special type of impact mill.



operating under high pressure simplified the process by obviating the necessity to modify the protein present by means of enzymes.

Artificial drying of mealies is becoming increasingly important as mechanization of the mealie industry increases, but because it has had undesirable effects the process is being investigated.

Information obtained by the National Institute for Nutritional Diseases of the South African Medical Research Council has indicated the desirability of enriching mealie meal with nicotinic acid and riboflavin as a prophylactic against pellagra. In a joint project with this Institute the techniques involved were investigated and satisfactory procedures were recommended.

Processing of soybeans

Soybeans are a very valuable source of high-quality proteins. However, the raw beans are nutritionally poor owing to the presence of undesirable substances such as enzyme inhibitors and saponins which can be removed, destroyed or rendered harmless by processing. Considerable attention is therefore being paid to finding the best method of processing this legume.

In the past the processing procedures applied in the NFR I laboratories involved soaking and autoclaving, but although the product was good, losses were high and the process was not suited to large-scale production. As a result the application of more modern equipment such as the 'Ultra-Rotor' and various types of cooker-extruder are now being studied in order to obtain an acceptable and nutritive product.

Preparation of kaffircorn grits

The use of unmalted kaffircorn grits in the brewing of Bantu beer has decreased considerably in recent years due to financial considerations and brewing difficulties. The Institute has therefore investigated procedures and apparatus to prepare grits that will meet all the objections to its use.

The main disadvantages of kaffircorn for this purpose are its high fat and wax contents and the toughness of the bran. These substances are concentrated mainly in the outer layers of the grain and the germ, which also however contain much of the valuable vitamins.

The investigation, financed by the Maize Board, was aimed at finding means of obtaining the highest possible proportion of suitable grits with low fibre, fat and wax contents, with the minimum nutrient loss. Three different processes have been developed and the beers produced using the products have been assessed as 'good' to 'very good'.

Two advantages of kaffircorn grits are a lower sedimentation rate and better foam control than when the usual mealie grits are used.

Rat breeds for protein evaluation

The nutritive values of proteins are conventionally determined by experimenting with rats. The success of the protein assayist in discriminating between the nutritive values of food proteins depends largely upon the homogeneity in the response of the rat strain employed. The greater the variability in the response of the rats in a test group, the less confident he can be of the results.

To find out whether different rat breeds do in fact differ in the variability of their response, and which rat breed would be most suitable for use in protein evaluation trials, a series of comparative studies was carried out with a Wistar-derived random-bred strain, two inbred strains (BD V and BD IX) and the first (F_1) and second (F_2) generations of a cross of the two inbred strains.

The results revealed significant differences between the rat breeds and suggested that, of the rats included in the study, those of the BD IX strain and of the F_2 generation of the two inbred strains are probably the least variable in their response to protein feeding.

Tissue calcification

Biological evaluation of foods includes investigations into their safety. An important aspect is the fact that some foods tend to cause calcification of certain organs such as the kidneys. To test the foods a suitable experimental animal is necessary. The ideal animal is that which, in respect of susceptibility to tissue calcification, corresponds most closely to man.

The Institute has for some time been looking for a suitable experimental animal. The first phase of this work was an examination of the potential of the laboratory rat. Earlier work on the dietary conditions conducive to tissue calcification in the rat has now been extended to include data on several rat strains. These studies revealed sex and strain differences in both the susceptibility to tissue calcification and the amounts of magnesium that need to be consumed daily for prevention of tissue calcification.

Utilization of iron at high intake levels

Certain foods have an exceptionally high iron content, causing tissue-iron overload. The main iron storage compounds, hemosiderin and ferritin, are stored in the liver and other organs.

An investigation into the quantitative distribution of these compounds among the various cell types of iron-overloaded rat livers showed that the hepatocytes contained almost all the ferritin, while the Kupffer cells contained almost all the non-ferritin, non-heme iron.

MICROBIOLOGY RESEARCH GROUP

A major project of the Microbiology Research Group for the past nine years has been the study of yeasts in order to supply data for the compilation of the second, completely revised, edition of *The Yeasts* under the editorship of J. Lodder. This monograph, which was published recently covers the taxonomy of 39 genera and 350 species. The material was contributed by 13 taxonomists in various countries. Approximately one-quarter of the data resulted from the Group's investigations. The treatise will be of very specific interest to manufacturers of fermentation products and to all who are directly interested in yeast taxonomy.

It is becoming ever more apparent that, where possible, insect pests should be controlled by biological methods such as the introduction of suitable parasites or predators, by using sex attractants or by male sterilization, rather than by the application of chemical insecticides. The use of the latter frequently results in the development of resistant strains and the problem of undesirable residues in crops.

Some insects depend on symbiotic associations with micro-organisms (particularly yeasts and fungi) for survival and interference with or disruption of the symbiotic relationship could be a means of biological control. Because of its active interests and experience in yeast and fungal taxonomy, the Group has initiated investigation of the yeast and fungal symbionts of Coleoptera found in South Africa and in particular of those associated with indigenous trees and timber.

Considerable progress has been made with the survey of the symbionts associated with the ambrosia beetles on timber and the indigenous trees in our forests.



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

Air Pollution Research Group

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 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.

Pollutants from factory stacks

A study of mathematical representations of the ways in which pollutants are dispersed from factory stacks has been completed. The results which are being processed should provide valuable information on the principles underlying the dissipation of pollutants. This information should make it possible to determine the correct heights of stacks for adequate dispersion of pollutants.

Radio sonde for measuring temperature

A new light-weight radio sonde has been developed and constructed to measure the micro-climate of cities more efficiently and accurately.

Air-sampling network

The national air-sampling network has been expanded to include two additional towns. Monitoring of smoke and sulphur dioxide is now being done in seven major cities and towns in South Africa.

Smoke from diesel vehicles

A recent survey in Johannesburg demonstrated once again

that diesel vehicles in South Africa emit more smoke than vehicles in Europe. This emphasizes the fact that control of diesel exhaust smoke is urgently needed.

Identification and measurement of trace elements

Two new studies have commenced. One is the identification and measurement of trace elements in urban and industrial environments; the other is the identification of gaseous organic pollutants so that it will be possible to detect the presence of undesirable but thusfar unidentified pollutants. Some twenty trace elements, including lead, magnesium, vanadium, barium, chromium and cobalt have been identified in the atmosphere of Pretoria.

Mobile laboratory

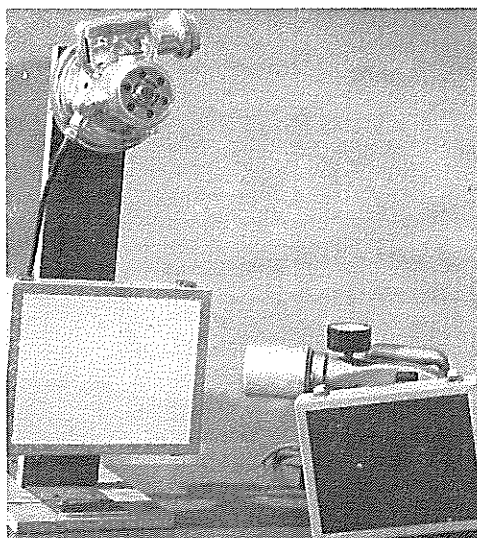
The mobile laboratory used for the survey of traffic pollutants has now been equipped for the measurement of nitrogen oxides. The monitoring of exhaust gas pollutants will be recommenced during next year.

Atmospheric Pollution Prevention Act

Several studies have been undertaken at the request of the Department of Health as a result of the implementation of the Atmospheric Pollution Prevention Act:

- a smoke survey made in Pretoria revealed some of the primary smoke sources
- fumigation experiments on sugar cane with hydrofluoric acid gas have produced new information on the reaction of the cane plant to fluoride
- micro-meteorological surveys were carried out at various sites proposed for industrial development.
- engineering studies have been made by the Chemical Engineering Group.

High volume samplers.



Fumigation chamber for sugar cane.



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



National Institute for Personnel Research

The optimum utilization of labour resources is of the utmost importance in South Africa with its acute manpower shortage, especially in respect of skilled labour. 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 includes:

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

Organization and staffing

There appears to be a growing need for a more formal organizational association of divisions within the Institute. Although the specialist expertise of these divisions may differ they very frequently have a common interest in research projects and specific research themes. A 'group' or 'programme' structure would ensure an integrated approach to the various aspects of a research problem as well as greater continuity in projects which suffer as a result of staff losses.

During the year several members of the research staff joined university staffs or accepted attractive offers from commerce and industry. Fortunately the situation could be eased by the part-time employment of suitably qualified and experienced married women.

Training

The Institute delivered over a hundred lectures and seminar contributions in the Republic and neighbouring territories during the year under review.

To improve the effectiveness of training and to reduce the amount of time spent by research staff on it, training manuals on certain specialist skills have been compiled, e.g. a manual for the analysis and classification of Bantu jobs in industry. Because of the heavy demand from industry for assistance in job evaluation, research has been done in order to shorten and simplify the present NIPR job evaluation procedure. A manual on the application of this simplified procedure is being prepared. Manuals in such fields as test administration and selection will also be produced.

As not all aspects of good supervision are dealt with adequately in existing training courses for front-line supervisors a study was started in order to develop a manual for the training of such supervisors by the programmed instruction

method. Three programmes covering personnel management functions of the supervisor, job instruction and human relations, were developed and applied to an experimental group at a telecommunications factory. General conclusions drawn from this study were that the training manual succeeded in imparting knowledge of supervisory principles; positive changes in supervisory behaviour were observed after final training; only a short training period (8 to 10 hours for all three programmes) was required and the programmes could be applied to individuals or to groups of different sizes; the success of such a project depends to a large extent on the active support of the management and unless the management identifies itself positively with training aims the training will have limited success and may even frustrate the worker.

Follow-up studies will be made in other industries, in order to demonstrate more concretely the positive effects of supervisory training on productivity.

Production and distribution of psychological tests

Since its inception, one of the main tasks of the NIPR has been the construction and standardization of psychological tests specifically for use in South Africa. NIPR test materials (and lately those of the Psychological Corporation of New York) are made available to South African test-users, who are also advised on their use. There was an increase of 20 per cent in the sale of test materials for the year, without any promotive activity by the Institute.

Despite this, an investigation carried out in collaboration with the South African Institute for Personnel Management revealed a serious need in this respect, and the NIPR is taking steps to improve the position.

Technical developments

A special-purpose computer for the analysis of neuropsychological data was commissioned during the year. The equipment can operate autonomously or with input to a general-purpose computer.

This development has placed the Institute in the forefront of neuropsychological facilities in the Republic and has established a far more precise, rapid and economic method of dealing with neuropsychological data than was possible before. It has opened up virtually unlimited research possibilities in the study of the psychological significance of electrophysiological data.

New research

Every effort is made to direct new research at problems related to the country's labour shortages or at problems associated with the development and industrialization of the country's Bantu peoples.

For example, a study of female labour and its better utilization in South African commerce and industry is being planned. A comprehensive literature survey was made and research areas which seem to warrant a high priority are the greater use of married women, and the fuller use of female labour in high-level occupations.

The differentiation of mental abilities during the development of Bantu children is being studied. The effect of urbanization

and increasing literacy on the differentiation of mental abilities amongst adult Bantu males is already being studied as part of the South African contribution to the International Biological Programme but the most meaningful results will be obtained from a study of rural Bantu children. A project aimed at stimulating the differential development of mental abilities is presently planned in collaboration with the Department of Bantu Education and as a complementary study to work being undertaken by Educational Testing Services in Princeton, USA. Findings from this research may contribute to the accelerated development of the Bantu people.

Shortage of bricklayers and plasterers

In 1969 the Institute was approached by the Industrial Council for the Building Industry (Transvaal) to investigate the current shortage of bricklayers and plasterers in the Transvaal.

Three main areas were investigated, namely the causes of the shortage, the feasibility of a two-phase training scheme and the possibility of integrating the trowel trades. During interviews, opinions on these points were obtained from employers, the trade union concerned, educational authorities and the Master Builders Association.

Proposals were made, relating, amongst other things to:

- The need for a greater awareness of personnel management responsibilities on the part of employers and the building industry as a whole.

- The introduction of two-phase training. The first phase would aim at providing basic skills within 18 to 24 months. The second phase would add a career element to the trowel trades. The ambitious and/or exceptionally competent worker would be able to progress to full tradesman status and ultimately supervisory or managerial status.

- The need for greater communication and co-ordination between interested parties in the industry.

- Less fragmentation during the training of artisans.

- The need to take into account long-term implications when implementing short-term solutions.

Subsequently, an attitude survey was conducted through the post. It would appear that principals of technical high schools and special schools favour the proposed two-phase training scheme and estimate that if the first phase were implemented, the number of boys from special schools entering the building industry would double. Because the second phase offers great possibilities for boys from technical high schools, the building industry should in future be able to attract more of these youths. The reasons given for the unpopularity of bricklaying and plastering, in particular, are lack of security and status, poor working conditions, wage insecurity and changes in work site. It would also appear that the unpopularity of certain trades derives from the poor image of those trades rather than from the work itself or from working conditions.

Applied services in Bantu labour utilization

For several years, there has been a steady demand from secondary industries for NIPR investigations into the management and utilization of their Bantu labour.

This year a number of follow-up studies were carried out which confirmed that the stability and productivity of Bantu industrial labour could be considerably enhanced by introducing a system of scientific job classification, coupled with occupational placement based on performance in NIPR classification tests.

The NIPR system makes it possible to compare, with some accuracy, jobs in different sectors of the economy in terms of skill required. This opens the way to developing a taxonomy of jobs performed by Bantu in industry on a regional and possibly on a national scale. It may also be possible to relate job complexity to scores on appropriate NIPR tests. Tentative findings from other studies suggest that the work motivation patterns of Bantu industrial labour are not, as yet, very complex. Thus test scores alone may be

sufficient for effective placement of this labour. Such a system could improve the industrial efficiency of Bantu labour significantly.

Continuous work tests for illiterates

An experimental series of practical performance tests has been designed and constructed in the Institute to measure sustained effort on a repetitive task, a feature of the motivational aspects of personality. The tests are intended specifically for illiterates. This research is relevant to repetitive work in industry.

Bantu labour in urban and border industrial areas

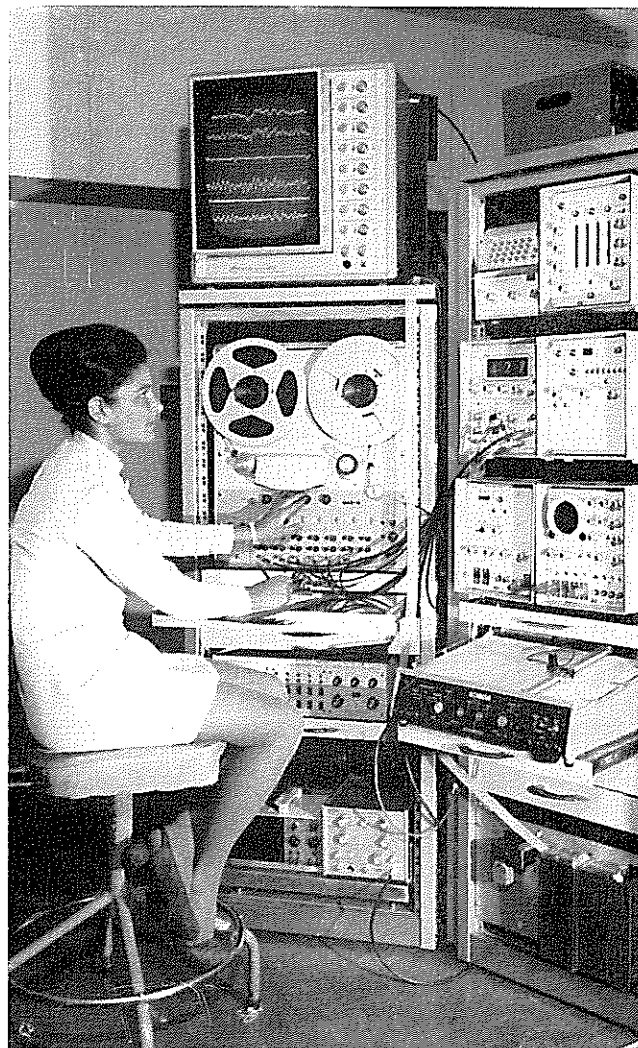
A long-term study of possible differences in stability and productivity between Bantu in urban and border industrial areas was undertaken at the instigation of, and in conjunction with, the Department of Planning and the Industrial Development Corporation.

Field work for a pilot study was carried out in an organization which had branches in urban and border areas which, for all practical purposes, were comparable in respect of management, production methods and composition. Comparative results revealed that absence rates for workers of both sexes in the two areas were not significantly different.

However, separation rates for men in the urban area were nearly twice as high as those for men in the border area, while separation rates for women differed little.

A study is being made of two other textile factories which are larger than the factories in the pilot study and make

Special-purpose computer used for the automatic processing of neuropsychological data.



different products from theirs. This project will not only be of practical value in the establishment of border industries, but will yield valuable information on the effects of cultural influences on performance in industrial situations.

Work motivation in an ethnic group in cultural transition

A multi-disciplinary investigation of Venda males formed part of South Africa's contribution to the human adaptability section of the International Biological Programme. The aim of the study was to trace the development of needs and their role in work motivation in a Bantu group in transition from a rural-traditional to an urban industrial environment.

This was probably the first study of its kind undertaken anywhere in the world. Most work motivation studies have been carried out in Western industrial surroundings among people in specific employment. This investigation was made with a sample of vhaVenda, the majority of whom, even when they were urban residents, were rural-oriented.

The theory on which the study was based was that of Maslow's need hierarchy, which postulates that human beings have certain basic needs. The five needs from lowest to highest are physiological, security, affiliation, esteem and self-actualization.

The results support earlier findings of the NIPR that among Bantu employed in mining and industry, although physiological needs are never entirely satisfied, higher needs are nevertheless present. The affiliation needs of many of the vhaVenda seem to be completely satisfied, and security needs were not strongly manifested. The group as a whole was oriented towards the physiological and esteem needs. There are indications that age and marital status influence motivation.

The results indicate that further analysis of the data is necessary.

Selection of CSIR scientific staff

Since 1966 the NIPR has made an intensive study of the criteria used in the selection of CSIR staff. At present particular attention is being paid to a more effective differentiation between various occupational groups in the CSIR, particularly the various scientific careers, and the demands made on research workers by the level at which they have to function. The nature of the intelligence required is also being studied intensively.

A report on the problem and theory of adult intelligence (with particular reference to the scientist) was submitted during 1969. This year reports on the intelligence of the librarian and on the intelligence and personality of the executive appeared. Two further studies are nearing completion, namely job evaluation studies carried out in the National Research Institute for Mathematical Sciences, and analyses of available test scores (in terms of age groups and specific scientific occupations).



Local and overseas journals in the NIPR library.

Preliminary results suggest that there are significant differences between individuals in one scientific occupation and individuals in another. These findings are being studied in order to increase the effectiveness of CSIR selection procedures.

NIPR library

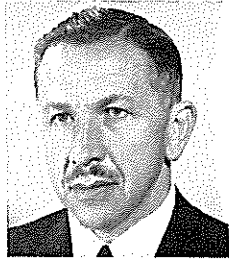
The library, which is a branch of the main CSIR library in Pretoria, houses literature dealing with the behavioural sciences and also has a large collection of works on ethnic studies, and on mathematical statistics and computer science. The stock consists of approximately 6 500 books, 3 500 pamphlets and 3 000 volumes of bound periodicals. The Institute subscribes to approximately 250 periodicals. Certain documents, e.g. theses and unpublished reports from abroad, which are otherwise not obtainable in the Republic, are available in microfilm or microfiche form.

The library's services are available both to the Institute's own research workers and to those from outside the Institute, as well as to businessmen, personnel officers, industrialists and students working for higher degrees.

Apart from its routine activities, the library prepares bibliographies on select subjects at the request of staff members and assist them in organizing their bibliographical references prior to publication.

During the year, the library's work was hampered by a continuous staff shortage and its activities had therefore to be restricted almost entirely to routine matters. Nevertheless, it coped adequately with the marked increase in the number of borrowers.

Mr S. H. Kühn, Director
of the National Institute
for Road Research.



National Institute for Road Research

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

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

New soil compactor

To strengthen soil it must be compacted. Many different machines have been devised to do this—rollers with steel wheels and drums, rollers with rubber tyres, tamping rollers, sheepfoot rollers and so on. But all these machines rely on the weight of the equipment to produce compaction. To achieve the depth and degree of densification required by modern engineering practice in such works as dams, railways and highways, this conventional equipment has been made increasingly heavy. Pneumatic compactors with a mass of 50t are in common use.

However, lighter masses used dynamically produce more effective densification than heavier masses simply resting or travelling slowly over the surface of a soil. Machines which are made to jump a few centimetres off the ground by compressed air or exploding gas are used for compacting earth in trenches. The dynamic effect is also used in vibratory compactors. These dynamic compactors are however limited as to the depth to which they penetrate, or the volume of soil compacted per hour.

Pursuing earlier work of a staff member, the Institute has further developed and tested a non-cylindrical roller, which when pulled over a surface delivers a series of high-energy impacts and can cover large areas at a relatively high speed.

Trials with a five-sided prototype and a four-sided commercial version of the Impact Roller have confirmed the validity of this concept of compaction. Comparatively high densities are being achieved to a depth of as much as two metres below the surface.

The South African Inventions Development Corporation handles development, patenting and commercial exploitation of the Impact Roller, and the Institute evaluates new test results.

Improved road tars

Tar, a by-product of coal, is used in road construction, but not nearly as extensively as bitumen, a by-product of distillation of crude oils. This is because tar is inferior to bitumen as a road-making material.

As it is desirable for South Africa to make the maximum possible use of the locally available products, improving tars to make them more suitable for use in roads is important. In the Witwatersrand area coke-oven tars are available quite cheaply from the steel industry.

Research at the Institute and overseas had shown that adding 1.5 per cent of polyvinyl chloride (PVC) to tar imparts elastic and adhesive properties to the tar (to improve its general weathering properties and the retention of chip-pings to the surfacing) while only fractionally increasing the cost of the material. Although bitumen is very durable calculations which take into account differences in price show that it may be more economic to resurface a road every 7 years with tar than every 10 years with bitumen.

Experiments have shown that for the PVC to be effective the amount of volatile oils in the tar must be limited. In this respect existing tar specifications are inadequate and the Institute has drawn up a new tentative specification. If this is successful after a trial period the existing SABS specification may be revised.

In early full-scale road experiments difficulty was experienced in blending the PVC with the tar, but as a result of recent laboratory work and pilot plant investigations these difficulties have been overcome and the Institute has advised manufacturers on the most effective techniques.

The earliest successful test sections were laid in February 1969 on the national road between Newcastle and Volksrust, and since then PVC-tar has been used in many parts of South Africa, Rhodesia and Mozambique.

Technical recommendations for highways

To improve the dissemination of research findings to the road industry and to keep practising engineers aware of current good practice in highway engineering, the Institute collaborated with the road authorities in establishing a new series of documents entitled *Technical Recommendations for Highways (TRH)*. These documents describe briefly well-proven guidelines developed from South African and overseas research and practice. Either the Institute or one of the road authorities prepare the documents, which are then approved in detail by a committee comprising representatives of all major road authorities. The first document in the series, *TRH 1—Guide on prime coats, tack coats and temporary surfacings for the protection of bases* was published in 1970, and drafts of another four were submitted to the committee for consideration and approval.

Vehicle vibration on Ben Schoeman Highway

The Institute was asked by the road authorities to investigate the problem of vehicle vibration on the Ben Schoeman Highway between Pretoria and Johannesburg after numerous complaints had been received from motorists.

Two methods were used to investigate the cause of the vibrations. First, geophones were mounted in test vehicles to detect the vibrations, and the results were evaluated in relation to the rolling circumference of the wheels of the vehicle. Second, a representative length of the road was levelled at 0.3m intervals using a precise level to determine whether there were any regular undulations in the surface profile of the road that could be causing the vibrations.

As the whole 18km length of south-bound carriageway showed the same pattern of measured vibrations, it was assumed that the 200m long test section chosen was representative of the road. The precise level measurements over this section indicated that the surface profile had been built to a high standard of evenness and that there were no regular undulations that could cause the resonant type of vibrations experienced at certain speeds with certain types of vehicle.

The wavelength of the measured vibrations coincided to within 4 per cent of the rolling circumference of the wheels of the test vehicles with different wheel diameters and the recorded geophone traces showed isolated irregular peaks that were larger than the average. These peaks corresponded with larger-than-average undulations in the measured surface profile such as at construction joints. Undulations of the order of 1mm over a 2m length could just be detected with the geophones.

It was therefore concluded that vibrations felt at relatively high speeds on this road are caused by imperfections of vehicle wheels and not by unevenness of the riding surface.

Road and travelling time

Two main roads linking Pretoria with Johannesburg and with Bronkhorstspuit have recently been supplemented by two

new dual-carriage highways. The time saved by through traffic using these new roads has been estimated from observations of travelling times of motor vehicles on the old and new roads.

The average travelling time for all types of vehicle was 8 minutes less per 22 miles (32.5km) on the Ben Schoeman Highway than on the old Pretoria-Johannesburg road, and on the new Pretoria-Bronkhorstspuit road it was 3 minutes less per 23 miles (36.8km). For commercial vehicles on the Ben Schoeman Highway the average time saved was 1½ minutes over 11 miles (17.6km).

The significance of these apparently small savings in time may be illustrated by considering the estimated saving in cost which they represent for commercial vehicles alone on the Ben Schoeman Highway. Data collected by the Institute indicate that for a commercial vehicle the value of time saved is about R4.00 per hour. Assuming that there are 2 000 such vehicles per day the total time saved over 21 miles (33.6km) is 150 hours per day. Over a 300-day year the saving therefore amounts to R180 000.

Traffic accidents and research

The numerous suggestions put forward from time to time, especially after holiday periods, on how to reduce the number of road accidents, and particularly the casualties, shows that the problem exercises the minds of many thinking people. But these suggestions are often based on individual opinion and unproven theory and it is clear that finding a solution to the problem—which is a world problem—demands more than common sense and ordinary knowledge.

Knowledge gleaned from research at the Institute and overseas which might reveal the best methods of reducing

A recently constructed dual-carriage highway.





The impact roller developed by the NIRR.

road accidents, has been summarized in a recently published paper.

Pedestrians form the largest group of fatalities in South Africa, viz. 42 per cent, approximately two-thirds of whom are killed in urban areas. Passengers in motor vehicles form the second largest group (27 per cent), the majority of whom are killed in rural areas.

Detailed investigation by a small team from the Institute into some 160 accidents has shown the extreme complexity of accident investigation and analysis. The findings are however yielding useful pointers to the causes of accidents: besides driving dangerously, e.g., not stopping at stop signs, traffic lights and yield signs, drivers often fail to perceive hazards and many manage their vehicles badly in emergency situations such as skidding. Many pedestrians are involved in accidents as a result of running across streets heedless of traffic.

It was found that 54 per cent of the road users involved in night-time accidents had consumed alcohol; in day-time accidents the percentage was only four. Results of an overseas research project concerning alcohol and accidents suggest that drivers with a blood alcohol level exceeding 0.08 per cent are more frequently involved in accidents than drivers with a lower level.

Very little information is available on the relation between speed and accidents in South Africa, but there is evidence from research in other countries that the imposition of speed limits, where previously none existed, reduced the number of accidents involving injuries and fatalities.

A study of the effect of road alterations on accidents has shown that some types of alteration decreased the number of accidents while others increased them. This shows the need for a scientific study of proposed alterations before the changes are made. A way must be found to compare the effectiveness of different alterations in reducing accidents.

Since so many different factors play a role in accidents, no single course of action by any authority—which is often all that can be undertaken because of limited funds—can be expected to reduce accidents to any great extent. Nevertheless, facts gathered by the Institute can be used by the authorities to prevent accidents. Important points are: programmes to improve roads based on the systematic use of accident data; education of all road users with emphasis on the dangers of alcohol; improved vigilance of drivers and pedestrians; increased use of safety belts and intensified enforcement of the law in respect of excessive speed and driving under the influence of alcohol.

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



National Building Research Institute

The National Building Research Institute (NBRI) is essentially an applied research organization working in close contact with the building and construction industries, the associated professions and related government and private sector organizations. Its activities include the improvement of building design and services; structural and foundation engineering; investigations into the lighting, ventilation, heating and cooling in buildings and the performance of building materials such as concrete, stone, paints and plastics; planning of schools, hospitals and housing for all population groups; studies of the fire resistance of structures and materials; and work in the fields of building management, organization, industrialization and economics.

About R1 500 million is spent annually in South Africa on building and construction (excluding roads). The success of the Institute in providing this massive industry with scientific and technological knowledge which will enable it to meet the problems posed by the rapidly increasing population and growing shortage of skilled labour, depends upon its not only meeting day-to-day demands for immediate and *ad hoc* assistance but also studying basic problems and long-term needs and requirements.

A shortage of qualified manpower and of funds make it increasingly difficult for the Institute to fulfil both these requirements satisfactorily. It is also essential that research findings be applied practically throughout the industry as soon as possible. This needs a dynamic co-ordinated programme of information dissemination directed at all levels of the industry and the associated professions.

Building and Construction Advisory Council

The Institute collaborates closely with the Building and Construction Advisory Council, with the Director serving both on the Council and on its Executive Committee. A scheme, based on a levy on new building and construction in the country in order to provide additional funds for building research, is being considered by this Council. The Minister for Community Development and Public Works has approved such a levy in principle and final details are being worked out. Sponsored work undertaken on behalf of the Council deals with building statistics, the demand for housing and the rational use of computers in the building industry.

Regional offices

The Institute's regional offices are providing valuable services to the building industry in their localities. The post of Regional Officer in South-West Africa has finally been filled.

Committees, congresses and symposia

During the year staff members worked on 125 committees serving the building and construction industry.

The Institute, in collaboration with other bodies, sponsored three conferences held in conjunction with two building exhibitions in Johannesburg and staff members presented papers at each of them.

A successful symposium on combating the deterioration

of building materials in coastal areas, organized by the NBRI was held in Durban during September.

Members of staff participated in a further twelve conferences in the Republic and contributed four papers.

Films

A television film on certain of the Institute's activities was produced by the SABC Film Service and shown on Rhodesian television in the weekly series *The South African Scene*.

The attendance figures for NBRI films (English and Afrikaans versions) on the national circuit are as follows: *Building on Expansive Soils*—540 000; *Air Flow and Building*—320 000; *Living with the Sun*—210 000. In addition, approximately 20 000 people see 16mm copies of these films each year.

Prefabricated brick panels

The patented process developed by the Institute for the manufacture of prefabricated brick wall panels is now being used in industrialized building. This represents substantial progress. The project is partly sponsored by the South African Brick Association.

One of the country's largest brick manufacturers, which installed prototype equipment based on NBRI designs for the manufacture of brick panels, erected a prototype house in 6½ hours from foundation level to the laying of carpets. The window frames, electric conduits and water pipes were all built into the panels at the factory. The inner walls were delivered to the site plastered while the outer walls were of high quality face bricks. The prefabricated roof was lifted onto the house by crane. The house was based on a design system for brick panel house construction developed by the Institute.

The same company prefabricated the brick panels used in the construction of a large school at Benoni.

The NBRI process of rapid and effective consolidation of the mortar by high frequency vibration and suction to remove excess water is in advance of techniques developed elsewhere. Numerous overseas enquiries are received for information on the technique and the rights concerning its use.

Multi-storey load-bearing brick masonry

The use of load-bearing brick masonry instead of reinforced concrete framed structures in the construction of multi-storey buildings such as hostels and blocks of flats has attracted much attention recently. The Institute has therefore studied relevant literature and could advise consultants and the local authority concerned in connection with several buildings that are being constructed in this manner. It has been found necessary to stress that much higher standards of detailing, preplanning and site control of materials and workmanship is necessary than with normal brickwork.

Resistance of windows to wind and rain

As a result of a contract investigation, a new and improved set of standards has been drawn up for windows in high buildings in Durban. The improvements deal principally with simulation of the combined effect of rain and wind

conditions that are met in practice. It has been found that pulsating wind pressures have a considerable influence on the water penetration properties and that the constant wind pressure differences previously recommended for performance tests place unnecessarily high demands on a window set. From an analysis of wind-speed measurements carried out in Cape Town it appears that the amplitude of the gusts of wind can be from 30 to 40 per cent of the mean wind speed. The investigations have led to the development of a type of sliding sash window which, according to tests on a prototype model, will not leak in severe rain and wind. This development has been patented.

Architectural planning

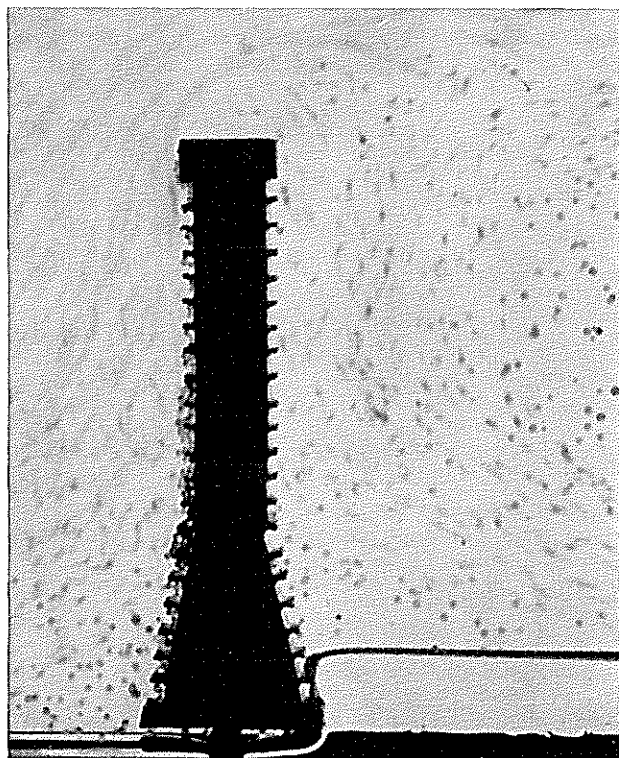
Wound infection is a major problem in surgery. The British orthopaedic surgeon, John Charnley, first used the clean operating enclosure principle with dramatic reduction in infection rates in surgery to the hip. Enclosures of this type have also been developed in industry for dust and bacteria free assembly of space research components. The Institute's Architectural Division drew on both these developments to devise, in collaboration with the Transvaal Department of Hospital Services and the National Mechanical Engineering Research Institute, a facility of this sort at the H. F. Verwoerd Hospital which can be used for most, if not all, types of surgery.

A highly efficient filtration system combined with laminar-type airflow permitting 360 air-changes an hour (as compared with 15 changes an hour in a conventional theatre), ensures that organisms liberated from staff or objects within the plastic-sided enclosure, are drawn into the airstream and evacuated. Persons needed directly at the operation site are in as clean an environment as possible. The anaesthetist and other theatre staff are outside the enclosure but can see all the activities within. The unit at the H. F. Verwoerd Hospital has been in use since August.

It is possible to manufacture sterile enclosures as portable units, and as such, their value in remote areas and for military use in the field will be considerable.

Precooked frozen food systems were also studied and a pilot scheme using one of them was introduced at the H. F.

Two-dimensional windflow around a high-rise building demonstrated in a water-tunnel.



Verwoerd Hospital. The CSIR itself also adopted this system for providing meals to staff in its institutes and laboratories at its research centre, Scientia, in Pretoria.

Hospital supply and disposal systems, architectural techniques to cope with growth and change in hospitals, and natural ventilation in large but compactly designed hospitals were also studied.

Other current projects cover the planning implications of the use of new audio-visual media in schools, design management and design brief information in the execution of the state building programme, functional improvements in the design of post offices and follow-up studies of experimental houses erected in Ovamboland and the Namib Desert.

Low-cost housing

The results of the socio-economic survey of Bantu housing, undertaken by the Institute for Social Research of the University of Natal, are being interpreted preparatory to the reassessment of standards of low-cost housing and urban planning.

Concrete technology

Investigations into the problem of plastic shrinkage-cracking of concrete showed that this was not attributable to either the chemical composition of cements used in the test programme or to the effect of different percentages of slag in the cement content of a concrete. Various methods of preventing plastic shrinkage-cracking will be investigated.

Investigations into the accelerated testing of concrete gave rise to certain difficulties in determining the confidence limits within which the results could be presented statistically. However, from strength tests carried out on one-day-old concrete specimens subjected to heat treatment in water, an estimate of the 28-day strength could be made within 10 per cent if only one type of cement is considered and within approximately 15 per cent, irrespective of whether the cement is ordinary Portland cement, Portland blast furnace cement or rapid-hardening Portland cement.

Storage of cement

Work on the long-term storage of cement in a silo showed that if the volume of cement withdrawn is automatically replaced by dry nitrogen gas while the silo is kept under slight gas pressure, there is no detectable change in the quality of the cement after three years.

Plumbing systems

The introduction of the British system of single-stack plumbing in the construction of multi-storey buildings in South Africa is still being investigated. Single-stack plumbing is essentially an unvented one-pipe drainage system. Its two main advantages are that it costs about 50 per cent less and requires less duct space for pipework than the conventional systems.

Having been recommended to do so, local authorities permitted single-track plumbing on a trial basis in some multi-storey buildings. Some installations however have not functioned satisfactorily because the design requirements have not been strictly adhered to. Every effort has been made to enlighten the appropriate authorities on the requirements.

Evaluation of new materials, components and building methods

The NBRI is the evaluating agency for the Agrément Board of South Africa. In the first year thirty-five firms formally applied to have their products evaluated with a view to obtaining a certificate. Twenty-five projects were referred to the NBRI for preparation of evaluation offers, ten of which were processed and conveyed to applicants. Work on several of these was proceeded with.

Inorganic materials

Numerous enquiries were dealt with on deterioration resulting from the ingress of moisture or undue exposure to moisture of inorganic building materials. Failures were caused by dimensional changes due to fluctuations in moisture content

and crystallization of soluble salts, by chemical reactions and by the incorrect application of materials and lack of basic knowledge of their behaviour.

Overseas reports indicate that concrete made with some impure dolomites and dolomitic limestones expands and disintegrates in alkaline solutions. As dolomite aggregate is frequently used in concrete in South Africa, it was decided to ascertain whether local dolomites behave similarly. After five months submersion in alkaline solutions the concrete specimens have not expanded or disintegrated but the local dolomites dedolomitize slowly in caustic alkaline solutions, as was expected.

Sand containing mica is often the only sand available for building over large areas in South Africa and particularly South-West Africa. Very little information is available on the performance of concrete, mortar, plaster, sand-cement bricks and calcium silicate bricks made with sands containing mica. The mineralogical, chemical and physical properties of micaceous sand are therefore being studied. Work is also being done to determine the creep properties of concrete made from aggregates containing mica, as there are doubts about the suitability of such aggregates for pre-stressed concrete.

It is extremely important to match a ceramic body and its glaze, particularly in a rapid firing process, in order to avoid failure. With this in mind the development of suitable tile bodies and glazes from South African raw materials for rapid firing was undertaken. Several suitable combinations of tile body and glaze have been developed.

Operations research in building and construction

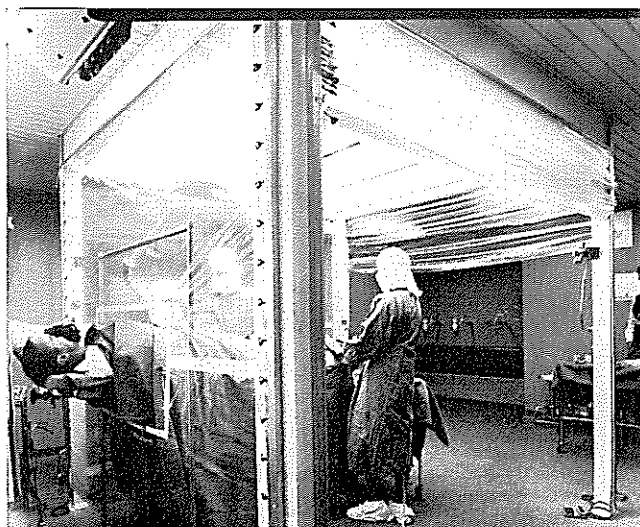
A pilot project in which network analysis was used for the scheduling of a CSIR contract was completed. The purpose of this project was to improve the control and management of the building project and at the same time to develop the facility for critical path analysis, both manually and by computer, and to identify the factors responsible for the success or failure of the scheduling technique. This study showed the need for a proper organizational framework within which the project management function can operate.

The use of network analysis to assist in the management of the cash resources of a multi-project building programme is also being studied.

Solar shadowscope

Two improved models of the NBRI's solar shadowscope for investigating sunlight and shade problems of buildings were developed: one for laboratory use and the other for general use. Both are sturdier than the old model and can be adjusted more accurately. Considerable overseas interest has been shown in the new models.

The clean operating enclosure at the H. F. Verwoerd Hospital, Pretoria.



Design weather data

Substantial progress has been made in the determination of design weather data for various centres in the Republic, South-West Africa and Botswana. These data are invaluable in the evaluation of the thermal behaviour of various structures as well as for the calculation of heating and cooling loads of buildings and include information on hourly values of dry-bulb temperature, humidity, wind speed and direction and solar radiation intensity. This work is based on basic climatological data obtained over a period of five years.

A complete set of tables covering horizontal and vertical shade and solar altitude angles, solar azimuth and angle of incidence of direct sunrays on a vertical plane, is now available for sixteen different orientations for the first and fifteenth day of every month for every two degrees of latitude between 18° and 34° south. The great demand for these tables indicates their value in calculations for the sunlight and shade design of buildings.

Paints and coatings

Much valuable information has been gained about pigment/binder ratios in emulsion paints and it is hoped that this will contribute towards a better understanding of the problems encountered in practice.

Work with a view to developing heavy textured coatings for use over pre-cast or off-the-shutter concrete is also progressing well.

Investigations into coatings for timber lay particular emphasis on clear or lightly pigmented coatings. It has been proved both locally and overseas that completely clear coatings seldom serve their purpose for more than 18 months. Water-repellent stains that are lightly pigmented and gradually erode away instead of chipping and flaking, are recommended because although their useful life is about the same as varnishes, they are easier to maintain.

Work was also done on the use of emulsion prime coats for timber and it was found that if the timber is pre-treated with drying oil, the emulsion primers are satisfactory.

Polyurethane foams

The thermal degradation of polyurethane foam and the release of chloride ions by polyurethane foam in moist conditions have been studied. The identification of the combustion and thermal decomposition products of polyurethane foam will, it is hoped, dispel some of the doubts about the fire hazard involved in the use of this material as insulation in buildings.

The release of chloride ions by polyurethane foam stems to a lesser extent from the use of compounds containing chlorine in the manufacture of the isocyanate raw material and to a greater extent from the use of chlorinated organophosphate fire retardants. Since soluble chloride ions in the foam often rapidly corrode steel with which the foam may be in contact, this could be a potentially dangerous property of the polyurethane foams as they are often used in sandwich constructions between galvanized steel sheets.

Foundations on expansive soils

Many enquiries received by the Institute deal with the problem of buildings on expansive clays and over the years this problem has been examined. Buildings on expansive soils constructed to NBRI recommendations suffered only minor damage over a period of 18 years while other buildings in the same area were severely damaged.

Although research in this field throughout the world has tended to stagnate there are still areas in which more knowledge is essential. One of these is the relationship between the different factors affecting heave. Some of these factors had been studied here and in other parts of the world but as it was felt that more exact criteria for the design of structures founded on expansive soils were needed, the Institute started an investigation to correlate the effects of all the factors concerned. The initial studies are restricted to the laboratory testing of undisturbed and remoulded samples

of one soil type but the programme will later be extended to other soils and field testing.

Moisture redistribution is a critical factor in soil heave and the regional study throughout the Republic and South-West Africa on soil moisture redistribution under covered areas in relation to climatic factors has continued. The computer processing and plotting of experimental data for the various test sites was updated and the existing computer program library was modified and extended to include the use of a time scale and rainfall histograms.

Reinforced and prestressed concrete

The strength and elastic properties of micro-concretes for small-scale structural models, in which aggregates such as norite and river sand were used, were investigated. The results indicated that the characteristics of a normal concrete could be closely simulated by several micro-concrete mixes. It was also found that it is important to use test specimens correctly scaled according to the relative maximum aggregate sizes in order to obtain directly comparable data for the prototype and model concretes.

The Institute undertook a major structural model study of the lower portion of a new 30-storey reinforced concrete building which is being erected in Pretoria. The unusual construction at ground-floor level posed considerable design and detailing problems and the model investigation is intended to verify the structural behaviour under both working load and ultimate load conditions.

An investigation on the steam curing of pretensioned concrete was completed. It was found that for a wide range of conditions steam-cured pretensioned concrete units are not inferior to those cured at normal temperature.

International activities

The NBRI has continued to participate actively in the affairs

of the various international and overseas organizations of which it is a member.

The Director of the Institute attended a meeting of the Executive Committee of the *International Council for Building Research, Studies and Documentation (CIB)* as well as the 4th Australian Building Research Congress and the 42nd Congress of the Australian and New Zealand Association for the Advancement of Science. He also visited building research organizations in Japan, France and Britain.

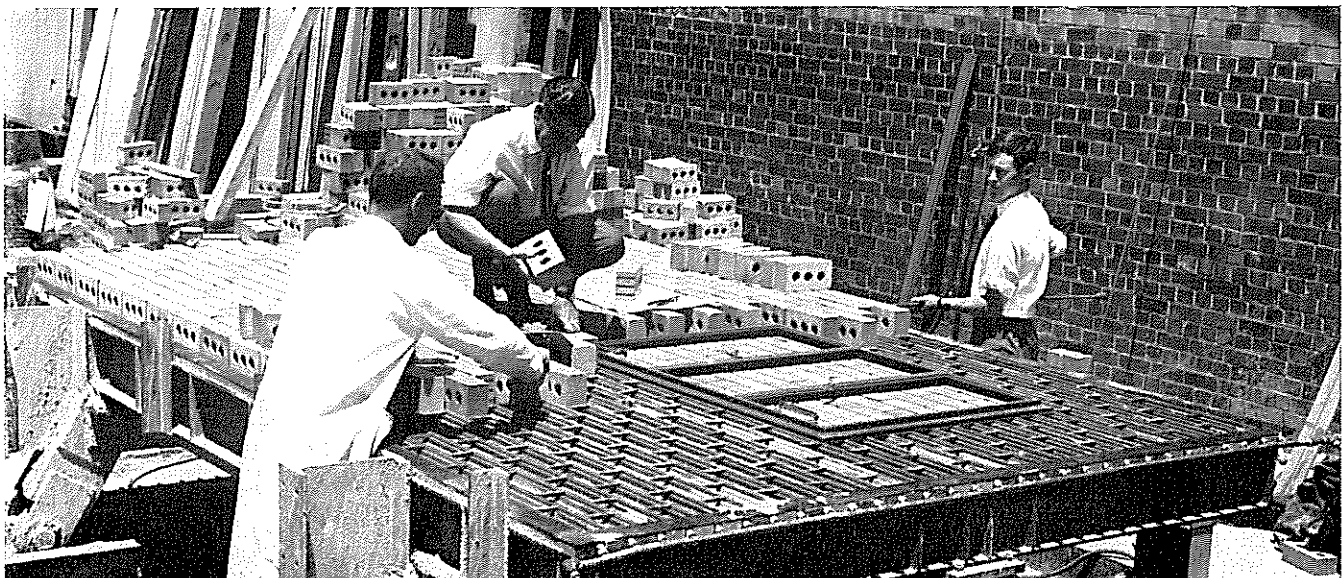
The Institute's development of a prefabricated brick panel excited considerable interest when a member of the staff reported on this work at the Second International Brick Masonry Conference held at Keele University, Stoke-on-Trent, England.

A senior member of staff visited the 'Bouwcentrum' in the Argentine to discuss the possibility of closer liaison and collaboration on climatological studies. The member also participated in a symposium, *Computer analysis for environmental engineering related to buildings*, held in Washington. Another member contributed to the session on *Co-ordination of software at the CIB Symposium, Some problems of information flow in the building industry*, held at Rotterdam in September.

The Institute has continued to assist adjoining and other African territories. Arrangements were made for closer co-operation with Rhodesia. A Portuguese team concerned with town planning and housing in Lourenço Marques visited the NBRI during October for detailed discussions on the Institute's work, particularly that on low-cost housing.

The overseas demand for publications and the steady stream of visitors from other countries is evidence of the international recognition accorded the Institute.

The machine used for the prefabrication of brick panels.



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



Timber Research Unit

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

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

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

Systems development

The TRU formed a Systems Development Division early in the year under review in an endeavour to develop forest products and promote their utilization in order to achieve maximum economic efficiency. The new Division will also ensure the sensible application of research results and advanced technological know-how in industry.

Systems development co-ordinates the work and aims of the scientist, economist, producer and manager. It is a formal, systematic and analytical method of improving the efficiency of a *whole* system and includes evaluation of existing systems and the selection of those most likely to benefit by improvement; the development, in close co-operation with industry, of the new improved system; its implementation; an assessment of the actual benefits attained and a critical investigation of discrepancies.

The first long-term project is the development of an efficient grading system, incorporating mechanical stress-grading.

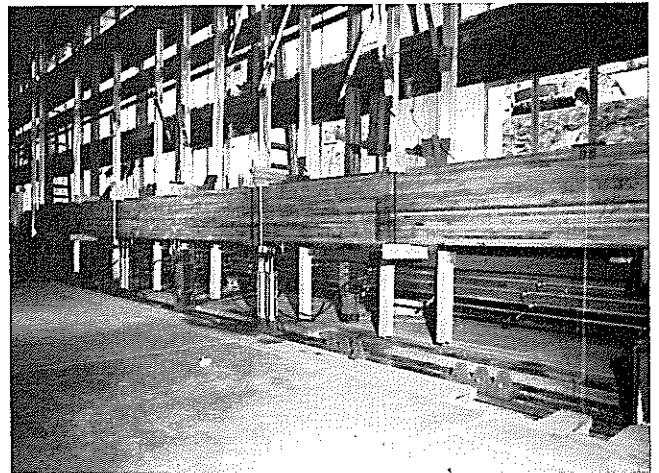
Timber seasoning

The importance of proper seasoning and the need to improve current kiln-drying practice was brought to the fore by the recent introduction of compulsory grading of softwood structural timber processed and sold in the Republic.

Preliminary work on the pattern of stress development during the drying of timber has been done. Knowledge of the nature and magnitude of drying stresses is important not only for understanding the fundamental physical properties of wood, but also for the development of kiln schedules, the control of shrinkage and the relief of residual stresses and sets.

The cost and technical aspects of different drying procedures, i.e. air drying, solar drying, pre-drying, kiln drying, and combinations of these methods, have been investigated.

Work is in progress to develop techniques for rapidly determining the moisture content of green boards, kiln samples and seasoned timber. Research is being done on how to eliminate or reduce seasoning degrade, especially that caused by twist.



A glued laminated timber beam under load in the TRU test rig.

This research aims to provide information which will enable the timber industry to season timber to SABS standards at the lowest cost. Much of the information already obtained has been incorporated in a code of practice on timber seasoning which the South African Bureau of Standards is preparing.

Board products

The relative durability of different types of wood-base board products exposed to the weather is being investigated. The panels were inspected after 2½ years of outdoor exposure. Their behaviour was similar to that of panels subjected to accelerated aging tests. The edges of these panels are the most vulnerable to weathering and methods of protecting the edges were therefore evaluated.

Adhesives

The effect of resin on the gluability of pine timber is being studied. An experiment was initiated to determine the mechanism by which various contaminants interfere with wood gluing. An experiment to determine the durability under service conditions of products glued with urea-based adhesives showed that no deterioration took place within a year. A short-term investigation to find a replacement for resorcinol adhesives used in manufacturing finger-jointed timber and glulam resulted in the recommendation of a melamine/urea mixture of which the melamine resin constitutes not less than 60 per cent.

Stress-grading

Progress in the development of the mechanical stress-grading method by which structural timber is classified according to strength much more reliably and efficiently than by current visual grading, is such that a full set of data for the application of mechanical stress-grading in the Transvaal, the major timber producing area in the Republic, will be available early in 1971.

Timber joints

Design data for economical nailed plywood joints for roof trusses have been derived and confirmed by tests. Pilot studies of glued plywood joints and nailed metal plate joints have been made as a basis for further work in this direction.

Roof trusses

Prototype roof trusses using the nailed plywood joints developed by the Unit have been designed and tested with very satisfactory results. A set of standard designs is being produced and should be available by mid 1971.

The basis for a South African standard specification for roof trusses, including provision for prototype testing and handling tests, is being developed.

Pulp and paper research

A techno-economic survey of the pulp, paper and board industry was conducted to provide a basis for the selection of research projects with the maximum economic value for local industry. The conclusion was that this branch of industry is largely self-sufficient as far as research is concerned and that the TRU could best assist by doing long-term research especially on raw materials.

Preservation of paper

After an initial study of the factors that could influence the deterioration of paper during aging, the investigation was extended to determine the simultaneous influence of temperature, relative humidity, aging period and acid content.

Requirements of pulpwood

Wood samples with different fibre properties are being characterized to determine how these properties influence the quality of pulp and paper. The fibre morphology and other physical and chemical properties of the wood are determined and paper sheets made from the wood are tested.

Techno-economic studies

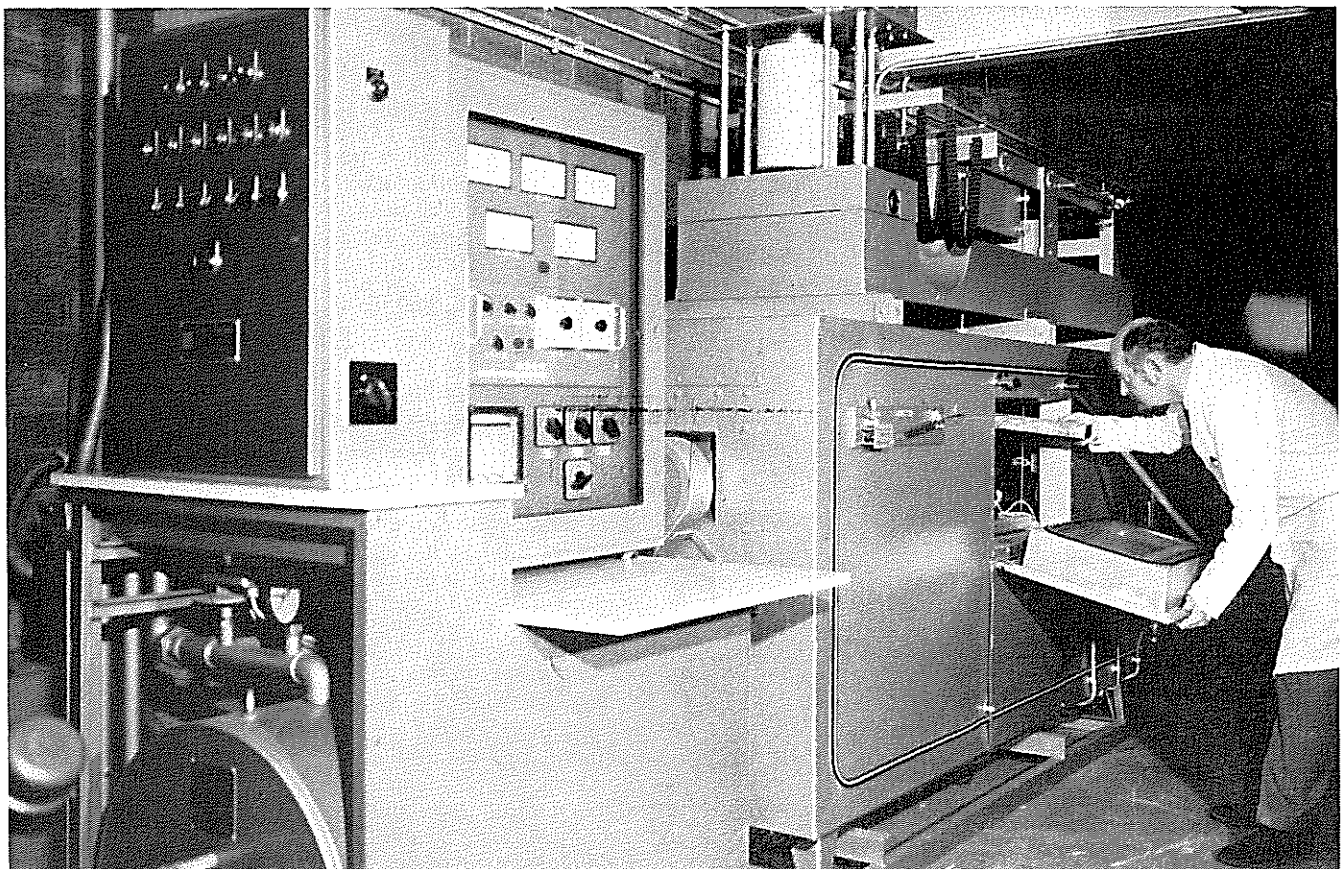
The project to determine and improve the efficiency of seasoning timber continued. The mathematical model for seasoning efficiency was refined and has already been applied at a saw-mill. The sensitivity of the model is being tested in the laboratories of the TRU.

A study of the cost of manufacturing undesigned laminated pine members (stock glulam) was completed. This study was undertaken to provide the TRU with information which could be used as a basis for planning research on this important product. An important conclusion was that although the locally manufactured product can compete with imported solid timber on a cost basis, the profit margin is low and research should aim at the reduction of production costs.

A techno-economic survey of the forest products industry comprising the pulp, paper and paperboard industry on the one hand and the sawn timber industry on the other, was undertaken in conjunction with the Techno-economics Division of the Information and Research Services of the CSIR.

A detailed study of the cost of producing sawn timber was also initiated as this information is required for various research programmes at the TRU.

A laboratory dryer in which the effects of temperature, humidity and air velocity on the drying of sawn timber are tested.



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



South African Wool Textile Research Institute

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

The past year the Research and Development Committee of the International Wool Secretariat for the first time since its establishment met in South Africa at the Institute's laboratories in Port Elizabeth. The Institute organized an international dyeing and finishing symposium to coincide with this. It was attended by 90 delegates and papers were read by leading wool research scientists from the USA, Britain, Switzerland and Australia as well as by the Institute's senior research workers.

Textile training

SAWTRI is the only CSIR Institute which controls a university department. The Director, as Professor Extraordinary of Textile Science, and senior research personnel who are all part-time lecturers, are responsible for training textile technologists at the University of Port Elizabeth. At the end of 1970 the first group of students completed the four-year B.Sc. (Textiles) course and graduated as the first fully South African trained textile technologists.

Machine washable wool

Because of wool's natural tendency towards felting shrinkage, the Institute is constantly engaged in developing methods to render wool shrinkproof and make wool end commodities completely machine washable. This can be done by prechlorinating wool hand-knitting yarn with 2 per cent active chlorine in the Melafix DM (Ciba) process, and then dechlorinating it with sodium bisulphite and finally treating the hanks with Hercosett resin at a pH increasing from 5 to 8.

A further development was a continuous process to make wool top shrinkproof with Hercosett 57. This is a modification of current methods of applying the Hercosett resin. A continuous combed sliver is prechlorinated on a pad and then treated with resin in a backwashing machine.

Dyeing wool in organic solvents

The use of organic solvents instead of large quantities of water is an important advance in the dyeing of wool. The new method dispenses with effluent purification and uses about 5 per cent of former water requirements.

A dyestuff is dissolved in a small quantity of water and this solution is added to an organic solvent containing a suitable dispersing agent. The wool absorbs the dyestuff and water almost completely, leaving little or no water in the solvent which can easily be recovered for re-use. The operation can be carried out in a conventional stainless steel dry-cleaning machine provided with heating facilities.

Dyeing karakul wool

Considerable attention has been given to the processing of karakul wool during recent years. Because the natural pigmentation of the fibre is not suitable for the application of bright colours the uses of karakul wool have been limited. Although an effective bleaching process has been worked out in collaboration with the South African Wool Board, this treatment adds to the cost of the final product. Further research into the application of reactive dyes to the yellowish-brown unbleached karakul wool has resulted in the achievement of bright shades without bleaching. Should greater brightness be required the karakul wool can be blended with 10 to 20 per cent of a coarse and relatively cheap type of mohair or wool.

Wrinkling of worsted fabrics

On investigating the effect of fabric constructional variables on the behaviour of woven fabrics it was found that fabrics made from coarser yarns are more wrinkle resistant than fabrics made from finer yarns. It was also found that in woven cloth there is a tendency towards lower wrinkle resistance with increasing sett (the number of threads per centimetre). The wrinkle resistance of a fabric can be increased considerably if the folding twist of the yarn is of an appropriate value.

Wrinkle resistance of fabrics woven under high loom tension can be increased by decatizing the fabric for a longer period. Increasing the severity of the setting conditions in high-temperature decatizing also improves wrinkle resistance.

Testing instruments

An instrument called the 'withdrawal force meter', has been developed by means of which the withdrawal force of a wool sliver can be measured in the laboratory of a processing factory in order to ascertain without delay whether the sliver has been gilled satisfactorily.

Measuring area shrinkage of samples after machine washing.



Normally the expected carding and combing performance of a consignment of scoured wool can only be determined by actually carding and combing a sample of 15kg to 25kg, which is time-consuming and expensive. Using the entanglement meter built by the Institute, the expected carding and combing performance can be obtained within a few minutes using only 500g of scoured wool.

Processing South African wool types

The carding and combing performance of 64's wools of different mean fibre lengths (mfl) has been investigated. Spinners' style wools from a certain district in the southern Free State were used. It was found that fibre breakage during processing increases rapidly with an increase in the mfl of the raw wool. However, the mfl of the combed top increased, and the percentage noil decreased when raw wool with longer fibres was used.

Noble comb for short wool

It is generally accepted that the Noble comb is suitable for long wool only. This may be because, with the comb functioning with standard size drawing-off rollers at normal distances from the circle, the throwover is such that uneconomical amounts of noil are produced from short wools. This makes the rectilinear comb preferable for short wool. However, the versatility of the Noble comb has been increased by special modifications and new techniques and it is now possible to comb six months' wool of a mean fibre length of 3.2cm successfully.

Fibre breakage in carding

It was found that the performance of a rectilinear comb improves when processing wool with a regain increased to about 25 per cent. The carding of scoured wool at regains higher than 25 per cent causes an increase in noil. Carding under relatively dry conditions, with the application of an antistatic additive before carding, is beneficial provided water is added directly during subsequent gilling to obtain the optimum regain conditions for combing. A scoured wool regain of 15 to 20 per cent, or even lower, is recommended provided there is not excessive fly during carding. The relative humidity of the wool is unimportant if an efficient antistatic lubricant is used. A marked improvement was noticed in wool gilled and combed immediately after carding compared with wool which had been stored after carding.

Hand and machine knitting yarns from mohair

Yarns were successfully spun from BH, CH, DH and BR quality coarse mohair on a double-apron ring frame, after drawing on three gill drawings and a high drafter. Some BH was also prepared on the conventional Bradford set. Yarns of R110 tex were successfully spun in all cases while yarns of R75 tex were spun from BH, CH and BR. The finest yarns that could be spun from the short type DH at 5 000 rpm was R88 tex. The hairiness of all the yarns was acceptable. Several other types of mohair (kid, young goat and BSFH mohair) were blended with various percentages of wool for knitting trials. In all cases spinning performance was satisfactory.

Dimensional properties of knitted wool fabrics

If all-wool, shrinkproofed knitted fabrics are to be machine washable, it is essential that the structures be stabilized against dimensional changes caused by relaxation shrinkage. During relaxation, the dimensions of knitted structures change considerably. Area shrinkages of 30 per cent have been found in some double-jersey structures. As the ultimate dimensions of the finished fabrics are known only approximately, relaxation shrinkage is a major problem for the commercial knitter. The rationalization of the knitting operation and methods of obtaining the fully relaxed state have made it possible to predict the fully relaxed dimensions of many weft-knitted structures with reasonable accuracy, prior to actual knitting.

Yarn properties, machine variables and knitting performance

An investigation of the knitting performance (ease with which a structure can be knitted on a given machine) of different double-knit structures has led to the determination of optimum values for yarn intake and run-in-ratio for a number of structures.

In another investigation it was found that a count range of R19 tex to R32 tex can be knitted efficiently on an 18 gauge double-knit machine. The important implication of this work is that wool yarns of relatively low tensile strength can be knitted successfully, provided the machine is set to optimum knitting conditions and has a positive yarn feeding device. However, the use of counts of yarn that are too fine for a particular gauge of machine spoils the aesthetic appearance and physical properties of the knitted fabric.

Weft skewing

One of the most perplexing problems confronting the worsted trade is the skewing of certain types of fabrics which distorts the pattern and creates difficulties when the fabrics are cut for making clothes.

For most of the parameters investigated (weave construction, fabric width, variation in sett, warp tension, twist, weft tension and the type of temple), the two classical weaves, 2/2 twill and 4/4 twill, gave opposite reactions. Thus it would seem that each weave has its own skewing characteristics.

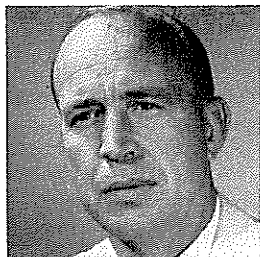
Wool-rich bunting

The use of nylon in an intimate blend with wool improves the flying performance of bunting. A blend of 70 per cent wool and 30 per cent nylon gives satisfactory performance in areas where prevailing winds are strong.

Co-we-nit

Although it started as a limited project the Institute's research on the Co-we-nit (a combination of weaving and knitting) has expanded considerably. The versatility of the Co-we-nit machine has been increased to such an extent that the Institute now has a practically unique collection of curtaining and furnishing fabrics. An important aspect of this development is the use of undyed and dyed karakul and mohair fibre to which the Co-we-nit technique is admirably suited. Hitherto the demand for karakul wool has been limited because of its restricted end-uses. Now however, with the possibilities created by the Institute's research, karakul should enter a new era.

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



Information and Research Services

The Information and Research Services (IRS) are concerned mainly with the following functions of the CSIR:

- Collection, storage, retrieval and dissemination of published scientific and technical information.
- Recording, publishing and making known the results of research undertaken or supported by the CSIR
- Encouragement and support of research and development in manufacturing industry
- Support of academic research in the basic natural and engineering sciences
- International scientific liaison.

Collection and dissemination of information

The central library provides services to all branches of the CSIR as well as to other organizations, industrial firms and individuals throughout the country. The following selected statistics indicate the scale of this operation:

Year	Publications issued and photocopies provided	Books and pamphlets ordered	Periodicals (subscriptions and exchanges)
1966	43 598	3 424	2 907
1967	44 995	3 704	3 136
1968	52 450	4 440	3 413
1969	53 845	5 605	3 457
1970	52 755	4 958	3 410

Production of the first edition of the union list of serial titles in South African libraries, under the title *Periodicals in South African Libraries (PISAL)* which is undertaken in collaboration with the University of South Africa (and financed jointly by the CSIR and the Human Sciences Research Council) proceeded as far as the issue of titles listed under the letter 'S'. At this stage it was decided to stop work on the first edition and proceed directly to the production of a complete second edition, using computerized procedures. These were adapted from procedures developed by the National Science Library of the Canadian National Research Council, whose help and co-operation is gratefully acknowledged.

In addition to this important bibliographic tool, a number of other directories and guides to sources of scientific and technical information in South Africa are compiled and published. A number of these directories and indexes are computer-produced, and during the year funds were provided for the development of information services based on magnetic tapes available from the major indexing and abstracting services overseas.

Good progress has been made in the application of computerized procedures to the recording of serial titles taken by the central library. On behalf of the State Library, Pretoria, the possibility of producing the *South African National Bibliography* in this country, using computerized listing and photo-composing techniques adapted from those developed for this purpose in West Germany, is being investigated. Research groups in the CSIR research institutes

are also assisted with the development of co-ordinate indexing systems for storage and retrieval of information.

On behalf of the National Library Advisory Council a comprehensive survey is being made of developments (present and planned) in the application of computers to library and information services in South Africa, including the use of microform and telecommunications links between libraries and information centres. Special attention is being directed to future needs in relation to international developments in this field. In another survey for the National Library Advisory Council, which is being undertaken in collaboration with the Human Sciences Research Council, the adequacy of literature resources available to research workers in South Africa is being investigated.

The CSIR, as the national member of the International Federation of Documentation (FID) was represented at the General Assembly and 35th International Congress of the FID in Buenos Aires in September 1970, by the Council's Director of Information and Research Services.

A group of geologists on one of the field excursions held in conjunction with the Second International Gondwana Symposium.



Liaison between the CSIR and small and medium-sized manufacturing firms is provided by a Technical Information Service (TIS) which handles technical enquiries as a routine activity, visits individual firms and assists with the organization of industrial symposia and of visits by industrialists to the CSIR. The TIS also produces a monthly bulletin *TI—technical information for industry*, as well as brief guides and technical pocket books for use by industrial technicians. During the year the TIS joined the Production Engineering Research Association in the United Kingdom as part of an effort to provide better information and advisory services to industry in the field of production technology. A technical information officer was stationed at Bellville to provide closer liaison between the CSIR and manufacturing industry in the Western Cape. An extensive survey is at present being undertaken of the present state and potential development of automation in the Republic. This project, which is expected to extend over two more years, is being undertaken on behalf of the Scientific Adviser to the Prime Minister and the South African Council for Automation and Computation.

Publishing and publicizing the results of research

Work on a guide for CSIR authors and editors aimed at establishing and maintaining adequate standards of presentation and documentation for CSIR research publications, is progressing steadily. The chapters which have been issued so far cover publishing policy, identification of publications, format and order of contents, preliminary matter, body of the text, reference and supplementary matter, scientific illustration, copy preparation and proof correction, typing of reports (including typing for direct reproduction), and the publication of conference proceedings. Further chapters dealing with language usage and with respective functions of referencing and editing are in preparation. In its present form the manual is intended for domestic use only, but it is the intention to publish an abridged version for wider distribution once all the proposed chapters have been completed.

Steady progress is being made with the compilation of the technical dictionary for the textile industry. The urgent need for an adequate, standardized Afrikaans textile terminology has led the CSIR to initiate this project in collaboration with the South African Bureau of Standards, the Vaktaalburo of the Suid-Afrikaanse Akademie vir Wetenskap en Kuns, the Industrial Development Corporation, the University of Port Elizabeth and the Departments of National Education and Agricultural Technical Services.

An *Index to CSIR Publications 1945-1968* was produced during the year. This lists all publications by CSIR staff and recipients of CSIR grants. Future cumulations will be facilitated by the use of the same computer program for production of the six-monthly lists of CSIR publications under the title *CSIR Research Review*.

The Permanent National Advisory Committee on Research Publications of the Scientific Advisory Council was assisted in reviewing the problems of primary research publications in South Africa. Publishing services were also provided for the *South African Journal of Antarctic Research*, the first issue of which is to appear under the auspices of the South African Scientific Committee for Antarctic Research in 1971.

The main media which have been developed for informing the public of the results and implications of CSIR research are the semi-popular monthly journal *Scientiae*, the four-monthly bulletin *CSIR Research Briefs*, the CSIR Annual Report, press releases (of which 80 were issued during the year to all newspapers, news agencies, magazines and the radio), and documentary films and film featurettes on particular events—for showing on the commercial cinema circuits. The CSIR's own staff, many of whom are stationed in other parts of the country, are catered for by a weekly staff newspaper, *Sciendaba*.

To promote communication at the personal level, symposia on topics of interest to industry are arranged from time to

time. The following industrial symposia were held during the year:

- Utilization of structural timber
- Spectroscopy in industry
- Earthing practices
- Food technology
- Tungsten carbide and steel grinding with diamond abrasives.

The average attendance at these meetings was between 100 and 150, and in each case the programme included visits to the CSIR laboratories concerned. In addition, about 3 000 visitors were taken on guided tours through the various laboratories and institutes at Scientia, Pretoria. These included organized tours of scholars and students, members of professional societies, representatives of organized industry, and foreign visitors.

Arrangements were made for special functions, including a visit by the State President on the occasion of the CSIR's 25th anniversary, the opening of the Stander Water Reclamation Plant at Daspoort, Pretoria, and a visit by the principals of South African universities.

Industrial research and development

In addition to the research undertaken by the CSIR's research laboratories, institutes and units on behalf of or in collaboration with industry, the CSIR has a specific brief to encourage and support research undertaken by industry itself. The CSIR is advised on these matters, including the distribution of funds for the support of co-operative industrial research by its Advisory Committee on the Development of Research for Industry. During the year, recommendations for the support and development of research during the ensuing five-year period were considered (on the basis of techno-economic surveys and reviews by sub-committees appointed by this Advisory Committee) for the Leather Industries Research Institute, the Fishing Industry Research Institute, the Timber Research Unit, the Bantu Beer Unit—and the industries served by them.

The Committee gave particular attention to incentive schemes introduced in other countries for promoting the technological innovation potential of manufacturing industry, and discussed the possibility of introducing similar schemes, adapted to South African requirements, with the Government and the Federated Chamber of Industries.

Studies of the optimum allocation of research support for the various economic sectors and disciplines in science and engineering have continued. Background information for this purpose is provided by national surveys of expenditure on research and development carried out on behalf of the Committee on Research Expenditure of the Scientific Advisory Council and partially financed by the Department of Planning. Reports dealing with expenditure during the financial year 1966/67 by the government sector, universities and university colleges, the private sector and also by the Republic as a whole, were approved by the Scientific Advisory Council. Similar reports on research expenditure for the financial year 1968/69 are in preparation and collection of information on expenditure on research and development during the financial year 1969/70 was initiated.

Complementary techno-economic surveys of individual sectors of industry are undertaken as an aid to the planning of support for research and development in the sectors concerned. In addition to surveys of the leather, fishing, timber and Bantu beer industries (referred to previously) work has continued on the techno-economic survey of the chemical industry. Various categories of products are being studied in detail, and a report on the phosphate group was published at the end of the year.

More detailed studies of the economic aspects of specific projects were undertaken on behalf of CSIR research groups. To this end research is undertaken into the application of industrial economics in the context of technological research—including technological forecasting. This is considered to be of particular relevance, as research planning requires

that current research should be relevant to the technologies which will be required in the future.

University research grants

Considerable improvement of the university research grant scheme was possible during the year under review following successful representations by the Council for an increase in the annual parliamentary provision for this purpose. The valuable assistance given in this regard by the Scientific Adviser to the Prime Minister and by the Department of Planning is gratefully acknowledged.

The major portion of the additional grant funds provided by the government was used to increase the value of bursaries awarded for research and post-graduate study at South African universities, with effect from 1st January 1970. It is believed that this will help to stop the downward trend in the number of post-graduate students enrolled at South African universities and that more post-graduate students who would otherwise have gone overseas for pre-doctoral studies, will now continue their studies at South African universities. The improvement of research facilities at South African universities is considered to be of such importance that a considerable portion of the parliamentary grant (and the additional amount provided) was used for this purpose during 1970.

Because of rising costs, particularly in the case of specialized equipment, it was not possible to provide for all the needs of universities in this regard but indications are that it is now necessary only in exceptional cases for students to go overseas for pre-doctoral study. This does not detract from the value attached to research and study at approved overseas institutions, and the Council's grant scheme therefore provides for support in the case of teaching staff and students for post-doctoral work overseas and for participation in international scientific conferences.

International scientific liaison

The main CSIR agencies for scientific liaison at the international level are the South African Scientific Liaison Offices in London, Washington, Paris and Cologne, and the Science Co-operation Division in Pretoria provides services in connection with the CSIR's national membership of the International Council of Scientific Unions (ICSU) and its affiliated unions—which are non-governmental international scientific organizations. These liaison services are provided for the benefit of the entire South African scientific community.

Activities during the year were concerned mainly with management of national programmes linked with global programmes under the auspices of ICSU's Scientific Committee for Antarctic Research, Scientific Committee for Oceanographic Research, and the Scientific Committee for the International Biological Programme. In addition, the CSIR organized the second international symposium on Gondwana stratigraphy and palaeontology, under the auspices of the International Union of Geological Sciences. It was attended by 180 scientists of whom approximately one half were from other countries. The year also saw the publication of papers presented at a symposium on South African contributions to the Upper Mantle Project—a global programme of the International Union of Geological Sciences—as a special publication of the Geological Society of Southern Africa.*

The CSIR also organized three other symposia in which foreign experts played a notable part, viz. the International Symposium on Mycotoxins in Human Health, the National Symposium on the Production and Use of Laboratory Animals (both in collaboration with the Medical Research Council) and the National Oceanography Symposium (sponsored by the South African National Committee for Oceanographic Research).

*GEOLOGICAL SOCIETY OF SOUTH AFRICA, *The Upper Mantle Project*, Special Publication No. 2, Pretoria, July, 1969.



A group of German industrialists on a visit to the CSIR.

Mr John Maddox (centre), editor of the British scientific journal, Nature, in conversation with Mr D. G. Kingwill, Director of IRS, and Dr S. Meiring Naudé, President of the CSIR. (Photograph: "The Pretoria News").



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



Leather Industries Research Institute

The Leather Industries Research Institute (LIRI) had its origin in research grants made in 1936 by the hides and skins and the tanning industries, which were followed in 1941 by the establishment of a research institute to serve the needs of the hides and skins industry, the wattle industry, the tanning industry and the footwear industry, as well as of the suppliers and bulk consumers of the products of these industries.

Since its inception, the LIRI has endeavoured to maintain a balanced research programme, making regular contributions to overseas scientific journals and applying the results of this basic research to the practical problems of local industries. Through its overseas publications, the LIRI has become the recognized world leader in several branches of fundamental chemistry, and has earned an international reputation. As a result of this, local industries have been able to benefit from applied scientific work carried out by overseas leather research organizations, even when such work is of a confidential nature.

The Leather Industries Research Institute has entered its sixth five-year grant cycle, and during the year discussions have taken place between the Board of Control and the CSIR Advisory Committee for the Development of Research for Industry.

During a recent visit by the Director to similar organizations in Australia, New Zealand, Japan, the United States of America, Britain and Europe, it was apparent that many of the ideas and processes germinated at the LIRI were being utilized overseas.

The world's leather industries are fighting a battle for survival against the synthetic substitute and survival will depend on the fullest possible use of modern science and technology. In this context, the Institute has a vital part to play in the growth and development of the important basic industries it serves.

Because of changes in tanning and footwear technology, new approaches to training at all levels are evolving. The trend is towards the type of training pioneered by the Institute six years ago with correspondence courses backed by infactory tuition and short block-release courses at the Institute. A record enrolment of 261 students from 19 countries is indicative of the important rôle played by these courses.

Hides and skins

In view of the irreversible and costly damage done by bacteria to hides and skins during curing and tanning, extensive studies have been made in the past year of the microbiology of curing and tanning processes. This investigation has been done with the co-operation of the Department of Botany and Microbiology, Rhodes University, and the hide and leather industries. The study involved determining the aerobic and anaerobic halophobic and halophilic bacterial contamination of wet-salted hides from South Africa, Rhodesia, Australia, England and New Zealand to compare quality, curing methods, etc.

The part of the hide which is converted into leather is the fibrous protein collagen. Bacteria with collagenolytic activity are therefore the most destructive as regards leather

production. Methods have been developed for identifying these bacteria and their gelatinolytic and collagenolytic activity. The tannery liquors used to process hides have also been analysed for bacterial contamination. Several technical reports and publications have resulted from this work.

Protein research

The studies on collagen continued, with the emphasis on the rôle of hydrogen bonds in protein stability and denaturation. Using polar organic molecules as perturbants, it has been possible to account for collagen denaturation by a predominantly polar mechanism involving hydrogen bonding of the perturbants to the collagen molecule. Hydrophobic bonding does not appear to play a significant rôle. The results of this work have been published in several papers in an overseas journal.

Alternative uses for wattle

The use of synthetic substitutes for sole and insole leathers has led to declining world markets for South African wattle. The wattle industry has increased its contribution to the Institute's research work on alternative outlets for wattle bark and extract. The main effort is being devoted to the production of chipboard, plywood and cold-setting finger-jointing adhesives based on wattle extract. Considerable progress has been made in collaboration with local large-scale chipboard and plywood manufacturers. A patent has been applied for for one of the major breakthroughs.

Other uses being explored are soil conditioners for trace-element deficiency and mud thinners for oil-well drilling. Large-scale trials are in progress in all these fields.

LIRITAN

The world's largest sole-leather tannery has used the Institute's rapid high-quality closed system of sole-leather tannage with great success. Sole-leather tanneries in the United States of America, threatened with closure because of effluent problems, are interested in installing the LIRI system. Arrangements are being made to give technical advice and assistance to those who wish to convert to the South African method.

Fundamental research on tanning

Research into the mechanism of the process of vegetable retannage of chrome leather was recently completed and the results of the work have been published. Through better understanding of the process it has been possible to improve the strength and durability of this type of leather.

Properties of leather

Competition from synthetic upper materials has made it imperative that leather offers the same level of performance as man-made materials, whilst maintaining the attributes which keep leather the preferred material for comfort.

In order to assess consumer preference, a statistically planned wear trial is being conducted and the observations

and measurements will be related to laboratory evaluations. Dynamic methods for measuring water vapour absorption and permeability of upper materials, as well as perspiration resistance, have been developed.

Metric sizes and fittings

The Institute has co-operated with the South African Bureau of Standards on all aspects of metrication in the footwear and leather industries, and particularly in the first stages of last measurement and re-marking for the proposed introduction in 1972 of the Mondopoint shoe-sizing system, which is likely to be adopted as an international system by the International Standards Organization. The implementation of metrication and Mondopoint is being co-ordinated by a South African Footwear Manufacturers' Federation Special Committee, on which the Institute is represented.

PVC and adhesives for footwear manufacture

With the development of special polyurethane adhesives, cross-linked by addition of isocyanate hardeners, PVC and polyurethane-coated upper materials, stuck-on moulded PVC unit soles and direct injection-moulded PVC shoe bottoms have been used increasingly in shoe manufacture in South

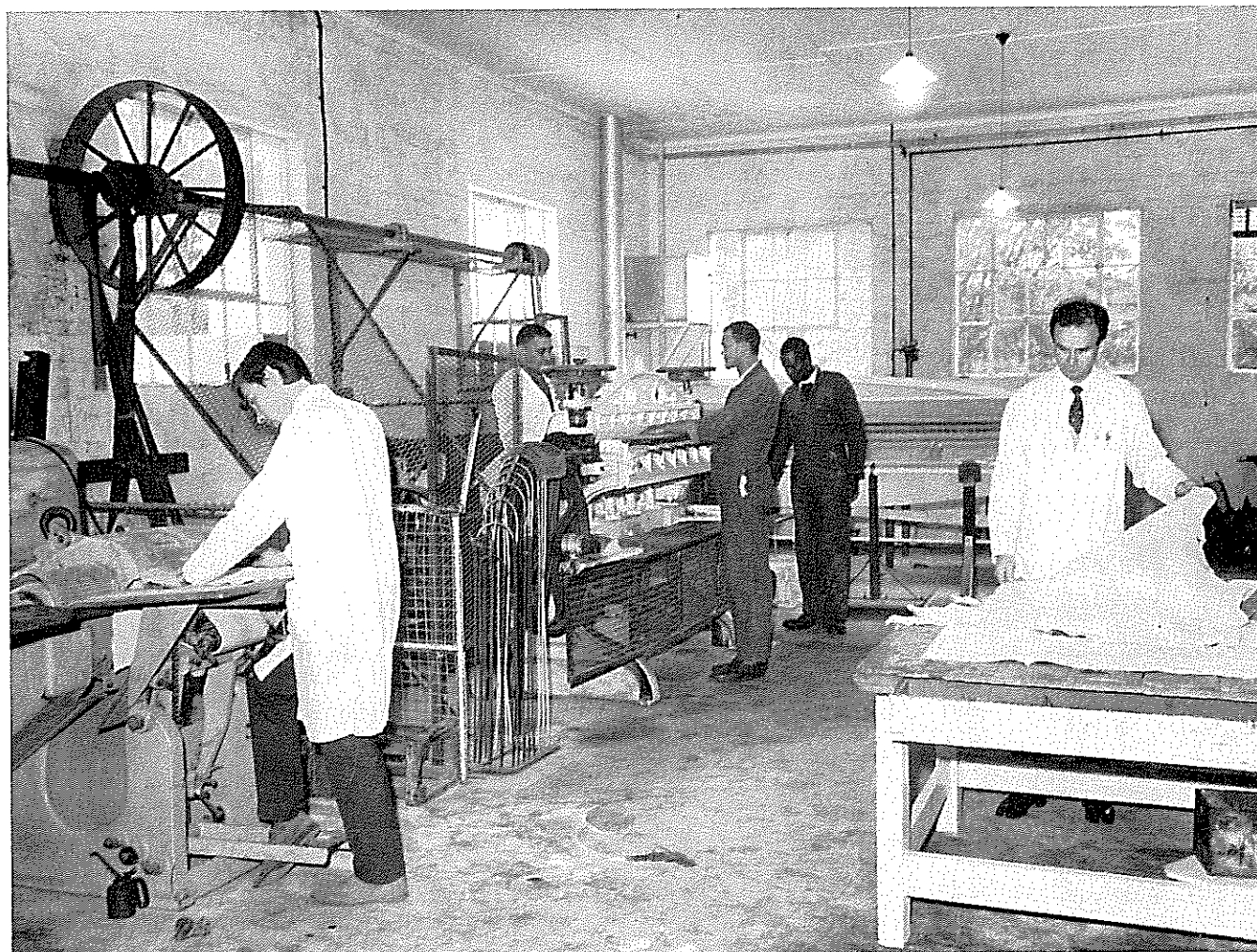
Africa. These materials and processes present special problems of adhesion and moulding and the Institute has assisted in the evaluation of polyurethane adhesives and PVC moulding compounds. Special attention has been paid to increasing the heat resistance of adhesives to improve their performance under South African conditions.

Polyurethane coated leathers and synthetic upper materials

The manufacture of current 'wet look' fashion leathers involves coating leather substrates with special high-gloss, flexible polyurethane finishes, very often applied over other synthetic resin base and pigmented colour coats. These processes pose problems of inter-coating adhesion, which affects the flex resistance of the finished leather. The Institute has developed special laboratory tests for assessing coating adhesion and flex endurance.

Modern 'poromeric' upper materials are laminated or through-structures of polyurethane; their modulus, elastic and plastic properties have been compared with those of different types of shoe upper leather. Their response to wetting, ability to absorb and transmit water vapour and their degradation by hydrolysis have all been studied at the Institute.

Part of the LIRI tannery pilot plant.





Dr R. J. Nachenius,
Director of the Fishing
Industry Research Institute
as from 1st June 1970.

Fishing Industry Research Institute

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

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

Research carried out at the Institute covers a very wide field including canning, chilling, freezing, salting and smoking of fish; production, storage and transport of fish meal and fish oil; the evaluation of the nutritional qualities of fish products; and the control of air and water pollution.

The Institute analyses finished products and raw materials for producers and buyers, and inspects fresh, frozen, salted, smoked, dried and canned fish. All South African and South-West African fish meal for export is sold on the basis of FIRI analyses and over 2 000 samples are analysed annually. This keeps the Institute in touch with the industrial problems and the results provide a good basis for the formulation of regulations, specifications and standards for raw materials and finished products. The Institute gives scientific and technical advice on specific problems and conducts tests for individual members at their expense. It also keeps its members informed of the latest relevant scientific and technical advances.

Fresh fish

Considerable attention has been given to improved methods of storing hake on trawlers as these go further afield for their catch. If fish are stored in ice, chemical treatment such as dipping them for 5 minutes in a 6 to 8 per cent solution of sodium tripolyphosphate with about 1 per cent ethylene diamine tetra-acetic acid (EDTA) at 0°C, and using ice containing 2 per cent of the phosphate with 0.1 per cent EDTA, virtually doubles the storage life to 20 days. Hake stored in fresh water saturated with carbon dioxide at 0°C remained fresh for 14 days as compared with 7 days for samples stored in untreated water.

FIRI also collaborates with overseas research organizations to ensure that the maximum benefit is derived from the current trend of freezing the catch at sea.

Salted fish

Salted fish, mainly hake and snoek, may become infected with halophilic micro-organisms which turn the fish pink or greyish-brown and make it inedible. If infection has already occurred, the bacteria and moulds can be combated successfully by dipping the fish in salt-sorbic acid solutions. The present trend is to pre-treat the fish in this way.

Fish meal

Sometimes the loads of fish delivered at factories are too small to warrant starting up the processing plant. The fish is likely to develop off-odours rapidly, particularly in hot weather, but the addition of 0.1 per cent sodium metabisulphite preserves it for up to 5 days. Apparently the quality of the meal made from the treated fish is not affected.

The accepted method in the manufacture of fish meal by pressing the cooked fish to remove the oil prior to drying is often found ineffective to reduce the oil content of the final dry product to the required level. The basic principles underlying pressing were examined and other methods of removing the oil tested. De-oiling by centrifugation of the mass of cooked fish was so successful that the necessary equipment has been installed at a factory and large-scale tests are in progress.

The effect of antioxidants on the nutritional value of fish meal has been tested both *in vivo* and *in vitro* and the results are being evaluated. Antioxidants keep the residual oil more soluble, the iodine value relatively high, tend to protect lysine availability and make the meal less reactive in terms of oxygen absorption and liability to spontaneous heating. Meal deliberately treated with inadequate amounts of antioxidant did not show signs of reactivation when stored for up to one year.

Amino acid analysis

The FIRI is doing research aimed at developing a more rapid and cheaper method of amino acid analysis. It is being endeavoured to use one of the existing gas chromatographs at the Institute to measure the amounts of certain amino acids in fish meal prepared from different species by different processes and stored under different conditions.

The amino acids as such are not volatile enough to be examined by gas chromatography, but if they are converted to the corresponding N-trifluoroacetyl butyl esters, results are encouraging. Qualitative examinations of fish meal hydrolysates have been successful and suitable conditions for obtaining quantitative results are being sought.

Tainting of flesh

The flesh of chickens and pigs is tainted if their feed contains high percentages of fish meal. A survey of chickens offered by the trade confirmed this. Tests carried out in co-operation with the Stellenbosch-Elsenburg College of Agriculture showed that diets containing more than 12.5 per cent of antioxidant-treated or fresh fish meal can taint the flesh. Cured meals (in



Dr G. M. Dreosti,
Director of the Fishing
Industry Research
Institute until 31st May
1970.

which the oil has been oxidized to some extent) forming 20 per cent of the diet do not impart a fishy taint, but make the meat less tasty. A starter ration containing 20 per cent antioxidant-treated meal followed by a ration with 12 per cent fish meal did not taint the flesh, but the flavour, instead of being typical of chicken, was rather insipid.

Taint is associated with the long-chain unsaturated fatty acids in the residual oil in the fish meal. The concentration of these fractions can be reduced by adding hydrogenated fish oil or other saturated fat to the presscake and repressing before drying. Feeding tests using such fish meal are under way. More fundamental research is also being done on the chemistry of tainting by fish meal.

Effluent

Disposal of effluents by evaporation is being tested as an alternative to chemical treatment or discharge into the open sea. Results are encouraging. Provided the salt content of the liquid is maintained above 10 per cent no off-odours develop. Entomological tests indicated that flies do not breed in the dry residue of evaporated effluent. Evaporation rates in the desert at Walvis Bay are high enough for an inland lake of moderate size to cope with the effluent from all the factories.

Salmonella in fish meal

Fish meal handled in bulk may have to be stored in an inert atmosphere, and to facilitate its transport it is pelletized. The effects of both treatments have been studied with regard to the survival of salmonella. Storage in nitrogen lowered the death rate by about 30 per cent as compared with storage in air. However, the heat treatment involved in pelletization immediately reduced the salmonella count in artificially inoculated meal samples by a factor of 10^2 to 10^3 .

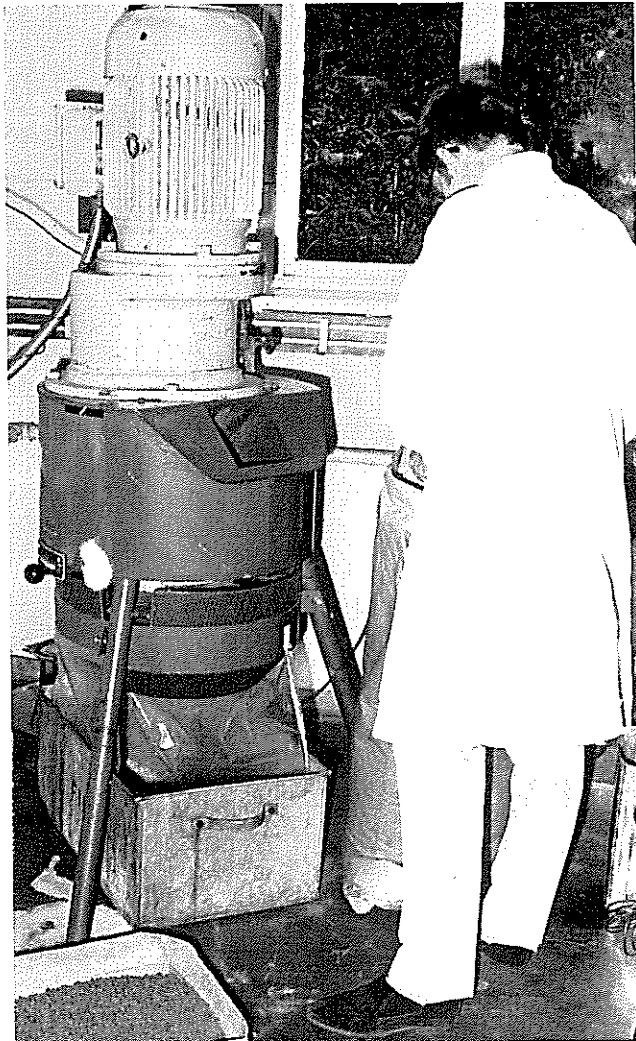
Bulk handling of fish meal

FIRI participated in a study of the feasibility of providing bulk handling facilities for the fish meal factories at Walvis Bay. The recommendations of the investigating committee will probably be adopted within the next two or three years.

Artificial bait for rock lobster

In collaboration with the Division of Sea Fisheries combinations of fish materials and inert carriers were tested as attractants for rock lobster. Disappointing preliminary results have led to a more fundamental study being undertaken.

Pelletizing machine used for tests on bacterial infection of fish meal.





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

Sugar Milling Research Institute

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

·**Research:** 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).

Diffusion

A laboratory study, initiated in 1969, of the mechanism of extraction, the most efficient method of extraction and the optimum extraction conditions during diffusion was continued. The results clearly indicated that preparation is the most important single variable in determining extraction and that with fine preparation a temperature of 68°C is adequate, producing the same order of extraction as at 78°C for 50 minutes retention. Whether or not advantage of the lower temperature could be taken in practice depends on the practical limit of preparation fineness. Unless preparation is extremely fine the amount of sucrose extracted from cane depends on diffusion. It has been concluded that commercial diffusers are controlled by diffusion and that design may be based on this principle.

The influence of retention times, temperatures, pH and cane preparation (degree of fineness) on extraction of reducing sugars, ash and colour, was not significant. Polysaccharides were the only impurities significantly affected by increased temperature and fineness but their levels were generally lower than those reported in the literature and were well within the range found locally in mill-mixed juices.

Impurities covered by the normal analysis represent only 90 to 93 per cent of the total impurities. The nature of the remaining 7 to 10 per cent is not clear, but it is known that organic acids form part of this fraction. The investigation was therefore extended to cover organic acids in diffusion juices, press-water and molasses. It was necessary first to develop analytical methods for determining these components and preliminary experiments indicated that a gas chromatographic technique seemed the most suitable. Preparation of

methyl-esters of a number of organic acids was therefore undertaken to provide the necessary standards.

Products of enzymatic starch hydrolysis

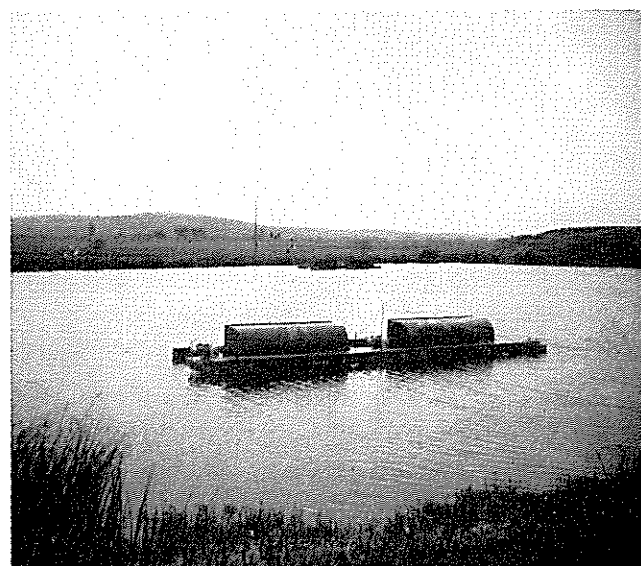
In contrast to the Rabe process, in which starch is mechanically removed from juice, enzymatic starch decomposition results in a number of starch fragments which remain in the process stream. It is therefore important to ascertain the nature of these products. Experiments were carried out using potato starch as substrate and a bacterial α -amylase under conditions which simulate an industrial enzymatic starch process. The reaction was allowed to proceed until 95 per cent of the starch present was hydrolysed. The total digest was concentrated and the oligosaccharides up to octatetraose were separated and estimated by means of quantitative paper chromatography. The recovery was between 95 and 100 per cent.

According to these experiments it appears that starch hydrolysis by bacterial α -amylases in sugar factories results in a range of oligosaccharides consisting mainly of maltotriose and maltohexaose and a dextrin fraction made up on the average of 60 glucose molecules.

Mixing of sugar and molasses

The Institute was requested by the Sugar Terminal Company to collaborate in the design of a mixing plant. Initially an extensive survey was conducted of equipment available from overseas suppliers, which may be suitable for mixing sugar and molasses on a large scale. Samples of sugar and molasses

Aerators at the Umfolozi Sugar Mill.



were sent overseas for testing on pilot mixing equipment and the finished product was evaluated. Tests were carried out at the University of the Orange Free State and at the CSIR on atomizing equipment for spraying molasses. A screw-type mixer was finally selected.

A basic preliminary design was prepared for the dosing plant and the Institute co-operated with the Terminal consultants in the final selection of control and dosing equipment. Flow characteristics under laminar flow conditions were established for various valves to be used in the Terminal plant.

Two tests were carried out during the loading of two ships to measure the flow rate fluctuation in the sugar during loading. For general export sugar the flow was within plus or minus 5 per cent of the mean for 98 per cent of a 30 000 ton load. For low pol sugar which was more sticky the flow fluctuations were slightly more serious but still of a low frequency and of a long-term nature. Although this indicated that flow ratio control was hardly warranted the consultants felt that it was necessary as a safeguard against sudden flow changes due to intermittent stoppages.

Tests showed that steam temperatures in excess of 140°C can be used in scraped surface heaters for heating molasses without significant colour formation. Subsequently it was shown that heating by direct steam injection does not cause a significant increase in colour. The small amount of condensate added would cause a very small increase in safety factor, which could if necessary be compensated for by lowering the limit for the solids content of molasses delivered to the Terminal.

An analysis of factors affecting the quality of coated sugar was undertaken and specifications have been drafted for the sugar which will be used in the Terminal plant.

Water pollution

The studies of water pollution at the Doornkop mill ended in August. Since the start of the investigations the partially-recirculating condenser water cooling system has been replaced by a totally recirculating one with the overflow pumped to irrigation, thus keeping all entrained sugar out of the river. In theory therefore the only remaining sources of pollution are the scum yard drain and windage from the spray terrace, which may blow into the river.

Further work was carried out on the stabilization ponds at Umfolozi. The ponds were surveyed and soundings were taken to calculate their volumes. An automatic flow recorder was installed in the main factory effluent and samples taken were analysed. It was found that although the two dams are fairly effective digesters they are not reducing the oxygen demand of the final effluent enough to make it suitable for discharge into the river under the present legislation. Both dams function anaerobically and the second dam appears to be overloaded. Present reduction of the chemical oxygen demand of the incoming effluent is nearly 90 per cent. To make the final effluent fit for discharge into the river, there are two alternatives, viz. to re-design the entire dam system, or to install surface aerators to increase the capacity of the present dams. The latter possibility is being investigated and details of available aerators are being collected.

Towards the end of the year work began on the final version of the *Code of practice for the control of water pollution by sugar mills*. A number of mills were visited and information was gathered on disposal practices, cleaning methods and water usage. A literature survey was done on practices in other countries. This work is being undertaken in co-operation with the National Institute for Water Research.

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



South African Paint Research Institute

Members of the South African Paint Research Institute (SAPRI) include manufactures of paint, manufactures of raw materials for industry and prominent consumers. Much of the work in this Institute is devoted to solving problems encountered by such organizations. In addition, it has a responsibility to the national economy in that its duties involve research in the vital field of protection by surface coatings in the very arduous conditions prevailing in this country. The research work of the Institute is guided by a Research Advisory Panel, consisting of CSIR appointees and of members elected by the annual general meeting.

At the last meeting of the Advisory Panel the programme of work was altered almost completely so that only interim results can be reported. Three main problems were investigated.

Control of hydroxyl value of resins

The present method of measuring hydroxyl values takes at least two hours and is therefore useless as a control during resin manufacture. The Institute was asked to devise a method which would yield an answer in 20 minutes or less.

A number of properties of resins have been measured, and the best method appears to be to measure absorption in the infra-red.

Release of solvents from paint films

Most paints contain a blend of solvents which are lost from the drying film, but not necessarily in order of volatility or boiling point. The final properties of the film, which are, of course, of interest to the user, are determined by that solvent which evaporates last. The film formation itself can be greatly

modified by the ratio of solvents present, which may vary throughout the drying process.

Methods have been devised to follow the composition and concentration of the solvent components during drying.

Adhesion of paint to substrate

A statistical evaluation of the 'pull off' method has been carried out on epoxy tar coatings on steel, leading to the general conclusion that the film is not pulled off the substrate but parts in itself, resulting in cohesive and not adhesive failure. That part of the film still adhering to the substrate may be so thin as to be invisible on ordinary examination. It may be impossible to measure adhesion as such. Instead, what is measured is the rupture of a layer in the body of the film which has been weakened by contamination.

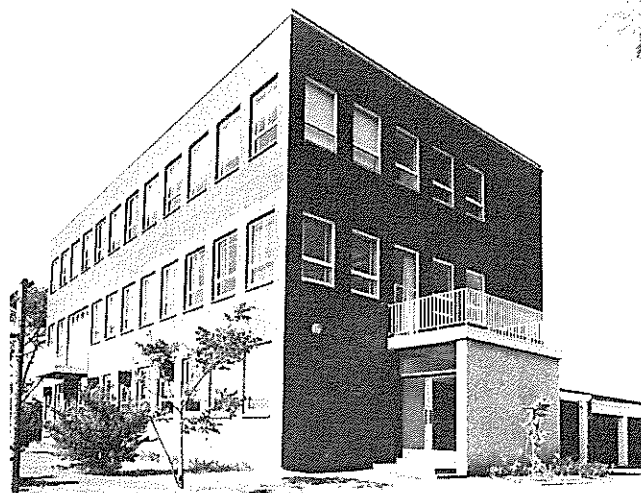
Analysis of materials

There is a constant demand from SAPRI members for the analysis of coatings or their constituent materials. In many cases of complaint or dispute the problem can be solved only by analysis, and the Institute therefore constantly investigates new or improved methods. Current topics of particular interest are the quantitative determination of amino resins in the presence of alkyds, and the determination of the mole ratios of dibasic acids in polyesters. An ultra-violet spectrophotometer has been purchased and should be very useful in the latter field.

Marine finishes

Exposure tests on a raft in Durban Bay continued. A new material, evaluated as a potential anti-fouling pigment, proved to be of no value for this purpose.

*Building of the South African Paint Research Institute at the
University of Natal, Durban.*



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



Technical Services Department

The Technical Services Department (TSD) undertakes the design and manufacture of 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 Graphic Arts Division's facilities for the manufacture of printed circuits were extended to meet consumer demand. The new extension provides amongst other things, for the manufacture of multilayer boards used in equipment which must be as small and as light as possible. A high-accuracy process camera has been installed and provision has been made for specialized plating techniques. The facilities are suitable for small runs of printed circuit boards, the quality of which will conform to military specifications.

Preparations for the establishment of a low-cost automation advice centre are nearing completion. Production methods simulated on a scale model will be used to advise small and medium-sized local industries with limited capital resources on the automation of mass-production processes. Simulation methods include electro-mechanical, pneumatic and hydraulic models of production processes. Low-cost automation will play an important role in the development of industries in South Africa with its shortage of skilled manpower. Results of investigations which can be applied by other industries will be published.

Training

The demand for craftsmen and technicians trained at the Training Centre for Instrument Makers has increased to such an extent that 50 per cent of those qualifying annually are recruited by the CSIR. Scientific instrument makers who after training leave the CSIR, take up employment in a variety of occupations. To meet the increasing demand for trained craftsmen and technicians the Training Centre is being expanded.

Projects

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

- A pilot plant for the horizontal hydraulic transportation of coal has been erected to establish the difference between the transport characteristics of segmented piping and conventional piping.
- A dynamic cone penetrometer, developed by the National Institute for Road Research for the measurement of the California Bearing Ratio of soil and the flexural behaviour of road foundations, was manufactured. A prototype mobile machine which simulates the pressure exerted on roads by moving wheels, was developed in collaboration with the National Institute for Road Research.
- The design and manufacture of equipment to mass-produce components for a dynamic axle weight analyser, designed

by the National Institute for Road Research, was undertaken on behalf of a manufacturer.

- An apparatus to determine the permanent deformation and fatigue characteristics of bituminous bonded materials under triaxial static and dynamic forces, was designed.
- An operating enclosure, ventilated with near-sterile conditioned air, to prevent wound infection during surgery, was manufactured for the H. F. Verwoerd Hospital.
- Several pressure transducers used to measure cerebral fluid pressure have been manufactured for neurosurgical research.
- An apparatus to determine the influence of milk containing penicillin on the bacteriological action of cheese-manufacturing processes, has been manufactured for the Dairy Control Board.
- A high-accuracy barometer for the calibration of altimeters in the range of 0 to 800mm Hg has been designed in collaboration with the National Physical Research Laboratory.
- A sample holder more easily manipulated than conventional holders has been designed and manufactured for electron microscope studies of single crystal structures.
- A water-cooled ruby laser for spectrochemical studies, which can discharge 25 shots per second, has been designed and manufactured in collaboration with the National Physical Research Laboratory.
- An improved tilting chamber for testing pupil pilots has been manufactured for the National Institute for Personnel Research.
- An apparatus for measuring the intensity of light sources has been manufactured for the South African Bureau of Standards.
- Various items of equipment for testing wool fibre, including a woolteasing scouring machine and a yarn friction tester have been built for the South African Wool Textile Research Institute.
- A prototype apparatus for the automatic control of flow of the water to sludge settling tanks, has been designed and installed at a mine.
- A model water-thickening apparatus has been manufactured to study the settling of flocculants and their effect on silt deposits.
- A working scale model of a sewage purification plant was manufactured for the water year exhibition.
- A pilot plant has been built for the extraction of agar from South African seaweed.
- Equipment has been manufactured for the study of the flow properties of water pumped through pipes and manifolds of different sizes.
- An apparatus to determine the efficiency of stacked air/liquid heat exchangers for chemical processing has been manufactured.

Technical information

The services of the Technical Information Division have, in collaboration with the CSIR's Information and Research Services, been supplemented by regular bulletins of concise information on topics with a specific bearing on the activities of the Technical Services Department.

Financial Statements

CSIR
Annual Report 1970

Balance sheet

as at 31st March 1970

CSIR
CENTRAL SCIENTIFIC INSTITUTES

	General Fund	Building Fund	1970	1969
Accumulated fund			R33 104 836-73	R31 349 947
Balance as at 31.3.1969	R19 205 567-11	R12 144 380-14		
Inter-fund transfers	322 000-00 (—)	322 000-00		
Transfer to SAMRC	18 883 567-11 1 316 512-56	12 466 380-14		
Sub-total	17 567 054-55	12 466 380-14		
Capital receipts				
Parliamentary grants:				
CSIR	1 388 500-00	450 000-00		
Grants	111 800-00			
Donations:				
CSIR	57 451-00	30 452-44		
Grants	1 569-57			
Interest		167 545-20		
Sale of assets written off:				
CSIR	20 209-03			
Grants	328-24			
Investigations and services	771 134-96			
Sub-total	2 350 992-80	647 997-64		
Add:				
Excess income	520 310-63			
Adjustment previous years:				
CSIR	5 052-20 (—)			
Grants	267-13			
Nett value of physical assets transferred	50 437-28			
	2 916 955-64	647 997-64		
Less:				
Cost of assets written off:				
CSIR	476 211-18			
Grants	17 340-06			
Sub-total	2 423 404-40	647 997-64		
Total	R19 990 458-95	R13 114 377-78	R33 104 836-73**	R31 349 947
Current liabilities				
Advances for investigations and services			1 804 700-22	2 246 998
Sundry creditors and credit balances			1 423 975-03	1 337 331

Total			R3 228 675-25	R3 584 329
Grand total			R36 333 511-98	R34 934 276

Notes: *Value of Assets transferred to S.A. Medical Research Council R1 142 372-56; to S.W.A. Administration R8 740-00 and from Magnetic Observatory R59 177-28.

**Contractual obligations against the General and Building Funds as at 31st March 1970 was R1 234 387 and R364 195 respectively.

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

J. H. Visagie *Secretary/Treasurer*

Pretoria, 23 September 1970

Statement No. 1

South African Council for Scientific and Industrial Research

	Additions		Written-off	Phys. assets transferred*	1970	1969
	Grants	CSIR				
Fixed assets (at cost)						
Land and buildings		R1 373 613-74			R12 722 090-04	R11 348 476
Laboratory equipment	165 662-63	1 483 866-70	438 886-34	1 032 339-76	14 479 608-53	14 301 305
Furniture and office equipment	192-26	145 447-60	18 722-13	33 500-20	1 014 613-26	921 196
Vehicles and cycles	—	388 101-63	35 682-77	106-15	720 226-37	367 914
Books and journals	172-94	107 680-05	260-00	21 411-34	896 304-98	810 123
Prefabricated structures	—	288-80	—	4 577-83	9 456-43	13 746
Shares in S.A. Inventions Dev. Corp.	—	—	—	—	140 000-00	140 000
Stores stock	—	54 972-99	—	—	381 338-82	326 366
Sub-total	166 027-83	2 180 357-77	493 551-24	1 091 935-28	17 641 548-39	16 880 650
Total	R166 027-83	R3 553 971-51	R493 551-24	R1 091 935-28 (—)	R30 363 638-43	R28 229 126
Current assets						
Wool stock					3 764-95	—
Sundry debtors and debit balances					1 269 310-55	814 731
Investigations and tests in progress					1 220 229-15	970 461
Advances and deposits:						
Research grants				320 416-07		
Other				287 876-07	608 292-14	1 393 795
Investments					2 738 271-35	3 357 727
Cash:						
At S.A. Reserve Bank				103 899-22		
Petty cash imprests				26 106-19	130 005-41	168 436
Total					R5 969 873-55	R6 705 150
Grand total					R36 333 511-98	R34 934 276

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

H. R. P. A. Kotzenberg *Controller and Auditor-General*
Pretoria, 12 October 1970

Operating account

for the year ended 31st March 1970

	1969/1970			1968/69
	University Institutions	CSIR	Total	
Expenditure				
Salaries, wages and allowances	R129 884-63	R10 804 003-13	R10 933 887-76	R9 073 700
Consumable stores and services	8 041-93	4 661 687-88	4 669 729-81	5 739 649
Subsistence and transport	9 022-76	550 957-36	559 980-12	555 459
General expenses	33 115-71	1 574 227-14	1 607 342-85	1 752 511
Subsidies:				
Research by industry	—	278 628-63	278 628-63	246 886
Grants	598 313-51	—	598 313-51	956 171
Sub-total	778 378-54	17 869 504-14	18 647 882-68	18 324 376
Less: Income for internal services.	3 421-10	2 142 119-18	2 145 540-28	1 955 324
Sub-total	774 957-44	15 727 384-96	16 502 342-40	16 369 052
Balance transferred to Accumulated Fund	13 957-01 (—)	534 267-64	520 310-63	12 743 (—)
Total	R761 000-43	R16 261 652-60	R17 022 653-03	R16 356 309

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

J. H. Visagie *Secretary/Treasurer*

Pretoria, 23 September 1970

Statement No. 2

South African Council for Scientific and Industrial Research

	1969/1970			1968/69
	University Institutions	CSIR	Total	
Income				
Parliamentary grant	R754 300-00	R8 866 900-00	R9 621 200-00	R8 125 040
Contributions to CSIR projects	—	575 042-59	575 042-59	525 060
Investigations and services	—	6 744 939-04	6 744 939-04	7 659 403
Publications	4 050-43	9 527-23	13 577-66	9 248
Sundry	2 650-00	65 243-74	67 893-74	37 558
Total	R761 000-43	R16 261 652-60	R17 022 653-03	R16 356 309

CSIR Budget 1970/71

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	12 913 482	4 279 204	573 529	580 121	—	1 792 650	2 653 200	17 485 786	9 364 800	8 120 986
Grants and subsidies	200 950	13 046	25 580	28 111	1 324 858	40 234	95 579	1 537 200	1 507 700	29 500
Total.	13 114 432	4 292 250	599 109	608 232	1 324 858	1 832 884	2 748 779	19 022 986	10 872 500	8 150 486

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	94 400	2 570 716	75 895	50 170	3 000	1 300 000	4 094 181	2 395 500	1 698 681	
Grants to universities etc.	750	100 951	699	—	—	—	102 400	102 400	—	
Total.	95 150	2 671 667	76 594	50 170	3 000	1 300 000	4 196 581	2 497 900	1 698 681	
Grand totals								23 219 567	13 370 400	9 849 167

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Subject Index

- accidents, traffic, 33
acoustic consultation, 9
adhesives for footwear manufacture, 47
adhesives for timber, 39
agar, extraction of, 53
air-conditioning, 20
aircraft construction, 22
aircraft design, 22
aircraft fatigue, gust loading effects on, 22
aircraft noise, 22
air pollution research, mobile laboratory for, 28
air-sampling network, 28
alarm signalling system, 16
algae, 23
amino acid analysis, 48
anaerobic digestion of raw sewage, 25
analysis of materials, 52
Antarctic research, 12
anti-shark research, 8
architectural planning, 36
artificial bait for rock lobster, 49
Atmospheric Pollution Prevention Act, 28
automation, 11
automation advice centre, 53
axle weight analyser, 53
- bacteria, pathogenic, 24
bait for rock lobster, 24
Bantu beer, 5
Bantu labour in industrial areas, 30
Bantu labour utilization, 30
Ben Schoeman Highway, vehicle vibration on, 32
bilharzia, 5
biostatistics, 14
board products, 39
boilers, low-pressure, 24
border industrial areas, Bantu labour in, 30
bricklayers, shortage of, 30
brick masonry, multi-storey load-bearing, 35
brick panels, prefabricated, 35
building, operations research in, 37
Building and Construction Advisory Council, 35
building committees, 35
building congresses, 35
building, international activities in, 38
building materials, evaluation of new, 36
building methods, 36
building symposia, 35
bunting, wool-rich, 42
- calcification, tissue, 27
cancer biochemistry, 6
carding, fibre breakage in, 42
cement, storage of, 36
cerebral fluid pressure, 53
chemical analysis, 10
chemistry, flavour, 26
circuits, printed, 53
- coal, large-scale testing *in situ*, 20
coastal design, 21
coatings, 37
collagen, 46
computer centre, 14
concrete, prestressed, 38
concrete, reinforced, 38
concrete technology, 36
cone penetrometer, dynamic, 53
construction, operations research in, 37
corrosion, 5
cosmic rays, 11
Co-we-nit, 42
- data-acquisition systems, 15
data bulletins, 12
data processing by computer, 15
deep electrical survey, 10
design weather data, 37
deuterium content of organic material, 9
diesel vehicles, smoke from, 28
dieldrin, toxicity to fish, 24
diffusion, 50
distance measurement, 17
double-knit structures, knitting performance of, 42
drilling platform, floating, 21
dual-carriage highways, 33
dyeing karakul wool, 41
dyeing of wool in organic solvents, 41
dynamic cone penetrometer, 53
dynamics, flight, 22
- effluents, disposal by evaporation, 49
effluents into the sea, 24
electrical engineering, 15
electrical resistivity of soil, 15
electrical soundings, ultra-deep, 9
electronics, medical, 15
electrophysiological data, 29
entanglement meter, 41
enzymatic starch hydrolysis, products of, 50
ethnic group, work motivation in, 31
expansive soils, foundations on, 37
extra-high voltage, 16
- factory stacks, pollutants from, 28
fatigue damage, accumulation of, 20
ferrous castings, surface quality of, 19
fibre breakage in carding, 42
films, 35
finishes, marine, 52
Fischer-Tropsch waxes at high pressure, 9
fish, fresh, 48
fish meal, 48
fish meal, bulk handling of, 49
fish production, 25
fish, salted, 48
fish, toxicity of dieldrin to, 24
flavour chemistry, 26
flight dynamics, 22
foods, composition of South African, 26
- footwear manufacture, adhesives for, 47
footwear manufacture, PVC for, 47
foundations on expansive soils, 37
foundry problems, technological, 19
fracture mechanism of rock, 20
fungi, toxic metabolites from, 5
- geomagnetic field-stations, 11
geomagnetism, 11
geophysics, 10
glow discharge source, 9
gold, chemistry of, 6
gold reduction plant, 15
grants, university research, 45
granular material, conveyance of, 20
ground-water, age of, 8
growth hormones, human, 6
gust loading effects on aircraft fatigue, 22
- hail, 8
hand knitting yarns from mohair, 42
harbour developments at Richards Bay, 21
heat exchangers, 6, 20
heat loss from human body, measurement of, 21
hides, preservation of, 46
high-speed wind tunnel instrumentation, 22
Highway, Ben Schoeman, 32
highways, dual-carriage, 33
highways, technical recommendations for, 32
housing, low-cost, 36
hydroxyl value of resins, 52
- industrial areas, Bantu labour in, 30
illiterates, continuous work tests for, 30
impact properties of metals, 20
industrial development, 44
industrial effluents, irrigation with mineralized, 24
industrialization, 29
industrial research, 44
industry, rock mechanics for, 20
information, collection of, 43
information, dissemination of, 43
information, technical, 53
inorganic materials, 36
insect pheromones, 5
Instrument Makers, Training Centre for, 53
instruments, testing, 41
insulation, 16
international scientific liaison, 45
ion exchange columns, 6
ionospheric research, 17
iron utilization, 27
irrigation with mineralized industrial effluents, 24
- joints, timber, 40

- kaffircorn grits, preparation of, 27
karakul wool, dyeing of, 41
knitted wool fabrics, dimensional properties of, 42
knitting performance of double-knit structures, 42
knitting yarns from mohair, hand, 42
knitting yarns from mohair, machine, 42
- labour utilization, Bantu, 30
La Cour variometers, 11
lanthanide chelates, volatile, 9
leather, properties of, 46
leather, polyurethane coated, 47
liaison, international scientific, 45
library, NIPR, 31
lightning, 15
lightning, source of radio noise in, 17
lightning damage to electronic equipment, 16
LIRITAN, 46
low-cost housing, 36
- machine knitting yarns from mohair, 42
machine tools, numerical control of, 14
machine variables, 42
machine washable wool, 41
magnetic activity indices, 12
magnetic conjugate point programme, 11
marina development in Knysna lagoon, 21
marine finishes, 52
marine pollution, 24
materials, analysis of, 52
materials, evaluation of new, 36
materials, inorganic, 36
materials data system for metals, 19
material testing, 19
mealies, 26
medical electronics, 15
metabolism in ruminants, 5
metals, impact properties of, 20
metals, materials data system for, 19
meteorological programmes, 12
metric fittings, 47
metric sizes, 47
microbiology, 27
milk containing penicillin, 53
mill liners, wear testing of, 19
mobile laboratory for air pollution research, 28
mohair, hand knitting yarns from, 42
mohair, machine knitting yarns from, 42
molasses and sugar, mixing of, 50
monolithic integrated circuit operational amplifier, 16
multi-storey load-bearing brick masonry, 35
- neuropsychological data, 29
NIPR library, 31
Noble comb for short wool, 42
noise, aircraft, 22
noise, analysis, instrument for, 8
- numerical control of machine tools, 14
- oceanography, 9
ocean wave research, 21
operating enclosure, 53
operations research in building, 37
operations research in construction, 37
organic solvents, 41
ozone observations, 11
- paint, 37
paint, adhesion to substrate, 52
paint films, release of solvents from, 52
paper, preservation of, 40
paper industry, techno-economic survey of, 40
parasites in water, 24
particle technology, 7
pathogenic bacteria, 24
penicillin in milk, 53
personnel training manuals, 29
pharmacological activity, substances with, 5
pheromones, insect, 5
Phormium tenax processing, 20
photo-electric observation of long period variable stars, 13
phragmalin, structure of, 9
piping, segmented, 53
planning, architectural, 36
plasterers, shortage of, 30
plastic deformation, 19
platinum, chemistry of, 6
plumbing systems, 36
pneumoconiosis, 6
pollutants from factory stacks, 28
pollution, marine, 24
Pollution Prevention Act, Atmospheric, 28
pollution, water, 51
polyurethane coated leathers, 47
polyurethane foams, 37
position fixing, 17
prefabricated brick panels, 35
prestressed concrete, 38
printed circuits, 53
process control, 15
programming, 15
protein chemistry, 6
protein evaluation, rat breeds for, 27
psychological tests, 29
publicizing results of research, 44
publishing results of research, 44
pulp, 40
pulpwood, requirements of, 40
PVC for footwear manufacture, 47
- radar, high-resolution, 8
radar, measuring rainfall by, 17
radio astronomy, 18
radio sonde for measuring temperature, 28
radio waves, absorption of, 12
rainfall measurement by radar, 17
rat breeds for protein evaluation, 27
raw sewage, anaerobic digestion of, 25
- reclamation, water, 23
refraction surveys, seismic, 10
refrigeration, 20
reinforced concrete, 38
research results, publicizing of, 44
research results, publishing of, 44
resins, hydroxyl value of, 52
Richards Bay, harbour developments, 21
river research, 23
road tars, 32
road traffic problems, 14
rock, fracture mechanism of, 20
rock, large-scale *in situ* testing of, 20
rock lobster, artificial bait for, 49
rock mechanics services to industry, 20
rock slopes, stability of, 20
roof trusses, 40
rope testing methods, 21
ruby laser, water-cooled, 53
ruminants, digestion in, 5
- salmonella in fish meal, 49
sandbeds, storing reclaimed sewage water in, 24
sand dam research, 21
scientific staff, selection of CSIR, 31
sea, effluents into the, 24
seasoning, timber, 39
seismic refraction surveys, 10
seismological programmes, 12
selection of CSIR scientific staff, 31
semiconductor analysis, 16
sewage, anaerobic digestion of raw, 25
sewage, purified, 23
sewage water stored in sandbeds, 24
shadowscope, solar, 37
shark research, anti-, 8
silicate analysis, 6
single crystal structures, 53
skins, preservation of, 46
smoke from diesel vehicles, 28
soil compactor, 32
soil, electrical resistivity of, 15
soils, foundations on expansive, 37
soil, thermal resistivity of, 15
solar shadowscope, 37
solvents from paint films, 52
solvents, organic, 41
sorghum, 14
soybeans, processing of, 27
space research, 18
spark mass spectrographic studies, 9
starch hydrolysis, enzymatic, 50
stars, long period variable, 13
steel wire ropes, testing of, 21
Stone Age in Southern Africa, 8
stress analysis, 19
stress-grading, 39
stress in rock, 20
substrate, adhesion of paint to, 52
sugar and molasses, mixing of, 50
synthetic upper materials, 47
systems development, 39

- taints in chicken meat, 48
 taints in pork, 48
 tanning, 46
 technical information, 53
 techno-economic studies, 40
 temperature, radio sonde for measuring, 28
 textile training, 41
 thermal resistivity of soil, 15
 thin-film technology, 16
 tilting chamber, 53
 timber, adhesives for, 39
 timber joints, 40
 timber seasoning, 39
 tissue calcification, 27
 toxicity of dieldrin to fish, 24
 toxic metabolites from fungi, 5
 trace elements, identification of, 28
 trace elements, measurement of, 28
 tracking, radio techniques in, 8
 tracking equipment for wild animals, 15
 traffic accidents, 33
 Training Centre for Instrument Makers, 53
 training manuals, personnel, 29
 tritium, proportional counter for natural, 8
 ultra-deep electrical soundings, 9
 university research grants, 45
 upper materials, synthetic, 47
 variable stars, long period, 13
 vehicle vibration on Ben Schoeman Highway, 32
 viruses in water, 24
 volatile lanthanide chelates, 9
 voltage, extra-high, 16
 water-cooled ruby laser, 53
 water, parasites in, 24
 water pollution, 51
 water reclamation, 23
 water reclamation model at Rand Easter Show, 23
 water-thickening apparatus, 53
 water, viruses in, 24
 wattle, alternative uses for, 46
 weather data, design, 37
 weft skewing, 42
 wild animals, tracking equipment for, 15
 winding ropes, service behaviour of, 21
 windows, resistance to wind and rain, 35
 wind tunnel, instrumentation for, 22
 withdrawal force meter, 41
 wool, dyeing of, 41
 wool, machine washable, 41
 wool, Noble comb for short, 42
 wool fabrics, dimensional properties of knitted, 42
 wool-rich bunting, 42
 woolteasing scouring machine, 53
 wool types, processing South African, 42
 work motivation in an ethnic group, 31
 work tests for illiterates, continuous, 30
 worsted fabrics, wrinkling of, 41
 wrinkling of worsted fabrics, 41
 yarn friction tester, 53
 yarn properties, 42
 yeast taxonomy, 27
 yeasts, 27

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