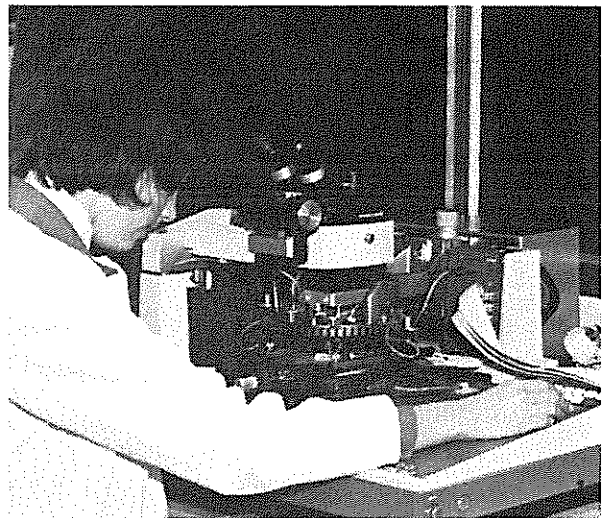


CSIR
annual report
1978





Council for Scientific and Industrial Research

CSIR

1978

annual report

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EXECUTIVE OF THE CSIR

President — Dr C v d M Brink. Deputy President — Dr F J Hewitt. Vice-Presidents — Dr P J Rigden; Dr J F Kemp; Dr D M Joubert (until 31 December 1978); Dr C F Garbers (as from 1 January 1979); Mr J P de Wit (as from 1 January 1979).

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The Hon. J C Heunis
Minister of Economic Affairs and
Environmental Planning and Energy

Sir

I have pleasure in presenting to you the thirty-fourth Annual Report of the Council for Scientific and Industrial Research. This report covers the period 1 January 1978 to 31 December 1978.

Balance sheets and statements of income and expenditure for the financial year ended 31 March 1978, certified by the Controller and Auditor-General, are included.

Yours faithfully

C v d M Brink
PRESIDENT: Council for Scientific
and Industrial Research
PRETORIA

1 April 1979

The year in retrospect



- The growth and development of the CSIR over the past 33 years have been closely related to the needs of the country. The main objective with which the Council was established in 1945 was to assist in developing our human and natural resources, and it has, throughout the years, concerned itself with research directly related to national progress while developing its expertise and facilities accordingly.

In recent years there has been a new approach to industrial research and development. Because of the rapidly changing international situation, economic considerations of yesterday no longer apply, and the entire question of import replacement, export promotion and a greater national self-sufficiency in all fields is being reconsidered. This has so far entailed, amongst other things, a re-evaluation of the utilisation of our raw materials and of our capacity to manufacture certain commodities. Attempts are currently being made to bring about a more dynamic and immediate technological awareness, based on a more effective interaction between the economy and technology.

Here an important part is played by the techno-economist, and also in this field the CSIR has, through the years, developed its expertise — including more recently the identification of key technologies which are expected to play an important part in economic, social or strategic developments or in protecting the resources of the Republic. These technologies include existing ones, ones that are currently being developed, and also ones that are merely foreseen in the less immediate future. A method has lately been developed for the identification of key technologies in particular sectors from data systematically assembled in a central databank.

For example, because of the chemical industry's importance to the South African economy, steps have been taken to establish such a databank for this industry. Information on a total of 800 product categories is collected and from this a short list of those categories which may be used to identify key technologies is compiled according to certain priorities, such as high import value, large import volume, high unit prices, high growth rates, strategic importance, and local manufacturing potential. From an analysis of imports a number of chemical product categories have already been identified for further in-depth analysis. A report was published during the year under review and

further data on local production and consumption are being collected.

Partly related to the above is the vital question of energy sources. As this covers such vast ground, it has been necessary to identify key areas and to concentrate all available expertise on these areas. The CSIR is currently engaged in the co-ordination of a national energy research programme, as part of its co-operative scientific programmes, to promote the conservation of energy and the utilisation of alternative energy sources to supplement or substitute imported petroleum. Problems that can best be solved by co-operative research are identified and defined, priorities for energy research in South Africa are determined, and research within the priority areas is selectively promoted.

The National Committee for Energy Research will from time to time be reporting to the Energy Policy Committee and to other interested bodies. To carry out its tasks as efficiently as possible, the Committee recently subdivided the field of energy research into four separate areas that were judged to be of the greatest current interest. These are (1) alternative chemical fuels, (2) renewable chemical energy sources and related energy storage, (3) the exploitation and utilisation of coal, and (4) energy conservation and rationalisation. Subcommittees have been appointed to give closer attention to research in each of these fields and, where necessary, to appoint technical committees and working groups. The members of both the National Committee and the subcommittees are scientists representing various interest groups and disciplines. In accordance with the principle of co-operative scientific programmes, research workers from both the public and the private sectors are invited to collaborate while liaison is maintained with international organizations in the field of energy research and development.

The interest expressed in the activities of the CSIR at the highest government level is gratifying. During the year the organization was honoured by a visit from the former State President, the late Dr N J Diederichs, with whom the CSIR was closely associated when he was Minister of Economic Affairs, with the CSIR under his portfolio. As head of State, Dr Diederichs maintained a lively interest in economic development, hence his desire for first-hand

information on the activities of the CSIR. It was with deep regret that the Council learned of his death shortly after the visit.

The CSIR was again linked with the portfolio of Economic Affairs in November 1978 when the present Minister, the Hon J C Heunis, was given the additional portfolio of Planning and the Environment. The Council looks forward to a fruitful period of co-operation with Mr Heunis and wishes to take this opportunity of expressing its appreciation to the former Minister of Planning and the Environment, Dr S W van der Merwe, for his co-operation and support over the past three years.

Some of the developments of the past year are highlighted here under broad headings related to national development, while specific activities are dealt with in greater detail elsewhere in the report.

DEVELOPMENT AND APPLICATION OF KNOWLEDGE

In addition to the obvious benefits to be gained from the development and improvement of products and processes for import replacement and export promotion, research should also be aimed at the long-term benefits which are to be derived from the development of our local knowledge and expertise.

Such expertise gained over the years in satellite tracking and remote sensing has enabled the CSIR to play an important role in the utilisation of data transmitted by satellite. Since the beginning of the year under review, images have been received from the meteorological satellite, Meteosat, and processed at the CSIR's Satellite Remote Sensing Centre at Hartebeesthoek before being transmitted by landline to the Weather Bureau in Pretoria. These images supplement conventional meteorological observations and are particularly valuable for aviation purposes. The CSIR has also been making a significant contribution to the interpretation of Landsat satellite data on the earth's resources.

Scientists from the CSIR are playing a major part in a comprehensive exercise related to the interpretation of data from the Nimbus 7 satellite. This satellite provides useful

data for a study of a number of oceanographic features, including the Agulhas Current and the upwelling area along the Cape West Coast. The first phase of the project, which involves observations also from research vessels and aircraft, was launched towards the end of 1978.

Receiving and processing such satellite data obviously require a high degree of expertise, in addition to highly advanced and expensive facilities. With the support of the Treasury, which made available the necessary funds on the recommendation of the Scientific Adviser to the Prime Minister, the CSIR was able to retain, adapt and expand the remote sensing equipment originally used in the NASA space programme at Hartebeesthoek.

A further contribution to weather forecasting was made by mathematicians of the CSIR who developed a criterion for the selection of consistent sets of basic equations for an atmosphere of which the lower boundary is the actual surface of the earth. The usual mathematical models used to describe the physics of the atmosphere in weather forecasting usually disregard the topography of the earth's surface in their simplification of the equations for numerical solution. As the presence of mountain ranges has a significant effect on weather patterns in South Africa, the new development is of particular value.

A new mycotoxin known as diplosporin has been identified as the toxic constituent of the fungus *Diplodia macrospora* and structurally analysed by CSIR chemists. Elucidation of the biosyntheses of diplosporin is of considerable scientific interest and also has implications in agriculture, as *Diplodia macrospora* is one of the major contaminants of maize in areas with a warm humid climate.

Another significant advance in the field of chemistry has been the discovery that the venom of the South African horned adder (*Bitis caudalis*) contains a potent neurotoxin for which existing snake bite antiserums offer no protection. This is the first reported instance of neurotoxicity in a member of the adder family in South Africa. The structure of the toxin has been determined and the information made available to the South African Institute for Medical Research which is now producing a specific antiserum for the treatment of persons bitten by the horned adder.



The main entrance, CSIR Conference Centre.

search by CSIR chemists has helped to elucidate the mechanism of alternating current corrosion. Until recently it was generally believed that alternating electric currents do not cause metal corrosion, but it has now been found that corrosion can occur above certain critical levels. This discovery could play an important role in the elimination of leakage problems such as in water pipelines near electrified railway lines, particularly as alternating current is now being used for traction on certain new sections.

A highly accurate instrument for material analysis has been developed by CSIR researchers. With this instrument, known as an atomic fluorimeter, various elements may be detected in extremely minute quantities in a variety of materials (such as copper in steel and aluminium, and copper and silver in gold). The instrument is also suitable for determining carbon, sulphur and phosphorus concentrations in steel.

A sound intensity meter capable of isolating the noise output from one particular source, even in the immediate proximity of other sources, has been developed and constructed at the CSIR. A sound intensity meter of this nature will be a valuable aid to noise control in industrial environments, where it is not feasible to isolate single machines for noise measurement by silencing all others.

Substantial progress has recently been made with an investigation into the possibility of using locally available raw materials for the production of catalysts that are currently imported at high cost. The CSIR has already succeeded in preparing several zeolites from raw materials such as kaolin, silica and alumina for use as cracking catalysts in the conversion of heavy hydrocarbons to motorcar fuels. Silica is locally available in South Africa while alumina deposits were recently discovered.

Studies on the pulping properties of *Eucalyptus grandis*, the main hardwood used for pulping in South Africa, have yielded results which can be applied by the Department of Forestry in the genetic improvement of pulpwood trees. This is a good example of technical development leading to the improvement of raw materials.

An efficient and economical system for the continuous monitoring of waste water quality has been developed by

the CSIR. This system is based on the principle that polluting substances in water cause changes in normal patterns of fish movement. The movement of fish in a series of tanks is measured by means of ultrasonic waves and an alarm is activated when a certain level of pollution is exceeded. This system is far less expensive than the automatic monitoring systems used in the major industrial countries.

DEVELOPMENT OF THE INFRASTRUCTURE

A considerable proportion of the work at the CSIR is directed towards the development of a sound infrastructure for economic growth. This includes research into roads, transport systems, harbours, water supplies, pipelines, telecommunications and other communications, as well as into building and construction. Some recent examples are briefly reviewed.

At the request of the Mealie Industry Control Board the CSIR undertook a study to establish the most economic means of transporting maize from some 250 railway sidings to approximately 120 mills in the Republic, with due regard to the interest of the users. An operational research team at the CSIR succeeded in devising a scheme that meets these requirements, and this has now been introduced by the Control Board.

The CSIR is involved in a project to investigate means by which the private sector can supplement government housing projects. This includes the production of a series of designs for different types of house in accordance with the layout of the town and its community facilities, as well as an investigation into the preferences of the employees and their possible participation in the planning of projects. A demonstration project is currently being carried out at kaNyamazane, a Black area in the Nelspruit district. One of the characteristics of this scheme is the arrangement of houses around open spaces of various shapes and sizes that are connected directly to service roads. This has the advantage of better land utilisation, fewer access roads, and a resulting reduction in capital and maintenance costs.

A systematic investigation initiated in 1976 revealed that

the deterioration of concrete structures such as bridges and buildings in the Cape Peninsula had assumed serious proportions. The deterioration was found to be due mainly to expansion of the concrete as a result of a reaction between the alkalis in the cement and the aggregate normally used in this region. An interim report defining the problem and offering possible solutions has been published in a leading South African engineering journal.

INDUSTRIAL DEVELOPMENT

The activities of the CSIR in this category include a study of technological innovation as a factor in industrial development and economic growth, the promotion of research in industry, research projects in the CSIR's own laboratories on behalf of various industrial sectors, and services related to production technology.

Considerable expertise has been acquired in the manufacture of custom-made, special-purpose integrated circuits in the two years since the CSIR's Integrated Circuit Production Facility came into operation. By using these circuits a number of South African manufacturers of electronic equipment have become less dependent on overseas component suppliers and have been able to simplify some assembly stages and produce more reliable end-products. The suitability of these circuits for applications ranging from mining operations, communications and computing to electricity consumption metering is being studied.

Mechanical stress grading results in a more efficient utilisation of South African structural timber, which can improve the country's export position. Because of an upsurge of interest in mechanical stress grading by the saw-milling industry, the CSIR has expanded its research in this field. A considerable amount of research has also been done on the visual stress grading of timber, and these results are being used by the South African Bureau of Standards as a basis for revising its specifications.

Research into the application of the technique of sizing fine singles yarn to strengthen it sufficiently for lightweight wool shirting fabrics has produced promising results. It has been possible to develop a drip-dry lightweight wool shirt

fabric which is completely machine-washable. The CSIR is promoting this development in the textile industry in collaboration with the South African Wool Board.

The Liritan process for sole leather tanning has been further developed to reduce the waste of vegetable tannins. The Liritan process, which is virtually effluent-free, has evoked considerable interest abroad — particularly in the USA, where it has been successfully applied by a tannery which was faced with major effluent problems. Various bleaching and finishing operations designed to be applied to sole leather after the Liritan process are also being investigated, particularly for tanners in the USA and Canada.

At the request of a large food processing company in the USA, an investigation was undertaken into the deodorising of hake mince intended for use as an added protein source to enrich a vegetable-based baby food. South African researchers in this field have acquired specialised skill in deodorising fish products for food enrichment, and it has been possible to recommend a suitable method.

Soft drink manufacturers sometimes have difficulty with acid floc in their products. This problem, which is currently receiving attention from researchers here and abroad, is caused when two impurities in sugar — a protein and a specific polisaccharide containing uronic acid groups — combine under acid conditions. Removal of these impurities is difficult as the quantities involved are very small, but following a comprehensive study to assess various filtration techniques, a technique suitable for industrial use has now been recommended.

Returnable containers made from locally produced high-density polyethylene or polypropylene have been developed by the CSIR in collaboration with the local packaging industry. As the containers are designed for mechanical handling and easy cleaning, low-cost mass production and durability, this development promises considerable financial benefits for the sorghum beer industry, as well as assisting the anti-litter campaign.

During the year under review the CSIR's Sorghum Beer Unit celebrated its 25th anniversary with a three-day conference where past, present and future research in the field of sorghum beer brewing was reviewed. During these



A view of the Computing Centre building.

25 years the work done by the CSIR has played an important role in the transformation of sorghum beer brewing from a tribal art to a modern industry.

The CSIR recently found a way of increasing the efficiency of rotary vacuum filters which are widely used in the processing of gold and uranium ore. The filter developed for this purpose by the CSIR offers almost twice the filter area of conventional rotary vacuum filters and should help the industry to effect considerable capital savings on filter installations.

PROMOTION OF GENERAL WELFARE

Work in this category entails research into such areas as urban development (including housing schemes), the design of hospitals, schools and other specialised buildings, the prevention of air pollution, the removal of waste products and the utilisation of water. The CSIR is concerned largely with problems peculiar to our subcontinent where imported expertise provides no solution, and the skills developed locally over the years can eventually be used to the advantage of neighbouring states that do not have the comprehensive research facilities of the CSIR.

During the year under review an agreement was entered into with the government of Bophuthatswana for research and other specialised services related to water supply and environmental hygiene. Aspects to which particular attention will be given include the development of new water sources, the prevention of water pollution in rivers and in new industrial areas, water treatment at recreational resorts and the training of personnel at water purification and sewage works. Assistance in the operation of purification works is also being given to certain homelands.

The CSIR played an important part in the monitoring programme for water quality in the Hartbeespoort Dam following the herbicidal treatment of the hyacinth in the dam. It was found that the quality of the water had not been affected to any marked degree by the spraying. The programme was carried out in collaboration with various interested bodies, including the Department of Water Affairs, the South African Bureau of Standards, the Department of Agricultural Technical Services and the Division of

Nature Conservation of the Transvaal Provincial Administration. The results of the work will provide guidelines for future herbicidal control of water hyacinth.

An investigation into metal pollution (including toxic metal pollution) in the Wilderness lakes near Knysna was undertaken by the CSIR at the request of the Department of Planning and the Environment. Signs of metal pollution were found in places, but the level of pollution could nowhere be regarded as exceptionally high.

A national survey of smoke and sulphur dioxide in the atmosphere confirmed a downward trend in the concentration of these pollutants, which is probably due in part to the introduction of smokeless zones. It was largely due to the CSIR's pioneering work in this field that legislation was introduced to control air pollution in South Africa. Continued research is essential to ensure the realistic application of control measures.

The CSIR is making a major contribution to South Africa's participation in the international project known as GEMS (Global Environmental Monitoring System) which includes the monitoring of freons, or halogenated hydrocarbons, at geographically strategic points. It is claimed that freons from aerosol spray cans and refrigerator installations cause a depletion of the natural ozone layer of the upper atmosphere, and in the USA these substances have already been placed on the prohibited list. Indiscriminate prohibition or limitation of the use and production of certain materials can cause considerable disruption with an effect far more harmful to human beings than that of the substances themselves. International co-operation is essential to ensure realistic monitoring of environmental pollution on a world-wide scale.

The results of CSIR research into aircraft noise are being successfully applied to control the development of residential areas in the vicinity of airports in South Africa. These studies take account of altitude and prevailing temperature - factors which are extremely important under South African conditions but which are normally disregarded by experts abroad.

TRANSFER OF SCIENTIFIC AND TECHNICAL INFORMATION

By virtue of its statutory obligations in regard to the collection and dissemination of scientific and technical information, the CSIR performs an important national function. Its information dissemination and exchange services are as essential a part of its activities as its research.

Scientific conferences and similar professional meetings play an important part in the transfer of scientific and technical information, and the CSIR Conference Centre — which was officially commissioned in October 1977 — has proved to be an extremely valuable acquisition. During the past year the Centre has been in constant demand not only by groups from the CSIR but also by numerous other scientific and professional bodies. Altogether 157 conferences, symposia and similar meetings, with a total attendance in the region of 12 000 people, were held at the Centre during 1978. In addition several hundred visitors attended audio-visual presentations and viewed the scientific and technological exhibition in the Centre. The Centre's comprehensive facilities and services, which include interpreting services, are greatly appreciated by users, as is evident from the large number of reservations already received for the year ahead.

There has also been an increasing demand for the CSIR's specialised information services in the scientific and technological field, including the computerised retrospective literature searching service introduced in 1976. This service is linked to bibliographic data centres in North America by means of modern telecommunications equipment. To cater for the anticipated demand for computerised literature searching elsewhere in the Republic, the CSIR's regional offices in Bellville, Port Elizabeth and Durban have now been equipped with terminals.

Because of its position at the vanguard of scientific and technological development, an organization such as the CSIR can make valuable contributions in the field of technical terminology. The publication of the *Textile Dictionary (English/Afrikaans; Afrikaans/English)* can indeed be regarded as one of the major achievements of the

past year. Modern computerised techniques were used in the preparation of this dictionary, and with the experience gained the CSIR is now assisting with the establishment of a computerised national terminology bank under the auspices of the Technical Terminology Bureau of the Department of National Education.

GENERAL

In the course of the year under review two Council Members retired, both after 15 years' service. They are Mr G C V Graham, who was well known in the textile industry, and Dr J N van Niekerk, a research manager in the steel industry. The valuable contributions made by these two Council members during their long terms of office are highly appreciated by the Council.

Dr C van der Pol, a well-known figure in the sugar industry, was appointed Council Member of the CSIR as from October 1978. His extensive experience in industry will be of great value to the CSIR, and the Council wishes to extend a cordial welcome to him.

Shortly before going to press it was announced that Dr J G H Loubser, General Manager of the South African Railways and Harbours Administration, had been appointed by the State President to fill the other vacancy on the Council. The Council welcomes Dr Loubser and is pleased to gain a member with his experience in engineering and management.

At the end of the year under review the CSIR took leave of one of the members of its Executive, Dr D M Joubert who, since assuming duty as Vice-President in January 1977, had made a considerable contribution, particularly with regard to the support of university research and contact with the agricultural industry. Dr Joubert also played a major role in gaining professional recognition for scientists and in preparing the required legislation. Among Dr Joubert's recent distinctions were his election in June 1978 to the office of President of the South African Association for the Advancement of Science and the award of a gold medal by the Fertilizer Society of South Africa. The Council wishes Dr Joubert every success in his new post as Vice-Principal of the University of Pretoria.

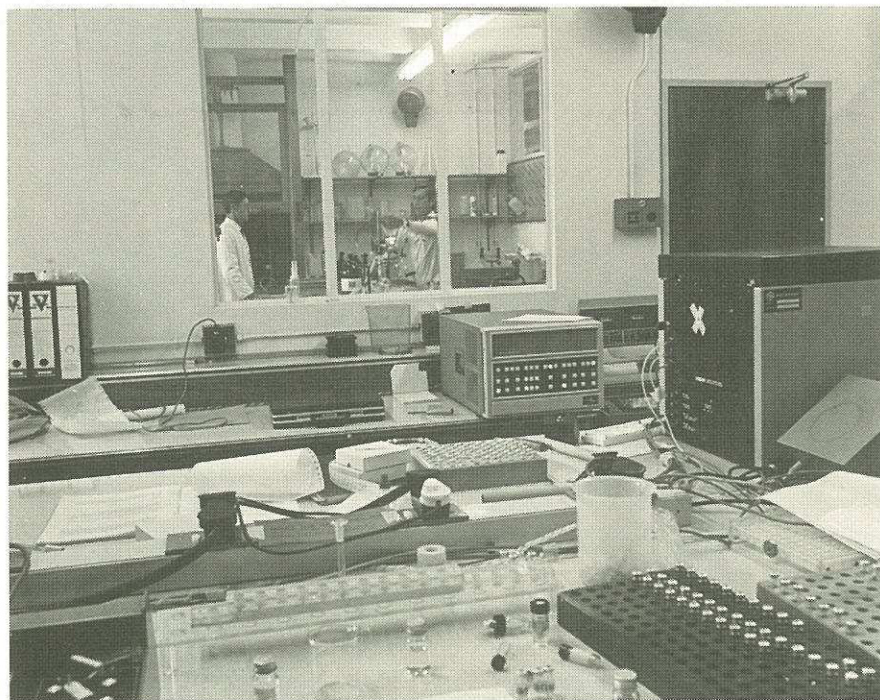
Dr C F Garbers was appointed Vice-President of the CSIR in the place of Dr Joubert as from January 1979.

Dr Garbers has distinguished himself in the field of organic chemistry, both as a researcher and a professor, and has gained national and international recognition.

Expansion of the CSIR's activities has made it necessary to enlarge the Executive, and a fourth vice-president has accordingly been appointed. He is Mr J P de Wit, former Director of the CSIR's National Food Research Institute, who has been with the CSIR since 1949 and has contributed significantly to the CSIR's activities, particularly in the field of food research.

Two other organizational developments may be mentioned here. The National Accelerator Centre, the establishment of which was reported in the previous annual report, acquired the status of a full national institute of the CSIR with Dr G Heymann as Director. The Centre will ultimately be housed at Faure in the Western Cape, on a site adjoining that of the Southern Universities Nuclear Institute. The CSIR Computing Centre, previously part of the National Research Institute for Mathematical Sciences, will now also be administered as a separate national institute, and is to be known as the Centre for Computing Services, with Dr E N van Deventer as its Director.

Reports on specific activities





Measuring the abrasion resistance of the fur on Karakul skins as part of the quality control procedures developed at the Leather Industries Research Institute (p. 26).

Knowledge - development and application

HARMACOLOGICALLY ACTIVE SUBSTANCES

The synthesis of rare carbohydrates suitable for conversion into medicinally useful nucleosides and antibiotics received increasing attention in the course of the past decade. Research at the CSIR has been concentrated on the development and application of synthetic methods for the preparation of novel carbohydrates¹. Notable examples include the preparation of cyanosugars and the reduction of alogenosugars to unsaturated compounds; intermediates of these types have been shown to be extremely versatile in the preparation of a variety of pharmacologically important substances.

Steroid hormone research focused attention upon the conformational properties of a series of modified pregnane analogues. It was demonstrated through force field studies and X-ray crystallography that specific arrays of functional groups are responsible for skeletal deformation in certain steroids. This information has been used to advantage in defining new synthetic objectives.

A new method has been developed for the degradation of bile acids to pregnane derivatives suitable for use as intermediates in the preparation of medicinally useful steroidal hormones. The method is less involved than other methods currently employed, with overall yields comparable to those obtained by existing means.

METABOLITES OF POISONOUS FUNGI

Diplodia macrospora is one of the major contaminants of maize in areas with a warm, humid climate. A new mycotoxin known as diplosporin was identified in the CSIR's laboratories as the toxic constituent of this fungus, and its structure was determined¹.

The biosynthesis of diplosporin was elucidated by supplementing cultures of *D. macrospora* with radioactive and stable precursors. It was demonstrated that acetate contributes ten of the twelve carbon atoms, giving rise to a single polyketide chain. The remaining carbon atoms originate from methionine; the bio-origin of one of these, a carbocyclic carbon atom, from methionine is unique amongst known fungal metabolites.

NEW SNAKE BITE ANTISERUM

A phospholipase A₂, isolated from the South African adder *Bitis caudalis*, has been sequenced and its pharmacological mode of action established as being that of an extremely potent presynaptic neurotoxin, on par with cobra and mamba postsynaptic neurotoxins¹. This represents the first instance of neurotoxicity reported for a member of the adder family occurring in South Africa.

It was found that the commercially available polyvalent snake-bite antisera offer no protection against this toxin. The South African Institute for Medical Research was alerted to the fact and a specific antiserum against this venom is now available for cases of identified *Bitis caudalis* envenomation.

RUMINANT DIGESTION

Hemicelluloses form a major part of the carbohydrates of the pasture plants and roughage eaten by ruminants. The animals themselves lack the enzymes required to digest these compounds and depend on the bacteria in their rumen to do the work.

In the past little was known about the number, species and activities of the hemicellulose-digesting bacteria encountered in sheep and cattle kept on different diets. A relatively simple means of counting these organisms has now been developed, however, and the principal species in the rumens of sheep fed on teff hay, lucerne hay, or a high

concentrate diet have been isolated and characterised¹. A study is being made of the extent and rate of hemicellulose breakdown achieved by different species of bacteria acting on the hemicellulose in teff cell walls to gauge their relative effectiveness.

CALCULATION OF MOLECULAR STRUCTURES

The acquisition of molecular structural information frequently depends on the availability of suitable single crystals, and alternative methods to complement diffraction studies are constantly investigated. Computerised force-field methods which allow the calculation of molecular structures from basic principles have been applied to a variety of problems with remarkable success¹. Such methods have proved to be especially useful in cases where the stability of a particular conformational isomer depends on small energy differences which can be computed directly. In several test cases the calculated structures were found to agree with the actual structures within the limits of experimental error.

IMPROVED ANALYTICAL SEPARATIONS BY ANION EXCHANGE CHROMATOGRAPHY

A new fundamental approach towards the elimination of tailing during anion exchange chromatography in dilute solutions has been developed at the CSIR¹. It consists of the addition of a strongly adsorbed non-complexing anion which effectively competes for exchange sites. The nitrite anion of nitric acid is well suited to this purpose. A systematic study has been carried out on distribution coefficients of bromide complex forming elements in HBr-HNO₃ mixtures and the selectivity sequence Au(III), Hg(II) > Bi(III) > Cd > Pb(II) > Zn > In > Cu(II), Fe(III), followed by many other elements, has been established.

The separation factors are high and most adjacent elements in the series can easily be separated using only small columns. Separations are sharp and quantitative, and the strong tailing shown by some of these elements in pure HBr disappears completely when between 0,5 and 2 M HNO₃ is also present. The concept thus developed is generally applicable, and some useful separations have already been executed.

HOMOGENEOUS CATALYSIS

A research programme involving the use of the synthesis gases CO and H₂, carried out in collaboration with the South African Coal, Oil and Gas Corporation, has received new impetus since the return of a young scientist from a sabbatical year at Bristol University, where he had specialised in the synthesis and use of metal cluster compounds which are potential intermediates in the Fischer-Tropsch synthesis of hydrocarbons¹. It is argued that these inorganic complexes facilitate catalysis via the mobility of co-ordinated groups between the metal atom centres. Numerous research teams throughout the world are working on these lines and the chances of success are highly rated.

CORROSION OF METALS BY ALTERNATING CURRENTS

The basic principles of the electrolytic corrosion and deposition (electroplating) of metals in aqueous solutions by anodically and cathodically applied direct currents, respectively, are well established, having been defined quantitatively more than a century ago. In respect of such direct currents the rate of anodic metal dissolution (corrosion) remains in linear proportion to the current density: one ampere of current, in the case of iron, is equivalent to a metal loss of 9,47 kg after one year.

Until recently it was generally believed that alternating electric currents, on the other hand, do not cause metal corrosion. It was assumed that metal ions going into solution during the anodic half-cycle are redeposited during the cathodic half-cycle, the nett effect being zero.

Research carried out by the CSIR has contributed substantially to the clarification of the mechanism of alternating current corrosion¹. It was established that the electrochemical reactions which occur on a metal surface during a particular cathodic half-cycle have a profound effect on the behaviour of the same metal surface during the succeeding anodic half-cycle, and vice versa. It appears that sufficient energy over and above that required to overcome the after-effects of the preceding reactions becomes available for the dissolution of the metal only when the alternating current density exceeds a vertical value.

The rate of the corrosion caused by an alternating current is therefore proportional to the current density, but only above this critical value; below that the corrosion rate does not constitute a serious problem in terms of iron metal loss.

SOUND INTENSITY METER

The control of noise in industry and in the community requires accurate measurement of the output level of noise sources. In a typical situation such as prevails in a factory, it is not practical to isolate individual sources of noise by silencing all others and yet, to date, no device has been available to measure the noise output of one source in the presence of others. Conventional sound level meters measure sound pressure and not sound power, which is the parameter that would indicate the true contribution of a given noise source to the total noise field.

Basic research in the field of sound intensity measurement at the CSIR has now culminated in the development of a practical sound intensity meter². With this instrument the power output of any sound source may be found simply by integrating a number of sound intensity measurements taken over a surface enclosing the source.

The meter has been built to encompass the intensity and frequency ranges specified by the International Standards Organization and is completely portable, and therefore suited to measurements *in situ*. The practical application of the instrument in the measurement of noise is at present being demonstrated in the Netherlands in association with a committee appointed by the Dutch Ministry of Public Health and the Environment.

ULTRA-MINIATURE LASERS

Novel techniques for the uniform excitation of high pressure gas discharges have recently been adapted by the CSIR to the construction of sub-miniature high-power ultraviolet and infrared lasers with overall dimensions of no more than a few millimetres². The discharges can be stabilised effectively with electrode separations of approximately 1 mm, which means that the lasers can be excited at relatively low operating voltages. These lasers can be manufactured at very low cost and will provide peak powers of 25 to 250 kW with a pulse duration of 0,1 to 10 ns. Gas pressures range from 0,1 to 1,5 MPa.

Potential applications of such small and robust laser devices include detector calibration, fluorescence decay measurement and radar-type distance measurement.

INTERNATIONAL TIME-TRANSFER EXPERIMENT

A joint experiment by the CSIR and the British National Physics Laboratory (NPL), performed in collaboration with the British Post Office, the South African Department of Posts and Telecommunications and the South African Airways, has resulted in a time-transfer of exceptional accuracy being effected via satellite². The time registered by the NPL Time Standard, when compared with that registered by the CSIR Time Standard, consistently revealed an accuracy to within 20 ns.

DEPTH PROFILING WITH THE IMMA

In order to measure diffusion profiles in layered systems with the ion microprobe mass analyser (IMMA), the CSIR developed a new method which reduces adverse effects of the crater rim and the beam neutrals on the resolution². The method involves a computer-controlled sputtering routine which includes the incident ion beam to produce a wedge-shaped crater. In this way the layered system within the maximum crater depth can be exposed over a distance of 400 μm . Due to the geometry of the crater, the depth resolution of an IMMA measurement over the slope is not degraded whilst the adverse effects associated with the conventional sputtering-and-measuring procedure, such as signals from the sputtered crater rim and topmost sample surface, are minimised.

GRAPHITE NODULES IN NODULAR CAST IRON

Modern analytical instruments, especially the ion microprobe mass analyser and the scanning electron microscope, are capable of determining the element concentration thresholds below which the harmful effects of trace elements in cast iron are insignificant. This information allows graphite precipitation to be controlled and cast iron of acceptable tensile strength and ductility to be produced.

Nodular cast iron is suitable for large scale use in the manufacture of high quality engineering components and agricultural equipment. In these applications it can replace steel, which is far more expensive.

Factors which influence the precipitation of graphite are the cooling rate of the metal and the concentration levels of various trace elements. There are some 38 elements involved in the process of graphite nucleation and the formation and growth of graphite nodules in the matrix.

In a study of the effects of composition and cooling rate on graphite morphology, undertaken at the CSIR² in an attempt to explain the structure of graphite nodules and the mechanism of their formation and growth, it was found that —

- a graphite nodule consists of a number of curved crystal shells growing in cabbage leaf fashion and not radially as postulated in the literature
- the content of boron should not exceed 0,02 per cent, beyond which limit it causes deterioration of the nodule shape
- the nodulariser, in this case magnesium, acts both as a former of graphite nodules and as an agent drawing elements out of the graphite nodule to the interfacial space graphite/metallic matrix
- the concentration of elements inside the graphite is inversely proportional to the free carbon content
- the cooling rate plays an important role in the preservation of the nodular shape of the graphite.

ATOMIC FLUORIMETER

An instrument called an atomic fluorimeter has been developed by the CSIR for the isolation and detection of spectral lines emitted by a source such as a glow-discharge lamp². The sample to be analysed is excited by the glow discharge and emits light which, in turn, is focused on the atomic vapour of the element of which the spectral line intensity is to be measured. The atomic vapour, which is created by a sputtering process, absorbs resonance lines emitted by the source and re-emits the energy as fluorescent radiation. The intensity of this radiation is measured at right angles to the incident direction and is directly proportional to the concentration of the element in the sample.

Many elements in a variety of matrices have been detected in this way, for example copper in steel and aluminium, and copper and silver in gold, with detection limits as low as 2 ppm. The instrument is also suitable for use in the vacuum ultraviolet region of the spectrum (below 200 nm) and permits the determination of carbon, sulphur and phosphorus concentrations in steel, with detection limits of 0,01 per cent, 0,002 per cent and 0,004 per cent respectively. A reference channel measures the radiation from the source directly through a suitable interference filter and acts as a monitor for the sputtering rate of the sample. This makes the determination of carbon, phosphorus and sulphur contents in steels of widely varying composition (high speed steel, stainless steel, manganese steel) possible, using mild steel standards only.

H-SETS IN CHEBYSHEV APPROXIMATION

The problem of approximating mathematical functions arises in various fields of application, as for instance in the fitting of experimental statistical data and the solution of differential equations in mathematical models of engineering and industrial processes.

An approximation function is a fixed expression in which certain of the unknowns can be so chosen as to ensure that the approximation will be as good as possible.

A Chebyshev approximation is characterised by the fact that the greatest deviation between the original and approximation functions is as small as possible for expressions of the given form.

The points where a Chebyshev approximation reaches its greatest deviations are of particular interest in the study of these approximations, and an H-set is a set of such points together with information which indicates whether the error at a specific point is positive or negative. It can be shown that an H-set satisfies certain conditions, and conversely that a set of points which satisfies these conditions must be an H-set. By determining whether the set of points where the given function assumes its greatest error does in fact satisfy the conditions for an H-set, it is then possible to test whether a given approximation function is a Chebyshev approximation.



Operators at work at one of the two computers, the IBM S370/158, in the Computing Centre.

Until recently the theory of H-sets was complete only for simple forms of the approximation function and, subject to certain constraints, also for the functions which appear in the approximation. As a result of research carried out by the CSIR over a period of about one year, this theory has been extended into a unifying principle for H-sets with more general forms of the approximation function and without the constraints mentioned. The theory also provides a practical method of constructing optimum approximation functions⁴.

SIMPLIFIED MATHEMATICAL EQUATIONS FOR WEATHER PREDICTION

As an aid to weather prediction, mathematical models are developed which describe the physics of the atmosphere in terms of sets of equations which then have to be solved numerically. For various reasons these equations need to be simplified to a greater or lesser extent. They have to be made manageable; in addition, certain irrelevant aspects of the behaviour of the system (such as the propagation of sound and gravity waves) have to be eliminated. Such simplification is useful both in yielding a model that produces a broad picture of the atmospheric motion and in reducing computing time and costs.

When these simplifications are made, the order of magnitude of the terms in the equations must be taken into account and it is necessary to ensure that the modified equations reflect the same physical characteristics, such as the conservation of energy, as the original equations.

It has been customary to disregard the topography of the earth's surface when making simplifications of this kind. In South Africa, however, the presence of mountain ranges plays a large part in determining the weather pattern. For this reason the CSIR, in collaboration with the Weather Bureau and the Scientific Adviser to the Prime Minister, has developed a criterion for the selection of consistent sets of basic equations for an atmosphere whose lower boundary is the actual surface of the earth⁴.

CONTROL AND OPTIMISATION

The CSIR has been giving considerable attention to the study of cone-constrained linear control systems⁴. An explicit scheme for the construction of linear-in-cone stabilising feedback laws was developed for arbitrary-

interval controllable systems. For a certain class of quadratic performance criteria, explicit piecewise linear optimal controllers were found, and escape times characterised in terms of a modified Riccati theory involving two vector Riccati equations. For general quadratic performance criteria, it was shown that boundedness below is equivalent to the existence of fixed points of certain nonlinear mappings in \mathbb{R}^n related to optimal feedback laws. In a general Hilbert space setting conditions of a spectral nature were developed under which a given quadratic functional is non-negative on a given cone. These conditions generalise standard Jacobi-type conditions in the theory of the second variation.

DRAWING BONUS BOND WINNERS

On behalf of the Bonus Bond Manager, the CSIR developed and implemented a minicomputer system with which to draw winning numbers⁴.

The system consists of a small computer with read-only memory, an operator terminal, a nine-channel magnetic tape unit and an electronic random number generator. The software makes provision for extensive integrity and security tests, in addition to the demonstrational and operational functions. The program is permanently stored in the read-only memory, which considerably simplifies the control procedure.

The number generator was also developed by the CSIR, while randomness tests were carried out both by the CSIR and by the University of Pretoria^{4, 9}.

DETECTION OF A CELESTIAL X-RAY SOURCE

Amongst the many known celestial X-ray sources, Cir X-1 is of particular interest because of its X-ray behaviour, which suggests it to be a likely candidate for black hole status. Observations at the CSIR's Observatory at Sutherland showed that a very faint star at the X-ray position is bright in the infrared and varies in both brightness and X-ray intensity with a period of 16 days⁵. Once in every cycle the X-rays cut off suddenly, at which time the infrared brightness increases by a factor of six within about one hour. This behaviour is quite unique and its discovery will greatly influence theories of X-ray sources.

COLLABORATION IN ASTRONOMY

Some of the most interesting astronomical discoveries of recent years have been made possible by collaboration between optical, radio and space astronomers. One such international effort, in which the CSIR made full use of its optical facilities at Sutherland, was a study of the variations of the nearest star, Proxima Centauri, which is a flare star⁵. CSIR staff made brightness measurements of this star every two seconds for several hours on each of the four nights of the project. This provided extensive data on 35 flares for subsequent comparison with simultaneous observations made from space and radio observatories.

The star Zeta Puppis is constantly losing matter into space. The CSIR conducted spectroscopic observations of this star in the visible region while US astronomers undertook similar observations in the far ultraviolet region using the Copernicus space satellite.

Two international projects were aimed at furthering our understanding of celestial X-ray sources. In one, optical observations of X-ray bursters by the CSIR were related to simultaneous X-ray observations carried out in space by US astronomers. In another project, the CSIR made optical observations of some of the optically brightest X-ray sources. The observations were carried out simultaneously with observations conducted by UK astronomers using the newly launched International Ultraviolet Explorer (IUE).

The geographic position and range of instrumentation at the CSIR Observatory at Sutherland make it attractive for space astronomers seeking collaboration on projects such as these. The agreement by which one third of the observing time at Sutherland is used by UK astronomers has continued.

THE MAGELLANIC CLOUDS

The extensive photographic photometry of Cepheid Variables in the Magellanic Clouds (the two nearest galaxies) was completed during the year⁵. Accurate light curves were obtained for 392 Cepheids; this is a large increase over the previously available data and should permit a considerable step forward in our understanding of Magellanic Cloud Cepheids.

GEOMAGNETIC AND OTHER OBSERVATIONS

Routine geomagnetic observations were continued during the year at magnetic recording stations at Hermanus, Tsumeb, Grahamstown and Hartebeesthoek, on Marion Island, and at the South African Antarctic base Sanae⁶. Cosmic ray recordings were continued with neutron monitors at Hermanus and Tsumeb, while the Hermanus station was also responsible for certain other services such as ozone, cosmic radio noise and meteorological observations. Observations of proton-excited auroras and pulsating auroras were conducted at Sanae.

A new photometer was designed and constructed for use at Sanae to improve the monitoring of pulsating auroras, and a new magnetometer is at present being developed for use under fieldwork conditions.

Routine data and calibration services were continued as in the past. Data from a number of the South African recording stations is routinely supplied to overseas data centres.

GEOMAGNETIC RESEARCH

The CSIR's geomagnetic research activities have, during the past year, been concentrated mainly in three fields: magnetic quiet day variations, magnetic storm phenomena, and the relationship between solar-terrestrial phenomena and the weather⁶.

An analysis of the progress of a proton-aurora occurrence at Sanae during a magnetic storm led to an extensive investigation into possible methods of correcting the data for such atmospheric effects as the scattering and absorption of the auroral emission.

In another study some attention was given to the dependence of the energy of long period (Pc5) magnetic pulsations on changes in the conductivity of the ionosphere. This study was completed in collaboration with the Institute of Earth and Planetary Physics in Edmonton, Canada.

Studies of the magnetic quiet day variation were aimed mainly at an investigation of the anomalous daily variation

patterns observed at Hermanus and Grahamstown and on Marion Island. Attention was given to possible methods of determining with certainty whether the anomalous conditions are caused by the proximity of the ocean or by the South Atlantic magnetic anomaly.

Investigations into a possible relationship between solar-terrestrial phenomena and meteorological conditions were commenced in the course of the year. Although it has already been shown that rainfall figures from certain parts of South Africa (such as the Western Cape) exhibit an eleven-year variation similar to that of the sunspot numbers, it is still necessary to identify possible relationships with certainty to permit coupling mechanisms between disturbances on the sun and meteorological conditions to be defined.

SATELLITE IMAGERY IN OCEANOLOGY

Satellite imagery is developing into a powerful tool in oceanological observations. An examination of the thermal infrared images of the upwelling region off the Cape west coast, obtained from the NOAA-5 satellite, has shown that the large cyclonic eddy centred southwest of the Peninsula is a semi-permanent feature of the upwelling region and that the front itself, probably corresponding to the Good Hope Jet, may be a transient meandering feature⁷. It has also been shown that there is good correlation between wind stress and the overall extent of the upwelling area.

Satellite imagery was also used in a study of the Agulhas Current, where it showed that waves are created in the boundary of the Agulhas Current south of Algoa Bay from where they develop into shear-edge eddies measuring hundreds of kilometres in extent. Although these eddies break up and dissipate rapidly they seem to be the dominant factor in the control of circulation on the Agulhas Bank and also, probably, the means whereby warm Agulhas water enters the Atlantic Ocean.

NEW WATER WAVE THEORY

In the solution of numerous coastal engineering problems it is necessary to have a mathematical means for the prediction of the characteristics of water waves as they travel from deep to shallow waters. Several theories have been developed for this purpose. The only theories which

predict wave characteristics with reasonable accuracy for all water depths have numerical solutions which are obtained after lengthy computations in an extensive computer program, thus rendering them unsuitable for normal engineering applications.

An important development has been the derivation, from first principles, of a new theory for the prediction of wave characteristics from deep to shallow waters⁷. The most important advantages of the new water wave theory are its simplicity, the fact that all wave characteristics are expressed analytically, and its good adherence to experimentally determined wave characteristics for all water depths.

FOUNDRY TECHNOLOGY

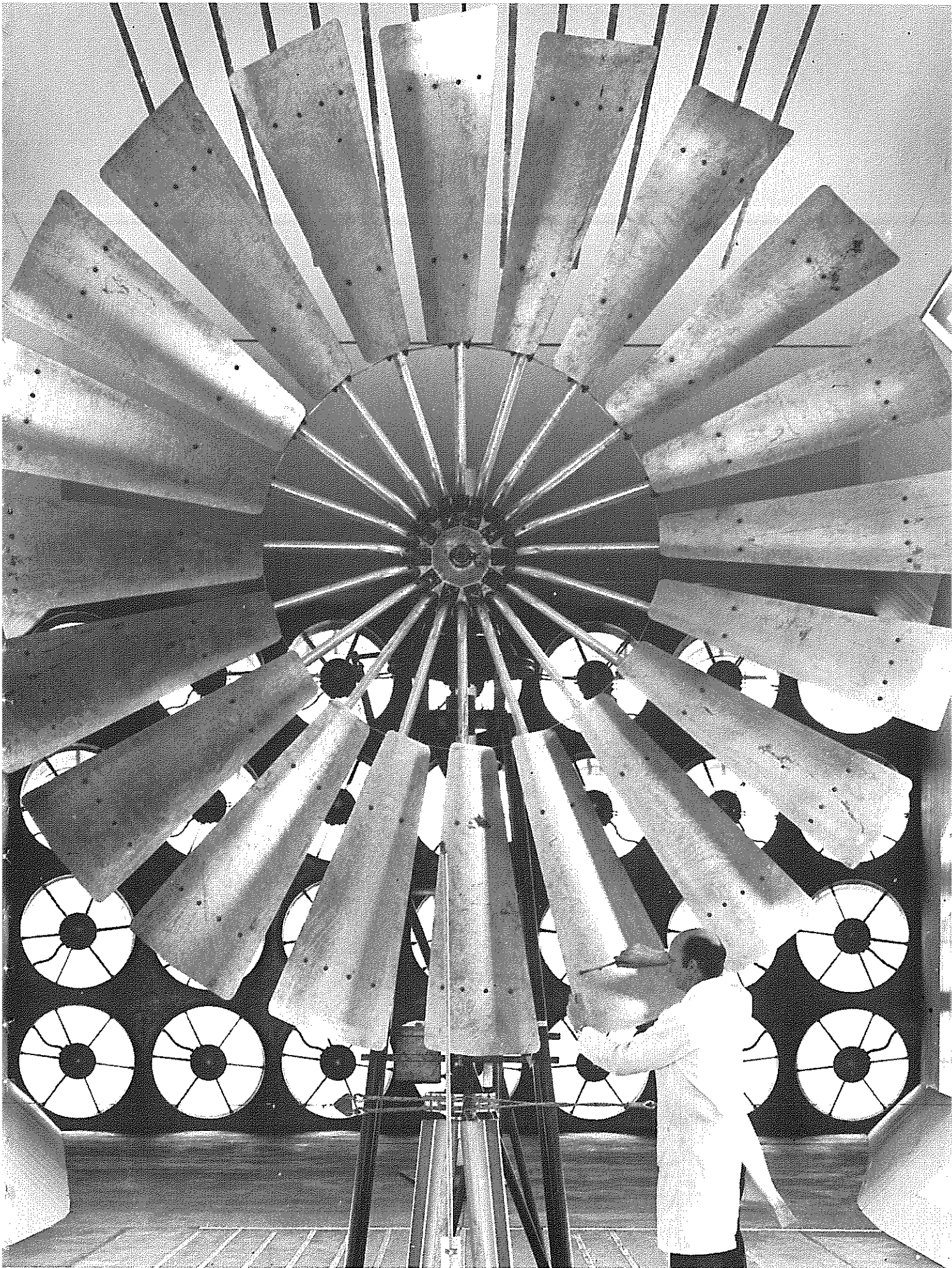
A manual entitled *Properties of some South African moulding sands* was compiled in collaboration with the South African Institute of Foundrymen⁸. The manual, which has been made available to industry, contains data sheets featuring information on properties such as the grain size, green strength and permeability of silica sands available from various suppliers in the Republic. It describes the tests required to determine these properties and discusses their significance in foundry practice with a view to maintaining and improving the quality of castings.

LARGE FORMAT WIND TUNNEL

A new tunnel complex erected at the CSIR includes a wind tunnel with a large working section measuring 7,5 m x 6,5 m across⁸. The wind tunnel facility was established to cater for research needs in the field of aeromechanics. Its large interior permits the testing of complete small aircraft or sizable models of larger craft.

The use of the wind tunnel is not limited to aeronautics. It is invaluable when studying the effects of wind forces on slender buildings and structures such as masts and power lines, the wind resistance of road and rail vehicles, the dispersion of smoke palls, and similar problems.

The tunnel itself represents a noteworthy development in that its design differs from the conventional designs of large tunnels overseas. In standard tunnels the airflow is produced by one or two large fans with variable speed drives. They are expensive, complex pieces of equipment.



A wind turbine being tested in the 7 m wind tunnel (p. 10, 12).

The South African tunnel, on the other hand, utilises an array of 28 ordinary industrial fans which together cost a fraction of the conventional blowers. The tunnel's air speed, capable of attaining 110 km/h, is simply but effectively controlled by switching fans on and off in predetermined combinations.

WIND ENERGY

Interest in power generation by means of wind turbines has revived in recent years, and the CSIR plays an active role in current investigations⁸.

The windmill or wind turbine is, of course, an age-old machine, and its centuries of reliable performance might well have discouraged attempts at improvement. Theoretical analyses have shown, however, that conventional windmill blades do not have the most efficient aerodynamic shape.

Comparative tests on various windmill configurations and blade shapes were consequently carried out in the CSIR's new large format wind tunnel. The results, based upon the theoretical and experimental data thus far obtained, are embodied in a two-blade airscrew type windmill rotor design which is expected to bring about a significant increase in windmill efficiency.

SOLAR ENERGY

The CSIR has developed an air-conditioning system in which solar energy is utilised for cooling and dehumidification in summer and heating in winter⁸. Compressors and conventional heaters are eliminated and, apart from a fan and some pumps which are driven electrically, all energy requirements are fully provided by the sun. It is expected that the new air-conditioning system will consume about 30 per cent less energy than conventional equipment.

The performance tests which were commenced in the middle of 1978 will have to be continued over a number of seasons to ensure a valid practical evaluation of the system's performance.

WIRE BREAK DETECTOR FOR MINE HOIST ROPES

Research into the fatigue of mine hoist ropes is carried out by the CSIR with the aim of assisting manufacturers in the development of improved rope designs⁸. Fatigue testing of complex rope structures is more difficult than the conventional fatigue testing of solid specimens, where fatigue failure becomes obvious when the specimen breaks. In the case of a multi-strand specimen, however, single wires may break undetected inside the rope.

A device has been developed by the CSIR to register and count the incidence of wire failures during the fatigue testing of rope specimens. The instrument picks up the vibrations caused by the sudden failure of an individual strand within the rope. As a result, testing times have been considerably shortened in comparison with the conventional method of determining the number of broken wires by untwining the rope and counting the breaks — a process that renders the specimen useless for any further testing.

SHORT RANGE TELEMETRY SYSTEM

Devices designed to transfer signals from a transducer on a moving, usually rotating, component to a stationary recorder traditionally use sliprings, mercury baths and the like. The modern trend in these applications is towards the development of short range telemetry systems which are more reliable and less affected by background noise.

The CSIR has developed such a system which converts the signal from the transducer into a frequency modulated signal which is transmitted to a pick-up where it is amplified and converted into a voltage signal which can, finally, be displayed or recorded⁸. The millivolt signals from the transducer on the moving part can be transmitted to a millivoltmeter, oscilloscope, or tape, pen or other recorder. The various prototypes produced by the CSIR and used to measure stresses on rotating shafts proved to be more reliable than imported equipment.

LIGHTNING ON POWER DISTRIBUTION LINES

Preparations are well under way for a singular experiment which is to be undertaken jointly by the CSIR and the Electricity Supply Commission to measure lightning surge magnitudes and wave-shapes on a 10 km length of unenergised distribution line⁹. In order to maintain a simple, uncomplicated system, there will at first be no substations connected, nor any overhead screening wires. Surge measurements will be correlated with photographs and video recordings of the lightning flashes and further additions will gradually be introduced to the line and the effects measured as the experiment proceeds.

CATALYSTS FROM LOCAL RAW MATERIALS

Substantial progress has been made with an investigation into the possibility of using locally available raw materials in the preparation of catalysts that are presently imported at high costs. These catalysts are of special importance to the petroleum and petrochemical industry for the conversion of coal and oil to liquid motor fuels.

Zeolites, which are used as cracking catalysts in the conversion of heavy hydrocarbons to motor fuels, consist mainly of silica and alumina and their catalytic properties are due to their characteristic crystal structure. Silica is freely available in South Africa and alumina deposits have recently been discovered.

The CSIR has succeeded in preparing several important zeolites from local raw materials such as kaolin (an aluminosilicate), silica and alumina¹⁰. Further processing of zeolites to render them suitable for use as catalysts in high temperature chemical processes are currently being investigated.

THE ULTRASTRUCTURE OF *MICROCYSTIS AERUGINOSA*

Eutrophic dams in the Transvaal are periodically infested by masses of the blue-green alga *Microcystis aeruginosa*. Not only is this alga aesthetically distasteful, but it may also cause fish kills by suffocation and decimation of domestic stock after imbibition of the liver toxin it sometimes synthesises. The same poison may also cause gastro-enteritis in human beings.

Transmission electron microscopy was used to examine the cytology of the tiny *M. aeruginosa* cells from both toxic and non-toxic water blooms to see whether morphological differences could be discerned¹². Other work had been confined to the isolation and identification of the toxic polypeptide molecule.

M. aeruginosa is an algal anomaly: like bacteria, it is prokaryotic, having no membrane-bound nucleus. It does, however, contain the algal photosynthetic pigment chlorophyll *a*. A typical cell wall is four-layered, as in gram-negative bacteria. Much of the cytoplasm is occupied by elongated, gas-filled cylinders with conical caps which give them a honeycomb appearance in cross-section. These vesicles collectively form gas vacuoles which enable the cells to regulate their buoyancy, thus giving them a competitive advantage over other algae in the water environment.

The number and arrangement of the membranes that ramify between the gas vacuoles vary according to cell age and physiology. Polyglucoside particles are scattered in the cytoplasm.

Several unbounded storage granules can be seen. Those of polygonal profile are polyhedral bodies, the site of the carbon dioxide fixation enzyme. Large, electron-dense circular cyanophycin granules store protein and increase in number as the cells age. Polyphosphate may also be stored.

Unusual features such as an extra microvillus-like cell wall layer were found in some cell samples taken from toxic water blooms. A crystal-shaped lattice reminiscent of prophage particle arrays in both size and three-dimensional structure was also perceived, while groups of concentric membranes occurred together with the lattices.

Toxin production in *M. aeruginosa* may be controlled by a prophage, as is the case in certain streptococci and staphylococci. The lattice arrays may therefore represent a certain part of a viral lysogenic cycle, or part of the virus itself.

MATHEMATICAL MODELLING OF MINERALISATION PROCESSES

The CSIR, in collaboration with the Department of Water Affairs and the Department of Agricultural Technical Services, has made considerable strides in the development of a mathematical model to simulate the various salt transport processes in river catchments¹². Two catchments which are being studied intensively are those of the Great Fish River and the Sundays River, both in the Eastern Cape. The proposed agricultural development of these two river basins constitutes an important part of the Orange River Project. The natural salinity of the waters of these two rivers is so high, however, that it requires close observation of the salinity patterns under existing conditions and careful consideration of the ways in which river salinity would be affected by increased irrigation in the future.

The development of the simulation model has led to a greater understanding of the mineralisation processes taking place in these catchments. Moreover, the model will eventually provide the basis for short-term predictions of the spectrum of salinities that can be expected at certain points in the river, given alternative rainfall cycles and irrigation procedures.

WATER QUALITY AND FISH MOVEMENTS

A continuous automatic monitoring system, based on the principle that polluting substances in water cause changes in normal fish movement, was developed by the CSIR^{12, 9}. These changes, which reveal changes in the general water quality, can be measured by ultrasonic sound wave disturbance.

The equipment employed is capable of monitoring the activity level of six fishes maintained in separate tanks. Each movement made by the fish is counted and stored in one of six counters. At the end of every hour the accumulated activity count of each fish is printed out. The count can also at any time be read from a digital display. Each of the channels has a facility for an adjustable alarm threshold: if the accumulated count for a particular channel exceeds its set threshold, an alarm light is activated and the alarm condition is indicated on the next printout. This condition occurring in a majority of sensor fish channels would indicate a deterioration in the water quality.

The system successfully monitors the effects of both lethal and sublethal concentrations of a number of common industrial pollutants, and in sufficient time to provide an effective advance warning of the appearance of toxic conditions. For example, lethal concentrations of copper, mercury and cyanide have been detected in less than one hour, whereas mortality did not occur until 20 to 35 hours later.

CHEMICAL CHARACTERISATION OF BITUMENS

It is essential in road construction engineering that the quality of the bitumen employed should be consistent, which is possible only if the source of the crude oil from which the bitumen is manufactured remains constant. Fluctuations in quality may result in the expensive failure of a road construction or maintenance project.

It is suspected that the source of the crude oil supplied to South Africa changed after the Middle East crisis of 1973, and there are various indications that this may have affected the quality of South African bitumen. Road authorities, particularly in the Cape and Natal, have observed an increased incidence of 'bleeding' on recently constructed roads, and bitumen emulsion manufacturers are encountering difficulties in emulsifying the bitumens.

Laboratories at the CSIR and elsewhere have analysed the physical and physico-chemical properties of current bitumen supplies and found little or no variation in these properties¹³. The analytical techniques used are on the whole relatively unsophisticated, however, and the results appear to be at variance with the conditions observed on our roads.

In the light of this evident need for a far more intimate knowledge of the composition of bitumen and for a method of identifying and classifying bitumens for specification purposes, the CSIR recently embarked upon a programme of research into the subject. The possibility that sources of crude oil may yet be found in South Africa provides further incentive to the work in hand: the discovery of oil in economic quantities would render instant and accurate information on the composition of the petroleum, oil and bitumen fractions of the new source invaluable. In addition, however, research is needed into the effects of various additives on bitumen, as these additives are the only means by which new and improved bitumens can be produced at this stage.



REMOTE SENSING

The Satellite Remote Sensing Centre of the CSIR, situated at Hartebeesthoek, receives and processes satellite data on the surface and atmosphere of the earth¹⁴.

The main task of the centre at present is to process information received from Meteosat, a meteorological satellite which provides images of cloud cover in the infra-red and visible parts of the spectrum from a point 36 000 km above the intersection of the Equator and the Greenwich meridian. From this position virtually a complete hemisphere can be observed, which includes Africa and the surrounding oceanic regions.

The images, which are transmitted every half hour, are received at Hartebeesthoek, processed, and relayed within half an hour by landline to the Weather Bureau in Pretoria. Due to the extensive and repeated coverage which they provide, these images are particularly suitable for the delineation of large scale weather systems and their development. By complementing conventional weather observations, Meteosat provides the meteorologists with a powerful aid for routine services and meteorological research alike. In particular, the cloud images have enabled weather forecasters to improve their shipping and aviation storm warnings considerably.

Apart from these meteorological applications, data from Meteosat are specially processed at the Centre to provide sea temperatures in specific coastal regions as efficiently as possible. It has, for instance, been established that sea temperatures can vary markedly from place to place and from time to time.

A preliminary experiment has already been carried out to correlate plankton concentrations with sea colour and temperature in the upwelling region off the West Coast, while in another project Meteosat data are being used together with data from other satellites to investigate the Agulhas current.

REQUIREMENTS OF *EUCALYPTUS GRANDIS* PULPWOOD

Besides pulp yield, the most important consideration in the choice of pulpwood is the manner in which its properties affect the properties of the pulp made from it. In order to determine these relationships of *Eucalyptus grandis*, the CSIR studied wood samples from the Northern Transvaal, Natal and Transkei¹⁹. This is the main hardwood used for pulping in South Africa.

Pulp strength and paper surface quality are mainly influenced by cell wall thickness, wood density, and the ratios of fibre length to fibre diameter and cell wall thickness to fibre diameter. Tensile and bursting strengths improve with decreasing density and cell wall thickness. Tearing strength increases with increasing fibre length/diameter ratio. *E. grandis*, with its low wood density, thin cell walls and high fibre length/diameter ratio will therefore produce the strongest pulp. Pulp yield also increases with an increase in the cellulose content of the wood.

These findings will be applied by the Department of Forestry in the genetic improvement of pulpwood trees.

Development of service infrastructure

At kaNyamazane, a Black area in the Nelspruit district, the CSIR is carrying out a demonstration project as part of an ongoing research and development programme in collaboration with the Department of Plural Relations and Development¹¹. A local business firm whose employees reside in the area has also decided to contribute to the raising of community living standards at kaNyamazane.

The aims of the project are to investigate the means by which the private sector can supplement the government's housing projects; to produce a series of designs for different types of houses, together with a layout of the town and its community facilities; and to investigate the preferences of the employees and their possible participation in the planning of the projects.

One of the characteristics of the development is the arrangement of houses around open spaces of various shapes and sizes, connected directly to the service roads. This layout enables more houses to be built on a given area, and because access roads are reduced by 20 per cent both capital and maintenance cost, e.g. for engineering services, are also reduced.

The CSIR, the Eastern Transvaal Administration Board, and the Department of Plural Relations and Development jointly designed a series of alternative basic dwelling types which were financed by the company involved. Construction methods familiar to the Board are applied, and locally produced materials are used — which stimulates the local building industry and local private entrepreneurs.

Additions and improvements to the scheme can be made later without involving the public sector. Occupants can save money by enlarging or improving their homes themselves or they can employ local builders, thereby contributing to the local economy.

DETERIORATION OF CONCRETE STRUCTURES

In 1974 the South African Railways commissioned the CSIR to investigate concrete cores from the Pirow Street Bridge in Cape Town¹¹. The preliminary investigation revealed signs of a reaction between the coarse aggregates and the cement.

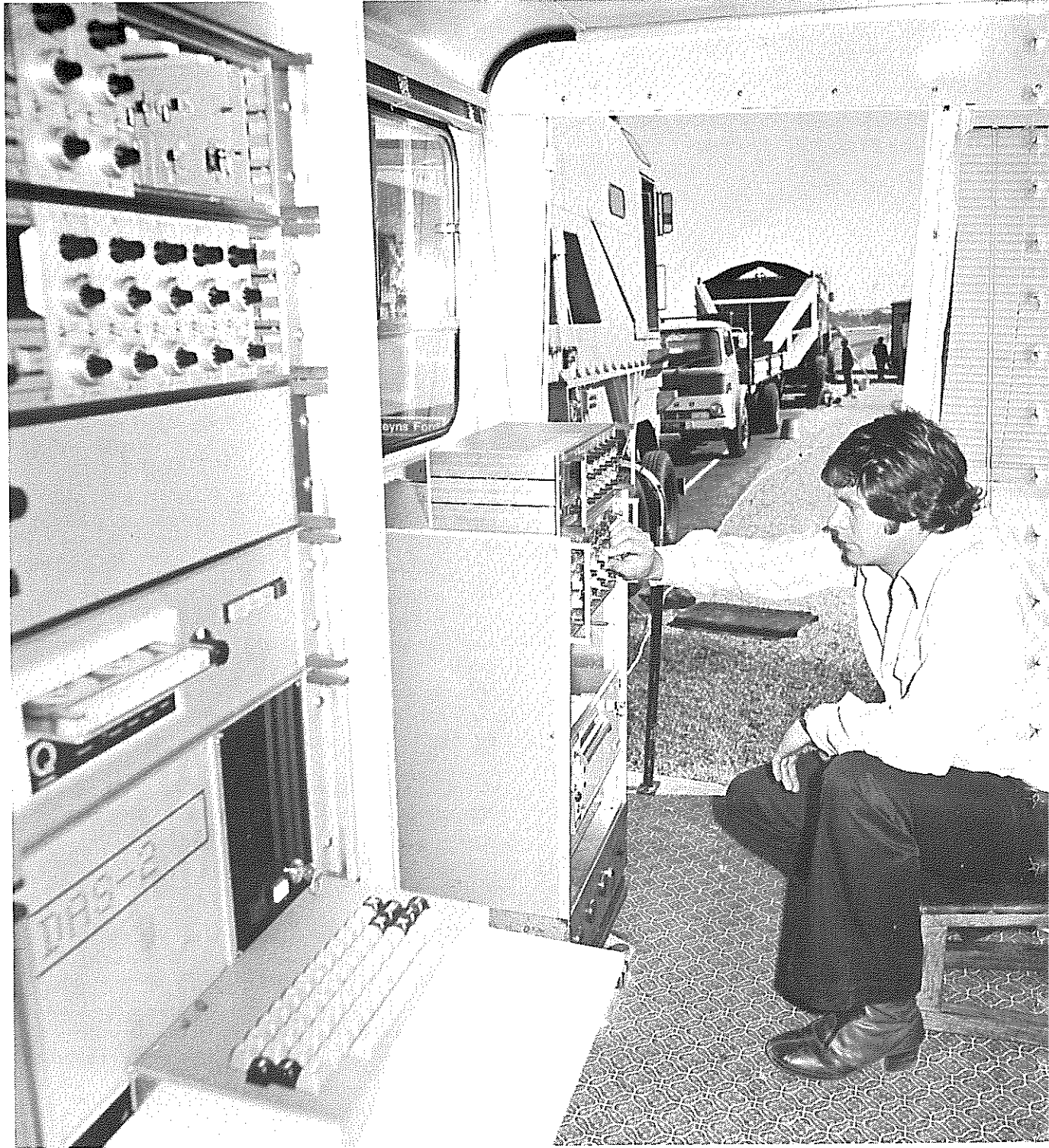
RAIL TRANSPORT OF THE MAIZE HARVEST

The Republic has approximately 250 railway sidings from which maize is transported to some 120 mills. Several years ago the CSIR was faced with the problem of determining the minimum total railage cost when the quantity of maize at each siding and the capacity of each mill are known⁴. A solution was found and applied by the Mealie Industry Control Board, but it had the shortcoming that, where each user had to defray his own railage costs, it was possible for the user to be favoured at the expense of another in respect of rail tariff. Ideally, a centralised scheme which ensures the lowest cost to the country as a whole should be acceptable to the users as well.

The problem turned out to be more difficult than expected, but the operations research team succeeded in arriving at a solution which is now being routinely applied by the Maize Board.

THE PRIVATE SECTOR AND LOW COST HOUSING

In our present age no government is capable of providing all the housing and related facilities required by its people, especially not in developing countries. The private sector therefore has a vital role to play in the provision of housing.



Inside the mobile service room of the CSIR's heavy vehicle simulator (in the background) which accelerates the effect of traffic on road pavement in order to simulate in a matter of months the wear on a pavement during its entire life.

The CSIR began a systematic investigation in 1976 and discovered the deterioration of concrete structures in the Cape Peninsula to be extensive and of a serious nature. Approximately 50 per cent of all exposed concrete structures are affected, the percentage being higher amongst the more recent structures. This deterioration has been attributed to the expansion of the concrete as a result of the reaction between the alkalis in the cement and the aggregate, which is from the Malmesbury group.

During 1977 and 1978 various public and private organizations contributed to the costs of an intensive research programme which is being undertaken by the National Building Research Institute with some assistance from the National Institute for Transport and Road Research in an urgent attempt to find a solution to the problem.

PERMEABLE CONCRETE FLUID CONTAINERS

Engineers are often concerned about the permeability of concrete used in the storage of liquids. High permeability means that valuable liquids are lost through the walls of the concrete containers, while the durability of the structure is adversely affected.

Little information exists on the subject, and there are no permeability values available for the various applications. The CSIR consequently determined the permeability of the concrete used for two new water reservoirs built in the Pretoria area recently¹¹. The concrete mixtures used in the two reservoirs differed both in strength and in permeability. After the reservoirs had been filled with water, the concrete which had shown the highest permeability in laboratory tests also leaked most, despite the fact that it was the stronger of the two types used. The other reservoir showed only one small leak.

Although it will take a while to complete this research, such information has been acquired to date and some advice can already be given on the subject.

GOODS TRAFFIC IN SOUTH AFRICAN CITIES

In accordance with a recommendation made by the Committee of Investigation into Urban Transport Facilities in the Republic (the Driessen Committee) the CSIR has been investigating goods traffic movements in South African cities¹³. Problems such as the contribution of goods traffic to congestion, under-performance of the delivery system, the slowness of heavy delivery vehicles, and their contribution to air and noise pollution were examined.

It was found that the problems encountered in the goods traffic system are not as serious as had been supposed. It had been alleged, for instance, that goods traffic contributed significantly to urban congestion. The proportion of goods vehicles in peak-hour traffic was found usually to be below five per cent, however, and since these vehicles are prohibited from loading or off-loading at the kerb during rush hours, they cannot be held responsible for much of the peak-hour congestion.

Double parking when the loading zones are being illegally occupied by private vehicles inevitably leads to a blockage of some lanes at other times of the day, and here a stricter kerb discipline and a better apprehension rate of offenders would ease the problem.

Only a small proportion of all goods vehicles operating in the cities, in fact about fifteen per cent, give rise to justified complaints of slowness and air and noise pollution.

After completion of the investigation it was recommended that uniform regulations be introduced for the marking and use of on-street loading bays and for the provision of goods-handling facilities in new buildings. The urban delivery system should be checked every three years for new or aggravated problems.

BUS SERVICES IN RANDBURG AND SANDTON

In September 1977 the CSIR was commissioned to undertake a full-scale study of the bus services for the

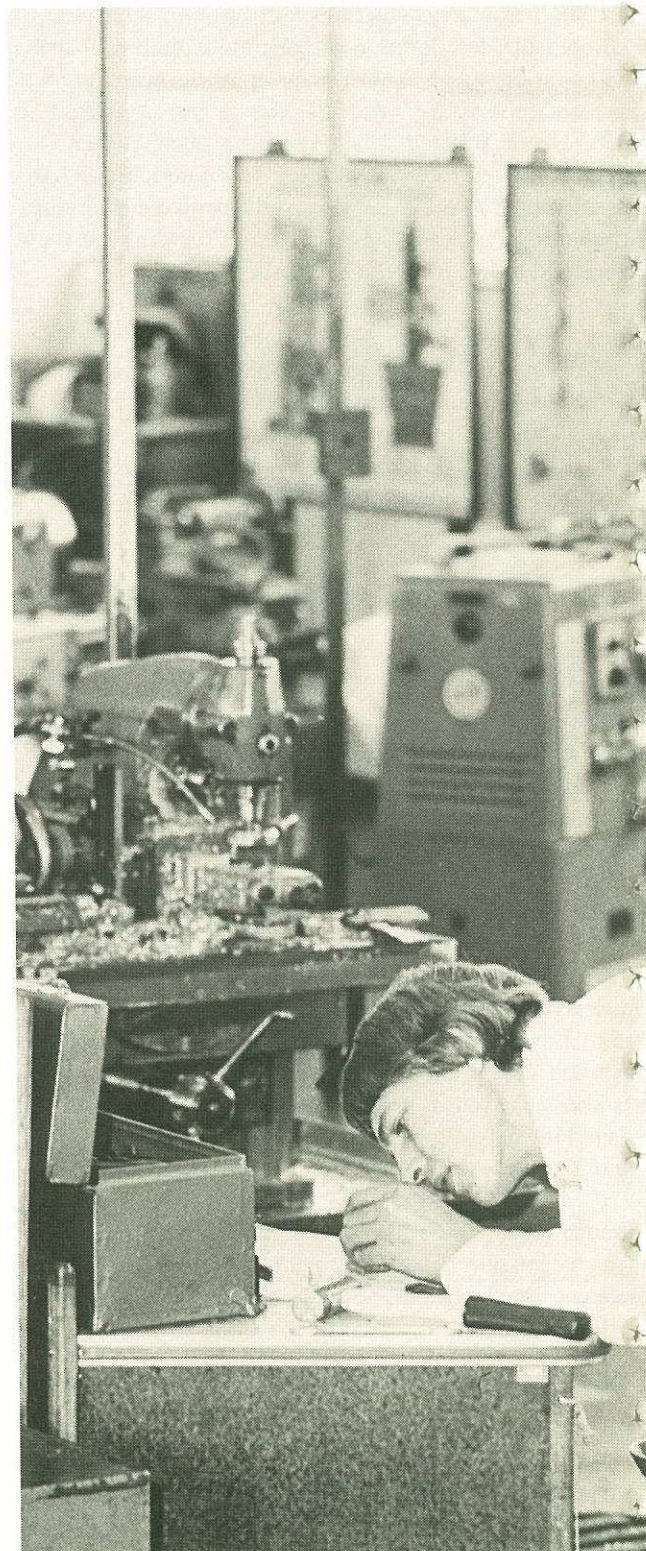
White community in the municipal areas of Randburg and Sandton in the Johannesburg metropolitan transport area¹³. The researchers were requested to estimate the demand for public transport in this area and to design a co-ordinated bus system to meet the demand.

Four surveys were undertaken, using self-administered questionnaires on board buses, at centres of employment, and at schools and shopping locations. Almost 7 000 completed questionnaires were received by the research team, with an excellent response rate: 30 per cent from the on-board bus survey, 60 per cent from the schools, 15 per cent from employees and 10 per cent from shoppers.

The surveys showed that more than 63 per cent of respondents reported having two or more cars per household. High car ownership and income, coupled with low residential density, made it extremely difficult to design a bus service which would significantly alter the modal split. Sensitivity analyses showed that the fuel price did not have a significant effect on the modal split, but that the introduction of parking charges equal to municipal bus fares in Johannesburg would increase the demand for bus services by 32 per cent in the area under investigation.

It was estimated that a revised fixed-route bus system would achieve a 60 per cent increase in commuters. Vigorous marketing would be required, however, especially for off-peak periods, to ensure the success of the new service.

The final report concluded that bus journey times from the area should be reduced by means of improved priority measures for buses and that school starting times should be selectively staggered to improve vehicle utilisation in the morning peak period.



Industrial development

GRouted BOLTS IN GOLD MINE TUNNELS

In deep-level gold mines the service tunnels between shaft and stope deteriorate in the course of time as the rock in the immediate vicinity of the tunnel becomes fractured and unable to withstand the stress without adequate support. A common technique of tunnel support is grouting: steel bolts of a length comparable to the diameter of the tunnel are cemented into holes that have been drilled in the tunnel walls. The bolts extend into the firm region of rock and provide the strength necessary to prevent further deterioration of the weak zone surrounding the tunnel.

A simplified mathematical model of this physical situation was developed by the CSIR in order to compute the minimum number of bolts necessary in a cross-section of such a tunnel, the required spacing of grouted cross-sections, and the length of the bolts⁴. An analysis of the results showed that the model is fairly realistic, and the conclusions that can be drawn from it seem to be in agreement with the actual situation although the model tends to overestimate the degree of support needed. The results have been prepared for a variety of parameters so that they can be tested or implemented in various mining environments.

ELECTRIC VEHICLES

The CSIR has been co-operating for nearly two years with a German consortium and a prominent producer of electrical equipment on a research and testing programme involving the operation of a battery-driven light delivery vehicle and a battery-driven minibus under fleet conditions⁹. The two vehicles have covered 16 500 km between them at an average electricity consumption of 0,7 kWh per kilometre and, apart from normal battery deterioration, have given little trouble. Negotiations are in progress to acquire a new version of the improved lead-acid batteries for these vehicles.

During the same period the performance of seven other electric vehicles has been measured and assessed by means of special instrumentation; a dynamometer was designed specially for the testing of electric vehicles to enable the efficiency of various drive systems to be measured accurately.

ELECTRICAL SYSTEM DISTURBANCES

As a result of the increasing demand for the measurement of electrical system disturbances such as spikes and over-voltages and harmonics or imbalances which are suspected of causing damage to equipment, the CSIR has acquired a mobile measuring laboratory containing all the necessary equipment for disturbance measurements on currents up to 33 kV and higher⁹. This service will be available to industrial concerns and consultants at a fee which will cover running expenses, and expert opinion on the origin and suppression of the disturbances will be offered in cases where no such expertise is commercially available.

MONITORING THE INSULATION OF HIGH-VOLTAGE MOTORS

About five years ago a research programme was started in collaboration with the Rand Water Board to assess the quality and deterioration rate of the insulation of large high-voltage motors⁹. Since then the number of industrial corporations expressing interest in this service has increased, and a larger measurement programme which will involve the monitoring of at least 150 machines per annum on a regular basis is envisaged. The CSIR has funded initial expenditure to obtain a mobile measuring laboratory, and

an experienced technical officer has been engaged to carry out the work on a cost per motor basis. It is confidently expected that this scheme will prove to be of valuable assistance in the planning of maintenance and rewinding programmes for high-voltage motors in applications demanding a high degree of dependability.

FILTRATION

The CSIR found a way in the past year to utilise rotary vacuum filters more efficiently¹⁰. The rotary vacuum filter is widely used in South African industry, especially in the processing of gold and uranium ore, where it is used to reclaim solids from slurries and to purify liquids by removing solids.

Conventional rotary drum filters are expensive and require large covered floor areas with complicated support structures. The efficiency of these filters can, however, be improved by making simultaneous use of the internal and external surfaces of the filter drum. The resulting device, designed by the CSIR and called the INTEX filter, offers almost twice as much filter area as the conventional model. The design has been further refined and a pilot scale plant constructed. The results obtained from a series of tests using a gold ore slurry show that the filter throughput is indeed approximately double that of the conventional rotary vacuum filter. The new model is also capable of filtering slurries containing coarse fast settling substances.

The better capital utilisation realised by the INTEX filter should be of importance both in the construction of new vacuum filter installations and in the increase of existing vacuum filter capacities.

REINFORCED PLASTIC PIPING IN UNDERGROUND SEWERS

A South African firm has developed and patented internationally a unique method of producing a new type of flanged plastics piping for underground sewer applications. Radial splines or flanges on the outside reinforce the pipe against distortion.

The CSIR was requested by the inventors to undertake an extensive research programme to determine the quality and possible use of this type of piping¹¹. A series of experiments in trenches and in the laboratory established that the radial splines increase the resistance of

the cylindrical wall of the pipe to possible collapse under pressure by a factor of approximately 50. The piping is also highly resistant to wear caused by abrasive materials in sewage sludge.

The manufacturers are at present promoting their new development in other countries and are establishing the production technique in licencees' production plants.

RETURNABLE CONTAINERS FOR SORGHUM BEER

In 1976 some 600 million litres of sorghum beer, packaged in non-returnable one-litre containers, were sold in the Republic. These beer containers are manufactured locally, mainly from imported food grade board with a nett import value rated at R12 million.

Anti-litter legislation now before Parliament may at some future date impose constraints on the use of such one-way containers. Because of this and other problems associated with current practices in the distribution and marketing of sorghum beer, the brewing industry has become interested in returnable containers. Research undertaken by the CSIR led to a collaborative development project with local packaging manufacturers which resulted in the design of returnable containers with nett capacities of 1, 2, 4 and 16 litres¹⁷. These containers are made from locally produced high density polyethylene or polypropylene and are designed for cleanability, ease of mechanical handling, low cost mass production, durability and improved product image.

Marketing tests with the 2 and 16 litre containers were conclusive and these are now available commercially and are being used in certain marketing areas.

The 4 litre container designed for use in rural areas and in the homelands is still being tested. The 1 litre container will be launched soon in a mixed market which includes both rural and urban areas.

In addition to the advantages of significant savings in the cost of imported materials and a sharp reduction in littering, the change to returnable containers, if successful and fully implemented, could also be of considerable direct financial benefit to the sorghum beer industry.

LIGHTWEIGHT WOOL SHIRTS

During the past few years considerable attention was given to a study of the technique of sizing fine singles yarns in order to strengthen them sufficiently for use in the warp of wool shirting fabrics. Unsized fine yarns are too weak to weave without causing a considerable number of breakages. By implementing the technique of sizing, however, the CSIR has succeeded in developing a drip-dry light-weight wool shirt fabric which is completely machine-washable¹⁸. The CSIR, in collaboration with the South African Wool Board, is now promoting this development in the industry.

COTTON DYEING IN LIQUID AMMONIA

There are several patents for the use of liquid ammonia as a solvent in cotton dyeing. Usually, however, the resultant dyeings are uneven.

The CSIR has found that by using a co-solvent (in this instance water) level dyeings can be obtained¹⁸. By the simple means of adding 10 per cent water by volume to the ammonia, the dyestuff is absorbed evenly. The ammonia can be removed by steam and the colour fastness increased to an acceptable level by subsequently treating the cotton fabric with an aminoplast resin. It is also possible to treat the cotton fabric simultaneously with both dyestuff and resin, which has the advantage that the resin in its commercial form contains a sufficient amount of water to act as co-solvent.

NEW COTTON CULTIVAR

From time to time the Department of Agricultural Technical Services requests the CSIR to test certain cotton cultivars prior to large-scale cultivation in order to identify any potential problems in processing behaviour¹⁸. Such an investigation, recently carried out on Acala SJ 141, revealed that although this new cultivar had a high micronaire value, its maturity was almost 100 per cent and the yarns relatively strong. An interesting phenomenon came to light in respect of the area of origin: samples from the higher areas along the Orange River were found to be finer. With this cultivar the Department of Agricultural Technical Services has achieved a much higher cotton production per hectare — the result, partly, of the cultivar's excellent resistance to diseases such as 'rooidood' (redleaf

disease) which is a major problem in the Lower Orange River Valley.

FIBRE CRIMP AND WOOL PROCESSING

For many years industry failed to recognise the relative importance of fibre crimp and its effect on the processing behaviour of wool. Recent experiments by the CSIR indicate that the role of fibre crimp can be largely underestimated¹⁸. Overcrimped wools (in terms of the Duerden fineness/crimp relationship) have a poorer combing performance, they tend to give shorter mean fibre lengths in the top, and they also have a poorer spinning performance. To counter overcrimping the fibres can be partially decrimped by wetting them out and drying them under tension (during backwashing, for example).

One advantage of overcrimped wool, compared to wools complying with the Duerden scale, is that it causes less surface irregularities such as cockling in the production of single jersey fabrics.

STRESS GRADING OF SOUTH AFRICAN PINE

A sudden upsurge of interest in the mechanical stress grading of timber by the sawmilling industry has resulted in the CSIR's having to expand its research considerably in this field¹⁹. Particular attention had to be given to the refinement and improvement of the data on which mechanical stress grading in South Africa is based; the design of new and efficient high capacity machinery for mechanical stress grading; more intensive research into the stress-wave method of grading, which holds great promise for the future; and assistance to the industry in the implementation of mechanical stress grading and the evaluation of present systems.

Mechanical stress grading results in a much more efficient utilisation of South African structural timber, and can improve South Africa's export position. The price structure for mechanically stress-graded timber as determined by negotiation within the industry has led to an increase of about 25 per cent in the gross value of construction timber produced in South Africa.

A considerable amount of research has also been done on the visual stress grading of South African pine sampled from all parts of the country. The results of this research are being

used by the South African Bureau of Standards as a basis for revision of the current visual grading specifications.

DEVELOPMENT OF ADHESIVES FOR WOOD PRODUCTS

Timber adhesives increase the usefulness of wood by extending the range of possible timber products, such as laminated beams and board products. Wood residues, which are otherwise of little use, are often transformed into valuable merchandise through the use of adhesives. Development in this direction has been hampered by the lack of adequate sources of cheap adhesives, however, with the result that synthetic resins which often contain expensive imported components had to be used extensively.

The CSIR is now engaged in developing new types of adhesives based on locally available raw materials¹⁹. To date tannin-based adhesives have received most attention. Tannins from wattle and pine bark were investigated, and adhesives based on wattle tannin have already reached the stage of being applied industrially in the manufacture of laminated beams, particleboard and plywood. Besides reducing production costs, these adhesives have also, in some cases, introduced improvements in the quality of products: the water and weather resistance of particleboard, for instance, has been improved to the extent that it is now suitable for exterior use in applications such as timber housing, road signs, and the like.

INVESTIGATION INTO THE SOUTH AFRICAN CHEMICAL INDUSTRY

A number of organic and inorganic chemicals, fertilizers, insecticides and pharmaceutical products which appear to have some potential for local production have been identified by the CSIR²¹. The analysis was made possible by the creation of a computerized databank for import, export, and local production and consumption particulars of 800 product categories. The new facilities enable future trends in the supply and demand structure of chemical feedstocks and materials to be constantly monitored.

Analysis of these data, coupled with studies of the most important factors affecting local production, have resulted in the identification of a number of organic and inorganic chemicals, fertilizers, insecticides and pharmaceuticals whose production merits further in-depth evaluation. The

products thus identified have been listed in a special report, together with a full description of the methodology which was developed.

A subsequent investigation of aromatics, olefins and alkanes indicates that the production of coke from low-grade coal could be a key process in the optimum utilisation of this indigenous raw material. Local production on a large scale would provide much sought after coke for export as well as valuable chemical feedstocks such as ethylene, and the aromatics benzene, toluene and xylene, for the local market.

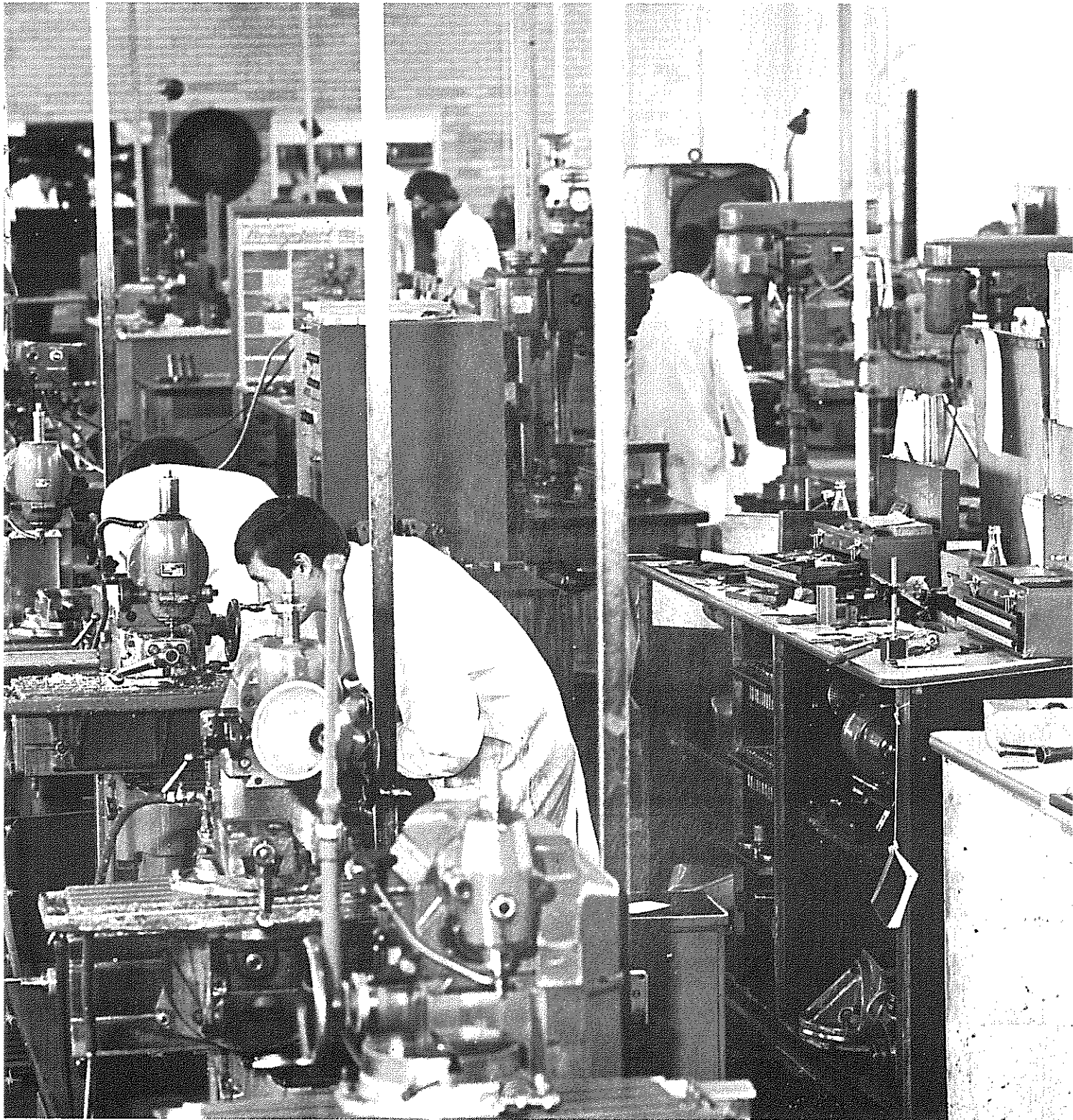
SINGLE COLUMN AMINO ACID ANALYSIS

A gas chromatographic technique developed by the Fishing Industry Research Institute for amino acid analysis by means of a single column has now been refined to a point where its advantages over the current dual column procedure, and for that matter over classical ion-exchange techniques, are being realised²⁴. Apart from its lower capital outlay and maintenance costs, the inherent speed and sensitivity of the technique render it the better method. In addition, the single column technique permits an increased number of samples to be analysed.

The estimation of cystine quantities in fish meal is impossible with the dual column gas chromatographic method, and current work aims to establish a novel technique which will enable this amino acid to be determined by means of the single column. A means of assaying tryptophan simultaneously with the other protein amino acids is also being studied.

MASS LOSS OF ROCK LOBSTER TAILS

Compulsory specifications governing the packing of frozen rock lobster tails state that the net product weight must exceed the declared weight by an amount of 2,5 per cent. This is to make allowance for loss of mass during freezing and subsequent cold storage. As long ago as 1957 the Fishing Industry Research Institute showed that lobster tails lost between 0,70 and 2,03 per cent of their mass during freezing, depending on the size and type of container used²⁴. As excessive overpack cannot be tolerated, mass loss was re-investigated in the light of the improved packaging currently available.



Tests showed that mass loss during storage is variable, being a function of the fluctuating cold store temperature and humidity, storage time and, most directly, the water vapour permeability of the package. To retard diffusion of moisture through the cardboard of the master carton, the use of polythene overwrap for the five inner cartons was recommended. This will permit overpack to be reduced almost to the limits of freezer loss.

FISH PROTEIN IN INFANT FOOD FORMULAS

A large food processor in the United States of America requested the Fishing Industry Research Institute to undertake an investigation into the elimination of the odour and flavour of homogenised hake by means other than solvent extraction²⁴. The intention was to use deodorised fish as an added protein source to enrich a vegetable based baby food.

The canned baby foods with the blandest flavours were those prepared from hake mince extracted four times with brine at temperatures below 10 °C. A carrot based product with added fish protein was considered to have the best flavour. The product had an attractive light yellow colour and the texture was better than that obtained with other formulas.

HIDE AND SKIN PRESERVATION

Extensive studies have been undertaken at the Leather Industries Research Institute to investigate the feasibility of salt reduction in hide and skin curing²⁵.

In contrast with the classical curing methods employing saturated salt, and the 'no-salt' preservation methods which rely on antiseptics only, this low-salt method depends on the enhanced antiseptic activity observed at intermediate salt concentrations well below the saturation levels used in conventional curing: single antiseptics applied in a dilute salt solution are found to be more effective than in aqueous solution. The low-salt method offers a means of bridging the gap between traditional salt curing and the more recent salt-free methods currently under development, and will reduce the amount of dissolved solids in the effluent.

In another field of research, studies of fur durability in Karakul pelts were carried out to determine the role of physiological factors such as curl type and pattern,

production practices (curing, washing and drying) and processing methods such as tanning, dressing and dyeing on the abrasion resistance of the fur surface. In a recent comprehensive investigation the influence of various stages of commercial dressing and dyeing on the abrasion resistance of the fur surface in Karakul pelts was examined in collaboration with the Karakul Board and five major processors in West Germany, Italy and France.

TANNERY EFFLUENT

In view of the fact that conventional salt-cured hides cause salt pollution when processed into leather, more tanners are becoming interested in processing fresh uncured hides. The Leather Industries Research Institute is investigating the possible need for modifications to conventional unhairing methods to render them suitable for the processing of such uncured, unsalted hides²⁵. The investigation includes a study of the effects of variations in the salt concentration in the unhairing (lime/sulphide) liquor and the use of enzyme auxiliaries in the processing procedure.

A modification of the standard Liritan process, called the flip-flop system, has been developed for the manufacture of sole leather. This system consists of two colouring vats used before the tanning system; the second of these vats doubles as a leather tempering vat after the tanning operation to reduce the waste of vegetable tannins. Various bleaching and finishing operations applied to sole leather after the Liritan process are also being investigated — in particular for American and Canadian tanners.

In the area of solid and liquid tannery effluent treatment, the re-use of lime/sulphide unhairing liquor, which is one of the main sources of tannery pollution, is being studied. This involves the development of suitable economic methods for solid removal from the unhairing liquor prior to re-use. Pilot scale high rate biofilters are also being used on tannery and fellmongery effluent to ascertain their efficiency in comparison with the completely mixed activated sludge systems which have been in pilot-scale operation for some time.

FOOTWEAR

Two of the major areas in which the Leather Industries Research Institute (LIRI) has recently made an important contribution to the footwear industry are the training of

factory staff of all races at all technical and production levels, and the quality control of materials and components²⁵.

Training by means of seminars, lectures, and in-factory training schools has been expanded considerably with courses on adhesives and quality control and training programmes for supervisors, closing room machinists, clickers and pattern cutters being offered or in the process of being implemented. The footwear industry has recently examined its training requirements for the future and has decided that LIRI will be taking full charge of its technical training on an expanding basis designed to satisfy the increasing need for training in the industry.

The LIRI quality control programme for the footwear industry has expanded significantly over the past year. In 1973 the Institute handled 538 enquiries from the footwear industry alone, while in 1977 the number rose to 990. The work involves the testing of materials and components before production and the analysis of completed and faulty or returned footwear. Recent developments include the installation of facilities to test the quality of leather and synthetic footwear upper and soling materials at -10°C for footwear export to countries with cold climates.

ELIMINATION OF ACID BEVERAGE FLOC

Acid floc is a precipitate which is sometimes obtained when a solution of refined sugar is acidified with phosphoric acid, as in soft drinks. Work carried out in South Africa and elsewhere has shown that the floc is formed when two impurities contained in sugar, one of which is a specific polysaccharide containing uronic acid groups and the other a protein, combine under acid conditions. The quantities involved are exceedingly small, which makes their removal difficult.

The Sugar Milling Research Institute carried out a comprehensive study to assess filtration as a method of eliminating acid beverage floc²⁶. The conditions necessary to inhibit flocculation were determined by filtering sugar solutions at various temperatures through membranes and filter aids.

It was found that the larger the membrane pore size the greater the amount of floc produced and the lower the temperature of filtration required to eliminate it. Solutions

filtered through membranes with a very fine pore size were floc negative even at temperatures of 80°C . Solutions below 50°C were floc negative when filtered through membranes with larger pores falling within a given diameter, irrespective of their initial turbidities.

Further studies with filter aids revealed that raw sugar solutions were rendered floc negative when passed through filter aids at temperatures below 65°C , while at higher temperatures floc formation was considerably reduced. Filtering efficiency was enhanced by increasing the filter cake thickness. Similar results were observed with refined sugars and in the case of laboratory melt phosphatation. A very fine-grained filter aid rendered all phosphated and refined sugars floc negative even at 80°C , but the flow rate was unacceptably low. A blend of two particular filter aids was found to be eminently suitable for industrial use as it produced acceptable flow rates and efficiently removed the floc precursors.

JUICE CLARIFICATION

The Sugar Milling Research Institute investigated the influence of various impurities, occurring either naturally in mixed juice or added during processing, on the clarification process and the quality of the clear juice²⁶.

The degree to which the return of filtrate from the mud filters to the mixed juice influences clarification depends on both the quantity and the nature of the filtrate. Experimental results indicate that the calcium phosphate precipitate suspended in the filtrate may be largely redissolved during the heating of the mixed juice at its natural pH. The addition of returned filtrate at the rate of 20 per cent by volume, with less than 1 to 1.5 per cent solids present, results primarily in dilution. The addition of filtrate with a lower suspended solids content than 1.5 per cent therefore yields greater settling rates and a marginally lower turbidity, whereas above this level a marked deterioration in settling rate is noted. The final mud volume is inversely proportional to the settling rate: an increase in the solid content of the filtrate results in a steady increase in the mud level. These results vary with the proportion of filtrate returned to the mixed juice.

The influence of starch was investigated by adding it to mixed juice prior to clarification. A slight increase in turbidity was observed, with no change in the initial settling



The quality of footwear upper materials being tested on a flexing machine at the Leather Industries Research Institute (p. 26).



The manufacture of specialised microcircuits at the CSIR's integrated circuit production facility for the local electronics industry (p. 29).

rate of the mud. This marginal effect of starch on raw juice clarification is in marked contrast with the effect it has on the phosphatation refinery process — the difference being probably due to the different physico-chemical properties of the raw juice, with its large impurity level, and a relatively pure concentrated sucrose solution.

The addition of excessive amounts of field soil to mixed juice raised its turbidity, due to the large proportion of colloidal material present. A low degree of hydrolysis flocculant proved to be most effective in settling this turbidity. An increase in the magnesium content of mixed juice produced a number of minor changes in clarification, including a slight decrease in settling rate, little change in turbidity and an increase in the calcium content of the clear juice.

A brief investigation into the ageing of cut cane showed the deleterious influence of ageing on settling rates and mud volumes, although little change in juice clarity was observed. The ageing of cut cane greatly increases the gum content of the juice, darkens its colour, and reduces its starch content.

CUSTOM DESIGNED INTEGRATED CIRCUITS

The CSIR's integrated circuit (IC) facility has maintained a regular production of integrated circuits for close on two years now, and satisfactory progress has been made in the accumulation of IC production expertise in certain standard processes⁹. The main objective, that of establishing facilities for the local design and manufacture of custom or special-purpose ICs not available as standard commercial items, has been realised. Some of these circuits are already being employed in equipment presently produced by South African electronic equipment manufacturers, and their use has resulted in a considerable simplification of some assembly stages. This has reduced dependence on overseas component suppliers while ensuring a more reliable final product.

Several contracts for the development of custom ICs are in progress, as well as studies to assess their suitability for applications ranging from mining operations, communications and computing to electricity consumption metering. Some of these ICs are relatively complex, and in several cases the sponsoring companies have appointed design engineers to work with the CSIR design team on the

development projects. This has been found to be a very effective way of obtaining optimum results while generating IC design know-how in industry for future use. In addition, several universities have been actively engaged in the design of ICs as part of student projects, for production at the CSIR's IC facility. An agreement has recently been concluded in terms of which some design work for industry can be channelled through the universities to assist the CSIR design team.

The ideal is to make the fullest possible use of this service, which was established for the benefit of the electronics industry in South Africa, and developments to date have come a long way towards realising this goal.

INDUSTRIAL AUTOMATION

The CSIR has been participating with industry in research projects involving data acquisition and control in the areas of sugar refining, gold ore reduction and sawmilling⁹.

In the case of each of the three projects the bulk of the work was carried out on production equipment in the factory. This required careful planning and co-operation with the factory staff to avoid upsetting the production schedule.

The investigation into sugar refinery control was undertaken on an experimental basis and has yielded valuable data for use in the design of a comprehensive control system. The project undertaken in collaboration with the gold mining industry is currently under way, whilst the sawmill research project has reached the stage where the initial problems have been solved and production data are being collected on a routine basis.

Promotion of general welfare

METAL POLLUTION IN THE WILDERNESS LAKES

The four Wilderness lakes near Knysna in the Cape Province may in time to come increase in importance, particularly with regard to the development of holiday resorts. The Department of Planning and the Environment requested the CSIR to conduct surveys in this area in order to determine the degree and distribution of metal pollution (including toxic metals)². Metals occurring in the area are copper, lead, zinc, iron, manganese, cobalt, nickel and cadmium, as well as the metals generally occurring in nature such as calcium, magnesium, sodium, potassium and aluminium.

A comprehensive survey during which water and sediments were examined gave a full picture of the current pollution pattern. By analysing sediments from different depths it was also possible to obtain a pattern of the pollution history.

There is very little metal pollution in the area, with the exception of the Island lake. Upper sediments taken from the lakes where motor-boats are used, however, show clear signs of lead. This pollution may stem from fuel or from lead-based paint. As may be expected, there are signs of metal pollution at the town of Sedgefield, but nowhere in the whole area can the measure of pollution be regarded as exceptionally dangerous. The markedly high iron content of the water in Ruigtevlei and Swartvlei and the high manganese content at Swartvlei may be ascribed to the natural penetration of these elements from the river source.

ENVIRONMENTAL REQUIREMENTS IN FACTORIES

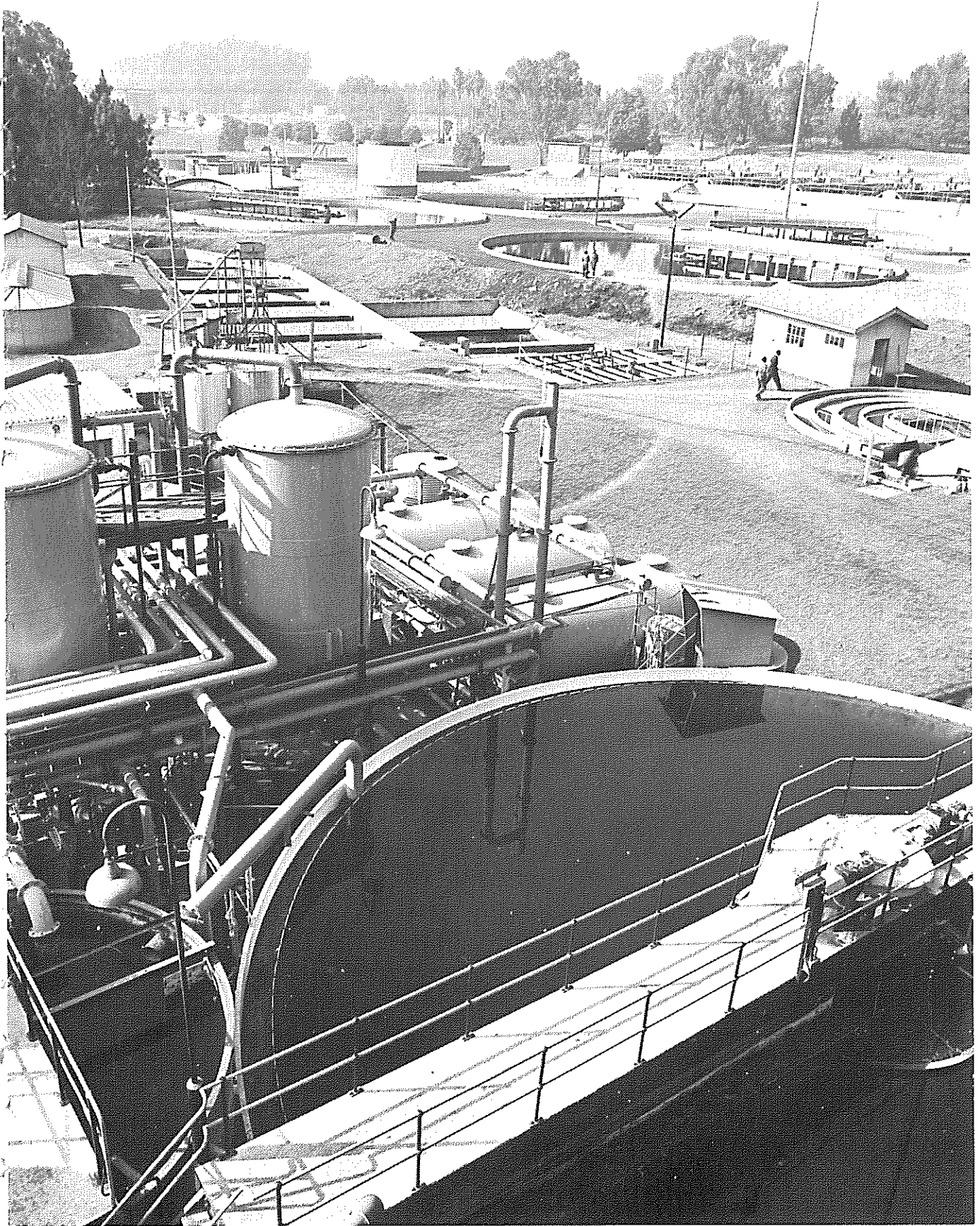
In the first phase of its investigation into human needs in indoor environments, the CSIR made use of a mobile climate room to complete a series of 'hot' tests with Black and White workers in various factories¹¹. A comprehensive report, parts of which will be published in the scientific press, is being drawn up.

The results of the investigation which involved, *inter alia*, the combined effects of heat and noise on potential productivity, were announced at an international congress on indoor climates in Copenhagen during August 1978.

WATER HYACINTH CONTROL

By March 1977 the water hyacinth in the Hartbeespoort Dam had proliferated to such an extent that it covered 60 per cent of the surface of the dam, which severely hampered its use for recreational activities. Furthermore, it was highly probable that the weed would in due course cover the entire dam. At this stage the Department of Water Affairs decided that the plant should be sprayed with a herbicide, and a programme was drawn up in collaboration with the CSIR and other interested parties for a thorough scientific monitoring of the dam's reaction to the spraying process¹².

The CSIR was responsible for a major part of the multi-disciplinary monitoring programme on the physical and



The full-scale Stander Water Reclamation Plant in Pretoria where methods of reclaiming water for household use from municipal effluent are being evaluated.

biological conditions of the dam and its water chemistry. The programme was partially financed by the Water Research Commission, and various organizations, including the Hydrological Research Institute of the Department of Water Affairs, the South African Bureau of Standards, the Botanical Research Institute of the Department of Agricultural Technical Services and the Nature Conservation Division of the Transvaal Provincial Administration, participated in the more than 20 000 observations and analyses which were carried out before, during and after the three separate sprayings of the weed. A helicopter was used to reach three of the sampling stations on the dam.

No dramatic changes took place in the water chemistry of the dam, but the concentration of dissolved oxygen in the water reached its lowest level towards the end of November 1977 — a month after spraying had begun. This had been expected and did not give rise to concern, since the available oxygen was still sufficient to sustain the fish and other aquatic biota. Extensive assessments of herbicidal residues in the water, dam sediments, fish tissues and agricultural crops showed that concentrations were well within the limits specified by the Department of Health. The relatively slight influence of the spraying can to some extent be ascribed to the fact that decomposition of the hyacinth took place gradually over a period of weeks. A detailed report of all the findings is in preparation, as well as guidelines which, it is hoped, will serve as a code of practice for the use of herbicides as a control technique in further dealings with the hyacinth.

TRANSFER OF WATER PURIFICATION TECHNOLOGY

The CSIR renders advisory services on water and sewage purification to government departments, provincial administrations and local authorities¹².

In terms of an agreement with the Department of Plural Relations and Development, the CSIR furthermore supervises and gives advice on the operation of water and sewage purification plants in the Homelands, where personnel are at present stationed. Similar services are rendered to certain developing independent Black states.

Simple standard designs have been drawn up for water and sewage purification plants particularly suited to areas

experiencing a lack of trained personnel and facilities. The Orbal sewage treatment unit, designed for the purification of wastewater in small communities, has been developed in collaboration with the South African Inventions Development Corporation which holds the patent rights. The effectiveness of the Orbal system has been proved at various centres over a number of years.

Two Orbal plants have been constructed in Gazankulu — one at Elim Hospital and one at Tintswalo Hospital. The plant at Elim was officially opened last year during the Symposium on Wastewater Treatment in Developing Areas. A third plant, a standardised water purification plant with a capacity of 18 m³/h, is in operation at Keiskammahoek in the Ciskei.

Since purification plants depend for best results on operating personnel and technicians with a reasonable amount of training, the CSIR has helped to establish suitable training facilities at South African technical colleges.

ROAD TRANSPORT OF HAZARDOUS MATERIALS

One major shortcoming in the field of transportation at present is the lack of control over the conveyance of hazardous materials by road. The individual contractor, no matter how large or well-run his organization or how many precautions he takes to prevent an accident, is in no position to provide a comprehensive and adequate emergency service in all the areas where he may transport hazardous materials.

In view of this, the CSIR recently carried out a preliminary investigation to determine the extent of the problem¹³. It was established that individuals and organizations in this country already possess a considerable amount of knowledge on the subject. The main requirement now is for co-ordination and liaison in order to channel all activities through a central organization which will have the power to propose any additional legislation necessary and to take full responsibility for the transport of hazardous substances.

There are four main classes of hazardous commodities: explosives, radio-active substances, flammable products and chemical products. The first three are fairly well covered by present legislation and municipal by-laws, but there is very little control over the transport of chemical products.

It is fortunate that the conveyors of these commodities voluntarily adhere to American and European codes of practice.

The CSIR is now investigating all aspects of the conveyance of hazardous materials by road and will seek the advice and co-operation of all carriers and of the Department of Health and the Department of Transport. Once the investigation has been completed, firm recommendations will be made in respect of legislation and codes of practice.

AIRCRAFT NOISE

Work has been in progress for some considerable time on the development and improvement of techniques to assess and predict aircraft noise disturbance. Such techniques are used around airports to delineate exposure zones within which residential development should be controlled. Serious economic and community problems which can arise where airports are hemmed in by densely populated areas may thus be avoided.

The current project was launched by the CSIR at a time when it appeared that overseas authorities in this field were ignoring certain variables such as airport altitude above sea level and ambient temperature; under South African conditions the influence of these factors is of considerable importance⁸. For this reason the CSIR project leader joined various international working groups to ensure that internationally accepted techniques would also be acceptable to the Republic. Decisive success was achieved.

The initial work, undertaken partly on behalf of the Department of Planning and the Environment and completed some time ago, was focused on the noise of large jet aircraft. The results obtained are now already being applied by local authorities to control township development near airports. Light aircraft noise was subsequently studied, and recently the final phase of the work, aimed at helicopter noise, was successfully completed¹⁵. At this stage the project leader was invited to present a paper on the assessment of noise exposure near airports to a congress of the International Council of the Aeronautical Sciences, held in Lisbon during September 1978.

The techniques used in the prediction of noise disturbance involve consideration of aircraft parameters, flight

procedures, noise radiation patterns, attenuation of sound in the atmosphere and over the ground, and subjective human reactions — taking into account such variables as sound intensity, spectral characteristics and noise duration. In the case of helicopters, an unusual impulsive noise is also encountered under certain flight conditions. The South African method of accounting for this noise component, in contrast with overseas attempts, is extremely simple and more reliable.

VOCATIONAL COUNSELLING AND OPPORTUNITIES FOR BLACKS

Improved labour utilisation depends on the effective selection and training of workers and the identification of their special abilities and interest patterns.

In the early fifties the CSIR developed a vocational counselling service for Whites which is still being used today¹⁶. The needs of the other social groups have remained largely unknown, and a research project has been launched to evaluate the merit of the existing techniques.

In co-operation with the University of Fort Hare, norms for certain psychological tests are being calculated and the achievement needs of Black students investigated.

The Urban Foundation is collecting information on the opportunities and needs of Black people in order to determine priorities which would permit it to draw up a programme suitable for implementation.

One aspect of the CSIR investigation, commissioned by the Foundation, concerns the personnel management and career counselling procedures presently available for Black workers. A questionnaire on prevailing practices in career counselling was sent to almost 1 000 business organizations. Visits were made to approximately 40 government and other organizations specialising in research and in training and development techniques in the field of Black labour requirements. Analyses of the results indicated that there was much room for improvement. It was found, for example, that although there was no substantial difference in quality between the various methods practised in the different geographical areas, marked differences occurred amongst the various sectors of industry. It was also found that more information and facilities are in fact available to

assist organizations interested in refining their counselling and training procedures than is generally realised. Inadequate co-ordination of facilities is a major limitation.

An extensive report, incorporating recommendations, was submitted to the Urban Foundation at the completion of the study.

PROHIBITED TISSUE IN BOEREWORS

A regulation issued in terms of the Foodstuffs, Cosmetics and Disinfectants Act of 1972 states that boerewors shall contain not less than 60 per cent lean meat and not less than 90 per cent total meat, i.e. lean meat and fat.

A microscopic examination of 60 boerewors samples purchased from butchers in the Pretoria area was carried out in the CSIR laboratories¹⁷. The examination showed that the majority of the samples contained prohibited animal tissue. Since boerewors is usually well cooked before it is consumed, the addition of the prohibited tissue is not regarded as an important health hazard, but it is nevertheless clear that a very high percentage of the boerewors samples examined must be regarded as adulterated products. Certain of the prohibited tissues originated from edible organs such as heart, liver and kidneys, but in many cases tissues of animal origin were found that are aesthetically unacceptable to the majority of consumers.

Chemical means of determining fat and protein nitrogen is inadequate and has to be supplemented by a histological examination to detect the adulteration of boerewors with prohibited animal tissue.

SMOKE AND SULPHUR DIOXIDE IN THE ATMOSPHERE

The national survey of smoke and sulphur dioxide confirmed the downward trend in the concentrations of these pollutants during the past year²⁸. The improvements may to some extent be attributed to the introduction of smokeless zones. As the name implies, smokeless zones promote the abatement of smoke and not gaseous pollutants in general. By restricting smoke emissions the use of electricity is encouraged, however, and as electricity gradually replaces coal as heating fuel in winter in the older and less developed urban areas of the country, gaseous pollutants will obviously decrease.

MEASURING THE FREONS

A realistic assessment of the worldwide impact of man-made pollution on the environment requires full international co-operation. At the Stockholm Conference on the Environment in 1972 a project called the Global Environmental Monitoring System (GEMS) was launched to assess the possibility of impending irreversible damage to the global atmosphere.

A factor at present enjoying considerable international interest is the release of halogenated hydrocarbons, or freons, from aerosol spray cans and refrigerator installations. There is some evidence that the continued release of freons may cause a depletion in the natural ozone layer of the upper atmosphere. This would lead to an increase in the intensity of ultraviolet radiation at the surface of the earth, with a number of disturbing side-effects.

The South African contribution to the GEMS project consists, in part, of measuring freons at geographically strategic points²⁸. This work has been in progress for just over a year.

Transfer of scientific and technical information

DATA CENTRE FOR OCEANOGRAPHY

It was decided in 1977 to establish a National South African Data Centre for Oceanography, which would be administered by the National Research Institute for Oceanology at Stellenbosch⁷.

The functions of the data centre would be to acquire, collate and store South African oceanographic data and to make it available to research institutes, industries and other local users of such data, as well as acting as the local agency in the international exchange of data between South African researchers and their foreign colleagues.

The first step was to make contact with the major oceanographic data centres in Europe to determine how they operated. The information which was thus obtained, as well as the guidance provided by the United States National Oceanographic Data Centre in Washington, was invaluable in the establishment of the South African data centre.

The recent installation of CDC terminals, linked directly to the CDC Cyber 174 system at the CSIR, will greatly facilitate the storage and processing of data.

TERMINOLOGY

Following the revision and expansion of the CSIR's bilingual list of textile terms which was published in 1973, the new *Textile Dictionary (English-Afrikaans; Afrikaans-English)* appeared during the past year²¹. The dictionary was compiled by means of computer techniques, and with the experience gained to date the CSIR is currently contributing to the establishment of a computerised national terminology bank under the auspices of the Terminology Bureau of the Department of National Education.

The CSIR is at present also represented on the Co-ordinating Terminology Board (COTERM). This organization, under the chairmanship of the Secretary for National Education, is responsible for the co-ordination of all aspects of terminological research in South Africa, the establishment of national norms and policies for the preparation of terminology lists and dictionaries, and for liaison with overseas bodies involved in terminological research.

INTERNATIONAL CONFERENCE ON DYNAMIC PROPERTIES OF HEAVY ION REACTIONS

An international conference on the dynamic properties of heavy ion reactions, sponsored by the International Union of Pure and Applied Physics (IUPAP) and organized by the head of the Nuclear Physics Research Group of the University of the Witwatersrand and his staff in collaboration with the CSIR and the Atomic Energy Board, was held in Johannesburg from 1 to 3 August 1978²¹. The occasion was hosted by the University of the Witwatersrand.

This conference, which was the first in South Africa to be sponsored by IUPAP, was attended by 102 participants, 47 of them from eleven overseas countries. It was preceded by a one-day symposium on the applications of heavy ions (such as carbon dating techniques) and was followed by a school in which chosen topics were treated in greater detail.

The success of the conference was underlined by the many favourable comments received from participants.



CSIR CONFERENCE CENTRE

A visitor arrives at the registration desk in the foyer of the CSIR Conference Centre at Scientia, Pretoria. During 1978, the first full year of the Centre's existence, 157 conferences, symposia and meetings were attended by more than 12 000 delegates, including representatives from overseas countries.

The Centre was designed to international standards to provide the South African scientific community with modern conference facilities.

INFORMATION AND LIBRARY SERVICES

Despite the adverse economic climate and a shortage of personnel experienced during the year, it was possible for the CSIR to maintain the number of subscriptions to the various literature current-awareness services offered to scientists and industrial firms²².

There was a marked increase in the demand for computerized retrospective literature searches since the service, known as SARIS, was introduced in 1976. These searches are conducted partly by means of teletype terminals and long distance telephone links with bibliographic data bases in North America, and partly by means of bibliographic data bases held on disk at the CSIR's Computing Centre.

In order to satisfy the anticipated demand for computerised literature searches in other parts of the country, the CSIR's regional offices in Bellville, Port Elizabeth and Durban have been provided with teletype terminals.

The South African Water Information Centre, which is housed at the CSIR in Pretoria and is operated under contract to the Water Research Commission, has extended its services considerably.

Through its involvement in the international MARC (MACHine Readable Catalogue) project in which South Africa participates under the aegis of the National Library Advisory Council, the CSIR is closely involved in an investigation into the possibilities of a computerised national library network²².

During April 1978, in co-operation with the South African Library Association and the Pretoria Branch of the Computer Society of South Africa, the CSIR arranged a successful conference on trends in information handling and library computerisation²². This conference was instrumental in promoting interest in computerised library and information services.

In order to improve accessibility to the collection of the Central CSIR Library, an investigation is under way to determine the preferences of scientists and engineers in respect of the various alternative methods of subject description in the library catalogues.

SINES BREAKWATER

The breakwater at Sines harbour, approximately 160 km south of Lisbon, Portugal, was damaged extensively during a storm in February 1978. The breakwater is protected by 40-ton dolos armour units, which is the largest application of these units in the world.

Because of its considerable experience with dolos units in South Africa, the CSIR has been requested to advise the relevant authorities on the causes of the damage⁷. CSIR personnel made an on-site inspection and held discussions with the authorities and the laboratories involved in the construction and repair of the breakwater. A workshop at which the CSIR will be represented has been arranged to discuss the repair of the installation.

Co-operative scientific programmes

To meet the scientific challenges facing the world today, the scientific community, armed with skills from an ever widening range of disciplines, is called upon to solve problems of unprecedented complexity. Where the problems are too wide and too complex for individuals or organizations working alone, the different disciplines are increasingly required to pool their resources and work more closely together than might normally be possible.

In view of the considerable reservoir of expertise currently available at universities and other organizations in the country, the CSIR established its co-operative scientific programmes to divide the responsibility for research projects of common interest amongst scientists from different disciplines and organizations in order to overcome problems which might lie beyond the range of individual researchers. The CSIR's contribution to the promotion of co-operative research of this nature is directly related to its function as the South African representative on the International Council of Scientific Unions (ICSU), a non-governmental, non-political body which seeks to promote international scientific activity for the benefit of mankind, while enabling scientists from all over the world to participate.

A large number of local research organizations — represented by approximately 600 individual researchers — are currently involved in the national co-operative scientific programmes. These programmes all relate to wide-ranging,

complex systems such as the earth sciences, marine sciences, upper atmosphere and space sciences, environmental pollution, terrestrial biology, ecosystem research, and energy problems.

The co-ordination and administration of the co-operative programmes are in the hands of a group of scientists at the CSIR who operate in three separate units: one for marine and earth sciences, one for technological programmes, and one to take care of environmental sciences.

MARINE AND EARTH SCIENCES

Oceanography — A co-operative national oceanographic programme, to be undertaken jointly by the various oceanographic research organizations in the country, was formulated in the course of the year and published under the auspices of the South African National Committee for Oceanographic Research. The programme will be focusing attention on those aspects of scientific enquiry which are most relevant to the effective exploration, exploitation, management and protection of our coastal areas, and to an improved understanding of climatic conditions, weather forecasting, and safer and more economical navigation.

Every effort has been made to ensure that the most modern techniques are used, and although the programme is aimed primarily at solving the more urgent problems, education and training is not ignored. To this end a fully illustrated brochure on oceanography in South Africa was recently published. The publication contains a number of articles on the various interesting aspects and activities of oceanography, written in semi-popular style by specialists, as well as a review of training and job opportunities in the field.

The Southern Ocean is the vast expanse of water that surrounds Antarctica — stretching, according to some definitions, as far north as the Cape coastline. The largely unexplored and unexploited but evidently rich fish resources of this area have often received attention in recent years, and a co-operative research programme, which will commence in the course of 1979, has now been formulated. The work scheduled under the programme will link up closely with international activities in the area and especially with BIOMASS (Biological Investigation of Marine Antarctic Systems and Stocks), an international programme in whose formulation local scientists have been

Navigation facilities on the bridge of the *S A Agulhas*. Much of this equipment is of particular interest to oceanologists (*right*).

The Department of Transport's new Antarctic research vessel, the *S A Agulhas*, at anchor off the research base at Marion Island. The craft is equipped with the most modern research facilities, including several laboratories and a helicopter deck.

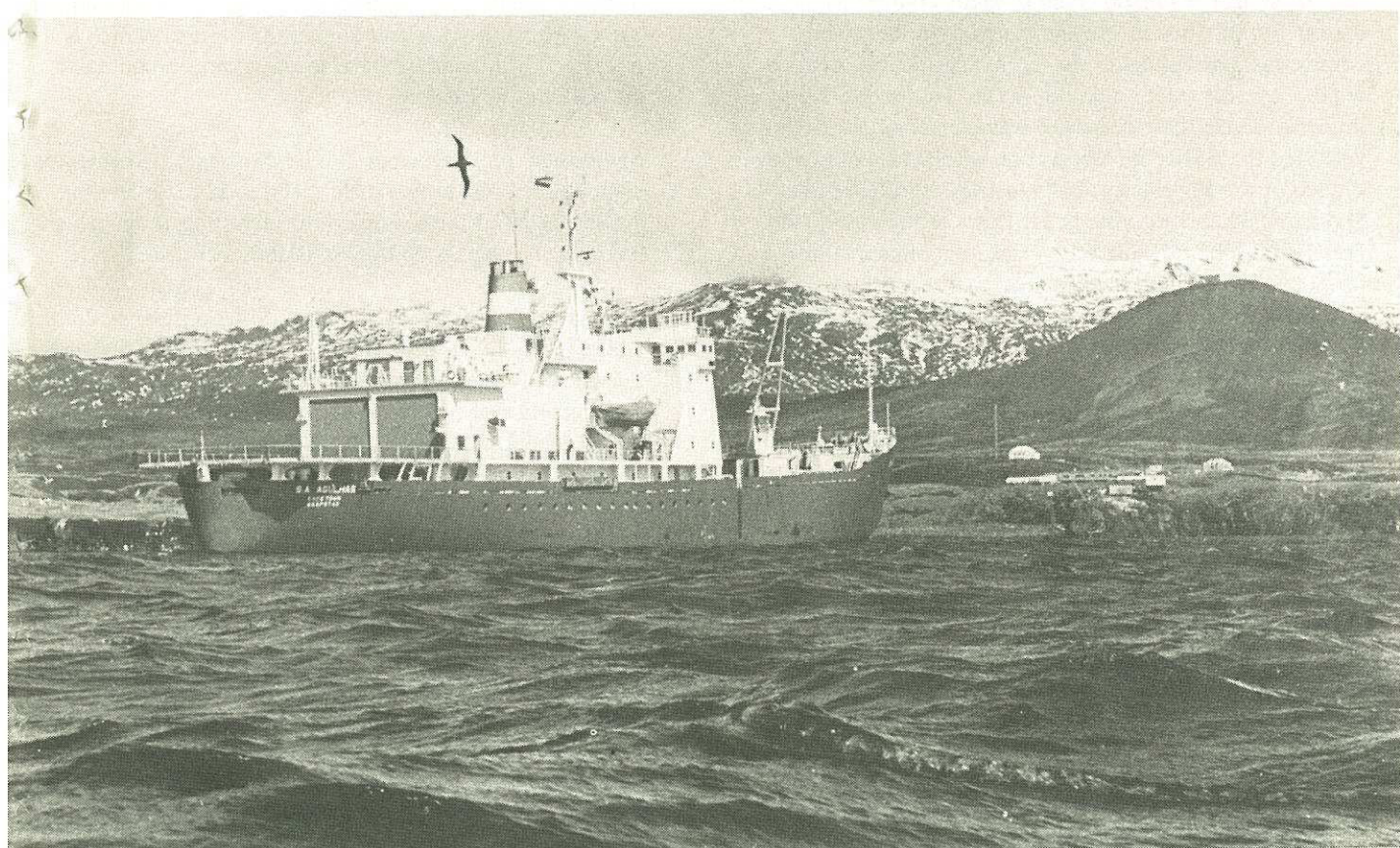
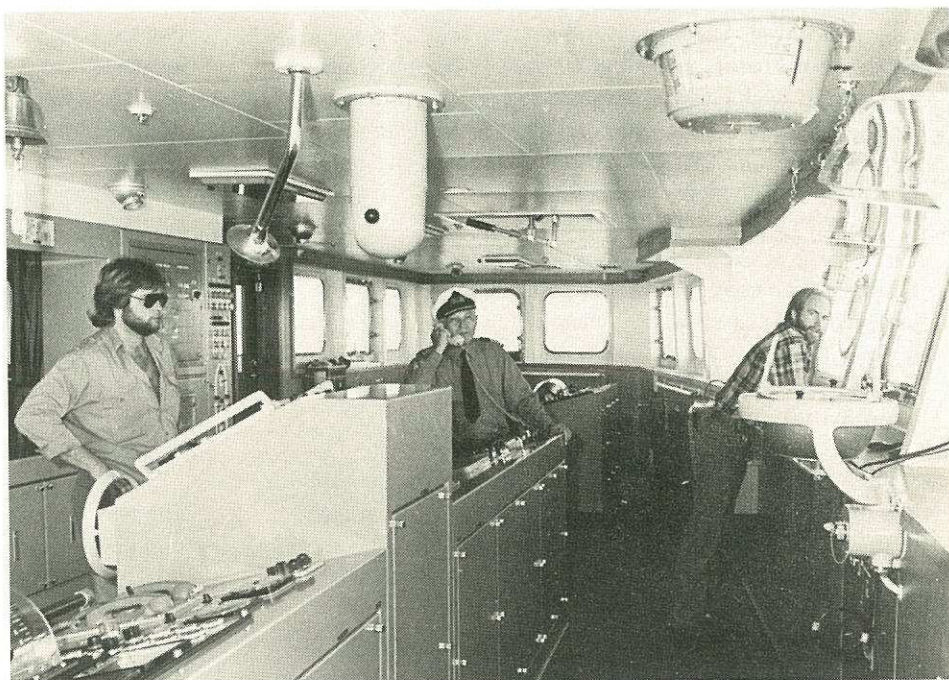
Specifications:

Length overall — 110 m;

Gross tonnage — 5 000;

Displacement — approximately 7 000 tonnes;

Accommodation — 40 officers and crew and 98 passengers.



closely involved. The new research vessel, the *S A Agulhas*, gives South African research organizations an opportunity to make a valuable contribution to the existing information on the Southern Ocean — information which is urgently required to ensure that the marine resources of the area are rationally exploited and conserved.

Particularly as a result of oil-polluting incidents along the South African coast, but also to fulfil a general need for knowledge of coastal water dynamics, a report containing a review of all the available information on the subject was recently published. The report serves to point out aspects on which additional information is urgently required.

A marine resource which has enjoyed very little attention to date is the sport- or linefish population of the east and south coasts of the country. In direct monetary terms this resource cannot be compared to the commercial fish resources of the west coast — the reason for the concentration of research efforts on the latter — but if their indirect value is taken into account, it soon becomes clear that these fish populations are of great importance. The reason for this lies in the importance of sport and commercial line fishing to the entire coastal area, with its related tourist trade and industries. The need for information on these resources was identified during the year, and the CSIR, in co-operation with the Sea Fisheries Branch of the Department of Industries, the Department of Sport and Recreation, the Natal Parks, Game and Fish Preservation Board and other research organizations, formulated a research programme to integrate existing activities and recommend additional research efforts. The object of the programme is to provide the information necessary for the effective conservation and exploitation of the available resources.

As a result of their participation in international space research activities, South African scientists have acquired a valuable understanding of the practical applications of space techniques. This placed local research groups in an excellent position to take part in a programme to investigate the usefulness of satellite remote sensing techniques in oceanography, with the consequence that a South African programme was one of only two programmes outside North America to be permitted to make use of a satellite launched late in 1978. The local programme aims to correlate satellite data with ocean productivity in the upwelling area off the Cape coast and with sediment

concentrations off the east coast. The Sea Fisheries Branch, the CSIR and the University of Cape Town are participating in the programme, and the principal activities have been scheduled for the summer of 1978/79.

Preparations for new base at Sanae — The CSIR and the Department of Transport have been in close co-operation to co-ordinate research activities on Marion Island, Gough Island and at Sanae in Antarctica. The Department of Transport is primarily responsible for the financing of the Antarctic programmes; the CSIR, in turn, is responsible for the scientific aspect of the South African Antarctic Programme and for international liaison with the Scientific Committee on Antarctic Research (SCAR).

The new Antarctic base, scheduled for construction in the summer of 1978-79, was planned in co-operation with both the Department of Transport and the Department of Public Works. The exact position of the base on the ice shelf is an important factor. It was designed to have a useful life of 20 years, and should therefore be situated on a stable part of the ice shelf. The optimum position is to be determined with the help of a Landsat 3 image of the area, which is expected to provide valuable information on concealed crevasses in the ice shelf.

Symposium on the biology of Marion Island — A three-day symposium was recently held in Pretoria to review the achievements of the biological research programme which has been in progress on Marion Island since 1963.

The symposium took place in the CSIR Conference Centre where Dr R M Laws, the Director of the British Antarctic Survey, delivered the opening address. Papers were read by participants in the programme, and the symposium closed with a general discussion of gaps in the existing knowledge and the nature of the future research. The papers will be published in a special issue of the *South African Journal for Antarctic Research*, which will serve as a permanent record of the results achieved to date.

Geological maps of the Sanae area — Research into the earth sciences in Antarctica was temporarily suspended at the end of 1976 until air transport could be made available.

The work done during the fifteen years of geological research in Antarctica is at present being compiled in a

publication which will include a complete map of the area south of Sanae. The map will give a background of the ice topography, with geological details of the isolated mountain peaks rising above the ice. For the production of this background, numerical data obtained from Landsat 1 and 2 were employed. Data from thirteen different Landsat images were used to produce a complete picture of the area.

Research into solar-terrestrial physics — This research, which falls under the South African National Committee for Geomagnetism, Aeronomy and Space Sciences, is financed partly by the Antarctic Programme and partly out of CSIR funds. Observations are made from stations in South Africa, on Marion Island and in Antarctica, as well as by satellites and from ships at sea. Close co-operation is maintained with other researchers in this field in Argentina, the USA, Canada, Japan, Australia and other countries.

National Geodynamics Project — The National Geodynamics Project forms the South African contribution to the International Geodynamics Project (IGP) which was initiated by the International Union of Geodesy and Geophysics and the International Union of Geological Sciences. The aims of the IGP are to gain more information on horizontal and vertical movements in the earth's crust, both at the present time and in the past. Increased fundamental knowledge of these phenomena is expected to bring to light the processes associated with the formation of economical mineral deposits. The IGP terminates in 1980.

A number of projects on intensive study areas, varying from the Cape Fold Belt in the south to the Limpopo Mobile Belt in the north, are under way in South Africa. The results of the work will throw new light on the early tectonic history of the subcontinent.

Intensive planning is in progress to formulate a possible national follow-up to the Geodynamics Project. The new programme will permit a continuation of the activities of the Geodynamics Project, with particular emphasis on economic geology.

TECHNOLOGICAL PROGRAMMES

Rapid industrial expansion and the quality of life — The CSIR has launched a co-operative research programme in collaboration with the Human Sciences Research Council (HSRC), Iscor, and the Department of Planning and the

Environment to study the influence of rapid industrial development on the communities affected. Researchers from the HSRC and the School of Business Leadership of the University of South Africa developed methods and equipment with which to determine the quality of life in these communities. Amongst other devices are a conceptual model which was designed to assess certain areas in terms of human requirements, and a sensitive group attitude test which was adapted to perform accurately under South African conditions.

A survey of the first phase of industrial development at Ellisras has also been completed, and a similar survey of third phase development in the Brits area will be finalised in the near future.

Solid and toxic wastes — Various government departments, industries, provincial administrations, municipalities, statutory organizations and universities are engaged in the development of a co-operative solid waste research programme aimed at improved work utilisation and reduced pollution.

A model designed to facilitate the regional planning of urban refuse treatment and disposal is in the process of being tested in collaboration with the local authorities. An interesting development in this regard is the series of pilot scale studies currently being carried out by the municipalities of Cape Town and Port Elizabeth, in collaboration with the industrial sector, to investigate the utilisation of urban refuse in the manufacture of such substances as pulverised refuse-derived fuel.

Provisional results from research undertaken at Potchefstroom University point to the possibility of converting plastic waste into petrol and diesel fuel. A comprehensive research programme has been launched into the breakdown of cellulose into chemicals and chemical solvents, which involves both chemical and microbiological processes. A number of organizations, including the University of Natal, the University of the Orange Free State, Rhodes University, the University of Cape Town and the CSIR itself, are working on the various aspects of the programme.

Two regional surveys, conducted with the assistance of the National Committee for Solid and Toxic Wastes in an endeavour to develop additional methods of disposal, are soon to be completed.

ENVIRONMENTAL SCIENCES

Inland water ecosystems — The construction of the Pongola Poort Dam in the Pongola River has already had a marked effect on the flow regime and the approximately 97 pans which depend on the regular floods of the area for their water supply. Research into the ecosystems of the floodplain and pans revealed that floods of high intensity are of brief duration. The flow exceeds $85 \text{ m}^3/\text{s}$ for no more than 33 days per year, for instance, and $198 \text{ m}^3/\text{s}$ for only seven of those days. The entire floodplain system depends on periodic flooding for the replenishment of nutrients, for part of the energy requirements of the area, and for the reproduction and survival of specialised flora and fauna.

The water in the pans contain a high concentration of total dissolved solids (TDS), presumably as a result of seepage, which affects all trophic levels. If flooding did not take place and the TDS were not reduced, permanent salination of the pans would result.

During summer the energy bound by the primary producers is derived first from decomposing *Potamogetan crispus* and secondly from the flooding of the marginal *Cynodon dactylon*. *P. crispus* appears to derive its nutrients from the sediment, while the decrease of both water level and water temperature during the winter months, with the concomitant clarification of the water, permits *P. crispus* and *C. dactylon* to appear.

The mid-pan invertebrates (Chironomidae, Oligochaetae and Lamellibranchiata) are detritus feeders, while the marginal benthos (Insecta and Crustacea) which appear along the *Cynodon* growths are more diverse.

Fifty different fish varieties were observed. The majority of these proved to be dependent on summer floods for their propagation, while certain others are primarily dependent on an increase in the water temperature. Flooding of the marginal flora provides breeding areas to the mature fish and food and shelter to the fingerlings. The different species of fish show some adaptations in respect of feeding behaviour which largely eliminate competition.

Socio-economic studies of the Tembe-Thonga population indicate that these people are fully dependent on the floodplain for their survival. The pans provide drinking water (to both men and animals), irrigation water, fishing and grazing. A survey recently conducted by the Department of Health indicated that there were approximately 36 000 people in the region of the floodplain, and it is clear that a change in the flow pattern can have a drastic influence on the existence of these people.

Terrestrial ecosystems — An ecosystem study of the fynbos biome in the Southwest and Southern Cape has been launched to proceed concurrently with the savanna ecosystem project at Nylsvley in the Northern Transvaal. The fynbos biome is of great scientific, aesthetic and economic interest. The flora is extremely rich and many species are rare and restricted in their distribution. The conservation and continued use of the biome is rendered difficult mainly by the frequent fires and the spread of invasive exotic trees and shrubs. Because of these and other environmental problems, some species have become extinct and many others are endangered or vulnerable. Particular attention is now being given to these two major environmental hazards.

Researchers from several universities, the Department of Forestry, the Department of Agricultural Technical Services and the Cape Department of Nature and Environmental Conservation are currently involved in the first phase of the programme, which entails baseline studies of the biome, the review of current knowledge, and broad surveys of climate, soils, vegetation, fauna and land-use patterns.

Another project, the South African programme on the ecological effects of fire, was initiated in 1977 as the South African contribution to the international mid-term SCOPE (Scientific Committee on Problems of the Environment) project on the same subject. It involves the analysis, interpretation and synthesis of information available from the numerous long-term burning trials currently carried out at various research centres around the country. Specific studies of the short-term effects of fire have also been initiated in areas of known fire history.



Marine pollution — The Marine Pollution Division of the National Programme for Environmental Sciences undertakes the identification of pollution problems along the South African coast, the identification of research needs and priorities, and the initiation and co-ordination of research into possible solutions to the problems. In order to establish a baseline against which future changes in the marine environment could be assessed, a national marine pollution survey was launched in 1974 to determine the sources, concentration levels, patterns of movement and general effects of pollutants in impact areas, river mouths and coastal and offshore reference areas along the South African coast.

Most of the major impact areas, coastal reference areas and river mouths were closely studied in the course of the survey, which is currently being concluded. A baseline for marine pollution having been established, a limited marine pollution monitoring programme is to be undertaken, involving only those areas shown to be suffering from pollution.

Atmosphere — The Pretoria Project was established to characterise the effects of a major urban complex such as Pretoria and Johannesburg on its environment. The project entails a multidisciplinary study conducted by the Air Pollution Research Group of the CSIR, the Atomic Energy Board, the University of the Witwatersrand, the University of Pretoria, Iscor, and the City Council of Pretoria. The aim of the project is to provide a better understanding of the diffusion characteristics of big cities, the mass loading and size distribution of smoke, dust and other particles, air pollution tendencies, the characteristics of the atmosphere, and the identification of gaseous pollutants.

A theoretical and numerical wind field model was developed for the characterisation of wind fields over a complex topography, and it is hoped that the model will also be helpful in determining the trajectory of pollutant clouds. Three simple diffusion models are used to determine SO₂ concentrations in order to assess the impact of industries on a city and the effects of pollution on existing residential and commercial areas.

The mesoclimatic survey showed the Magaliesberg to have a barrier effect on the catabatic winds, resulting in an accumulation of cold air in the southern basins with very high inversions and exceptionally deep layers of stable air.

It was found, in addition, that winter inversions are much more strongly developed than summer inversions.

The heat island project revealed the way in which topography influences inversion conditions by creating spatial differences in inversion strength. Although heat islands can be expected over Johannesburg they are not frequently observed, which indicates that surface inversions are seldom broken down by heat islands.

The active research aspects of both the inversion climatology project and the urban heat island project are nearing completion and the conclusions are being prepared for publication. During 1979 a start will be made with the production of wind rosettes for different stability conditions, and an investigation of the turbulence structure is to be launched.

Support of research at universities and other institutions

Our universities possess a research potential that can be better utilised if sufficient funds are to be made available from other sources. For this reason, and by merit of its responsibility for the promotion of research into those areas for which it is particularly responsible, the CSIR supports independent academic research at universities and museums by means of annual grants allocated on the grounds of applications received from individual researchers, institutes, units and groups²⁷. The CSIR is assisted in this undertaking by the Research Grants Committee, with subcommittees for the more important disciplines in the natural science and engineering fields on which academic personnel from the various universities serve in rotation.

During the past year more than R2 300 000 was allocated for this purpose. The vast field covered by this research is reflected in the names of the various units, groups and institutes that receive support at present. There are two main categories: those which receive financial support from the CSIR and report back to steering committees of the CSIR, and those which are financed by the relevant universities themselves and report to the universities' own councils while receiving block grants from the CSIR.

Amongst the organizations in the first group are the Geochemistry Research Unit, the Chromatin Research Unit and the Carbohydrate Chemistry Research Unit at the University of Cape Town; the Polyene Chemistry Research Unit at the University of Stellenbosch; the Flavanoid Chemistry Research Unit at the University of the Orange Free State; the Uranium Chemistry Research Unit at the University of Port Elizabeth; the Cosmic Ray Research Unit at Potchefstroom University; the Research Group on Solid State Electronics and the Magnetism and Semiconductor Physics Research Unit at the Rand Afrikaans University; the Desert Ecological Research Unit attached to the Transvaal Museum and situated at the Namib Research Institute in South West Africa; and the Photosynthetic Nitrogen Metabolism Research Unit attached to the University of the Witwatersrand.

Those in the second group include the Bernard Price Institute for Palaeontological Research, the Hydrological Research Unit, and the Solid State Physics Research Unit at the University of the Witwatersrand; the Institute for Chromatography, the Institute for Microstructures, the Institute for Geological Research on the Bushveld Complex, and the Mammal Research Institute at the University of Pretoria; the Institute for Groundwater Studies and the Institute for Environmental Sciences at the University of the Orange Free State; the Institute for Freshwater Studies, the Tick Research Unit, and the J L B Smith Institute for Ichthyology at Rhodes University; the Percy Fitzpatrick Institute of African Ornithology and the Precambrian Research Unit at the University of Cape Town; the Southern Universities Nuclear Institute at Faure, and the Group for Cenozoic and Sedimentological Research in the Southern Cape at the South African Museum in Cape Town.

1.

NATIONAL CHEMICAL RESEARCH LABORATORY

Director — DR P R ENSLIN

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.

In accordance with its policy — that of concentrating on research in fields where a need for more basic knowledge exists — many of the Laboratory's research projects are carried out in collaboration with research organizations that are more directly concerned with the practical problems involved. Well-motivated long-term projects are therefore approached from a fundamental point of view.

The NCRL is organized into divisions for analytical chemistry, biological chemistry, inorganic chemistry, organic chemistry, molecular biochemistry, physical chemistry, structural chemistry and corrosion research.

2.

NATIONAL PHYSICAL RESEARCH LABORATORY

Director — DR A STRASHEIM

The activities of the National Physical Research Laboratory (NPRL) are determined by the industrial and national needs of the Republic of South Africa. Research and development is undertaken in the various fields of the natural sciences, including optics, solid state physics, spectroscopy, materials sciences, geophysics, acoustics, geochronology and atmospheric physics. The research is usually carried out in fields of application where a need for further knowledge exists or is anticipated, but it can also be of a more fundamental nature.

The NPRL is organized into three main research groups dealing with applied physics, earth physics and materials sciences, respectively, each of them consisting of a number of key divisions staffed by specialist researchers. Proficiency is required in highly advanced techniques, and

personnel of the NPRL have to be especially conversant with those involving physical measurements and methods.

In addition, in terms of Act 76 of 1973, the NPRL enjoys statutory responsibility for the maintenance of the national measuring standards of mass, length, time, temperature, electricity, light, pressure and radiation.

3.

NATIONAL ACCELERATOR CENTRE

Head — DR G HEYMANN

The National Accelerator Centre was conceived as a multi-disciplinary national facility to satisfy the heavy particle requirements of researchers throughout the country. Its aims are, amongst others —

- to provide facilities for research in the basic sciences involving accelerated ions
- to provide service facilities in South Africa for particle therapy and related clinical tests
- to provide consumers in the nuclear medicine and industrial fields with accelerator-produced radioisotopes.

The Accelerator Centre will be available to scientists from Government organizations, provincial administrations and universities which require accelerator services. It is envisaged that the Centre will serve as a national focus of activity for biologists, chemists, physicists, medical researchers and technologists who are interested in the use and operation of accelerators. This would not only promote research in the individual disciplines, but also create stimulating interaction between the major peripheral fields of enquiry.

4.

NATIONAL RESEARCH INSTITUTE FOR MATHEMATICAL SCIENCES

Director — PROF D H JACOBSON

The National Research Institute for Mathematical Sciences (NRIMS) consists of divisions for mathematics, computer science, operations research and statistics, and a computing centre.

Research activities cover the various branches of mathematics and their applications. Typical fields of study are differential equations, statistical decision techniques and the design of experiments, numerical computation, and data handling on digital computers.

The computing centre provides general-purpose computing facilities and services to all the institutes of the CSIR.

5.

SOUTH AFRICAN ASTRONOMICAL OBSERVATORY

Director — DR M W FEAST

The South African Astronomical Observatory (SAAO), which is operated by the CSIR in co-operation with the Science Research Council of Great Britain, was established to specialise in astrophysical research. The headquarters of the SAAO are situated in the grounds of the former Royal Observatory in Cape Town. The site for the observing station at Sutherland in the Karoo, at an elevation of 1 760 m, was selected because of the favourable night sky for astronomical purposes; that is, the number of fine nights per year, freedom from urban atmospheric pollution, absence of wind and freedom from atmospheric disturbances (the astronomers' 'bad seeing').

Many of the research programmes undertaken by the Observatory involve massive amounts of observation and reduction time. It is important that observatories such as the SAAO, which has a substantial establishment of long-term staff, should undertake those programmes which cannot be tackled by universities and other small research departments.

6.

MAGNETIC OBSERVATORY

Head — DR G J KÜHN

The Magnetic Observatory at Hermanus is an important link in a world-wide network of organizations engaged in studies of the geophysical processes that occur in the earth's magnetosphere and in interplanetary space. Since they are usually caused by the precipitation of charged atomic particles in the atmosphere, the observed phenomena are closely related to the behaviour of the magnetic field of the earth. Variations both in this magnetic field and in the intensity of particle radiation are therefore continuously recorded. In addition to its various monitoring programmes, the Magnetic Observatory conducts countrywide magnetic surveys, maintains magnetic standards and co-operates in national and international programmes.

Research at the Observatory consists of the analysis and interpretation of a variety of geophysical data.

7.

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY

Director — F P ANDERSON

The National Research Institute for Oceanology (NRIO), which has its headquarters at Stellenbosch, consists of divisions for physical oceanography, marine geoscience, marine chemistry, marine biology and coastal engineering and hydraulics.

Studies are being undertaken to obtain data in the oceanic areas around South Africa and to provide the data and knowledge needed for the continued development of our coastal areas for economic and recreational use and resource exploitation.

NATIONAL MECHANICAL ENGINEERING RESEARCH INSTITUTE

Director — DR H G DENKHAUS

The National Mechanical Engineering Research Institute (NMERI) deals mainly with the development of mechanical engineering processes and techniques and the improvement of machinery and plant designs and materials used in industry. The Institute is also active in civil engineering hydraulics and geomechanics, which plays an important role in mining and civil engineering.

The laboratories of the Institute at Scientia, Pretoria, accommodate divisions for metal mechanics, strength mechanics, process mechanics, geomechanics, fluid mechanics, aeromechanics and heat mechanics (including air-conditioning and refrigeration). The Mine Equipment Research Unit in Cottesloe, Johannesburg, which deals mainly with the safety of mine hoist ropes, is also part of the Institute.

NATIONAL ELECTRICAL ENGINEERING RESEARCH INSTITUTE

Director — J D N VAN WYK

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

10.

CHEMICAL ENGINEERING RESEARCH GROUP

Head — W G B MANDERSLOOT

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

The research and development items on the programme of the Group are selected according to the immediate and anticipated needs of industry. The Group provides the industrial sector with a wide range of consulting services which can, if necessary, be supported by applied or fundamental research.

11.

NATIONAL BUILDING RESEARCH INSTITUTE

Director — DR T L WEBB

The National Building Research Institute (NBRI) was one of the first institutes of the CSIR when it was founded shortly after the Second World War.

With its present staff establishment of about 250, the NBRI operates from headquarters in Pretoria and regional offices in Cape Town, Windhoek, Durban and Port Elizabeth. Its annual budget of about R3,6 million is approximately one-tenth of one per cent of the amount spent on building and construction in South Africa every year.

About 55 per cent of the Institute's income is derived from Parliamentary funds and the remaining 45 per cent from

research projects and related investigations and services undertaken on behalf of central, provincial and local governments, the private sectors and individuals with particular building problems. Donations are also received from a number of public and private sector agencies.

The emphasis is on useful research and on the effective dissemination of relevant information, both self-generated and derived from work done elsewhere in South Africa and in other countries.

12.

NATIONAL INSTITUTE FOR WATER RESEARCH

Director — DR G G CILLIÉ

Water research is vital to a country like South Africa, with its limited sources of water. The National Institute for Water Research (NIWR) therefore strives to develop expertise in the efficient use and conservation of available resources. Its activities include investigations into the purification of water prior to use, the treatment of effluent after use, and the various types of pollution encountered in dams, rivers, estuaries, and the sea.

The Institute has a total staff establishment of 227 and is divided into a number of research groups and regional laboratories. While the regional laboratories in Durban, Bellville, Bloemfontein and Windhoek concentrate on local water problems, research groups in Pretoria undertake basic and applied research on a broad spectrum of problems concerning the optimum utilisation of water. Research groups have been established for freshwater biology, water quality, biological treatment processes, physical-chemical treatment processes, and desalination. A sixth group deals with the practical application of technological innovations developed by the Institute.

13.

NATIONAL INSTITUTE FOR TRANSPORT AND ROAD RESEARCH

Director — DR S H KÜHN

Road and traffic authorities encounter a wide range of problems in their endeavours to ensure the most economic use of roads as a public amenity. The research programme of the National Institute for Transport and Road Research (NITRR) is directed at finding solutions to these problems through research into the planning, design, construction, maintenance and operation of roads and road systems; road safety and the behaviour of road users; and the role of roads and road transport in society. Another important function of the NITRR is to ensure the effective dissemination and application of research findings throughout the road industry.

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

14.

NATIONAL INSTITUTE FOR TELECOMMUNICATIONS RESEARCH

Director — R W VICE

The work of the National Institute for Telecommunications Research (NITR) in Johannesburg embraces the study of natural phenomena and their effects on radio waves, as well as the development of radio systems for particular applications.

Rivers and dams are regularly sampled to establish criteria for the rehabilitation of dams enriched with plant nutrients and the prevention of such eutrophication in other dams.



15.

NATIONAL INSTITUTE FOR AERONAUTICS AND SYSTEMS TECHNOLOGY

Director — DR T J HUGO

The National Institute for Aeronautics and Systems Technology (NIAST) consists of departments for aeronautics, mechanical systems, and electronic systems. Its task is to develop technological expertise in these fields for the benefit of the relevant industries.

The Institute's main activities are concentrated on flight dynamics, aerodynamics, aircraft structures, propulsion, servo-mechanisms, and digital and microwave systems. Multidisciplinary projects, some involving extensive systems analyses, are also undertaken.

16.

NATIONAL INSTITUTE FOR PERSONNEL RESEARCH

Director — DR G K NELSON

The optimum utilisation 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) in Johannesburg 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 job situation there are certain factors directly affecting the worker's productivity and happiness. The NIPR is concerned with the study of these factors, which include:

- definition of the characteristics of the work, i.e. description of the job, analysis of its physical and psychological demands on the worker, evaluation of a specific task in relation to others, and determination of the skills involved in the work

- selecting the right man for 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 the work, such as manpower problems, social relations in the job situation, work motivation and attitudes
- investigating problems arising from maladjustment to work, including absenteeism, accidents, occupational disorders and group conflicts.

17.

NATIONAL FOOD RESEARCH INSTITUTE

Director — J P DE WIT

The main aim of the National Food Research Institute (NFRI) is to promote the effective utilisation of South Africa's food resources. The Institute consists of four research divisions: Food Chemistry, Food Technology, Biological Evaluation, and Techno-economics. It also administers and is closely associated with the CSIR's Microbiology Research Group and Sorghum Beer Unit.

Typical fields in which fundamental and applied research is being carried out are food processing, cereal technology and biochemistry, food packaging and storage, flavour chemistry, food microbiology, food analysis, food chemistry, and brewing technology. Biological studies of the utilisation of nutrients in foods and diets are also undertaken.

8.

**SOUTH AFRICAN WOOL AND
TEXTILE RESEARCH INSTITUTE**

Director — DR D P VELDSMAN

The South African Wool and Textile Research Institute in Port Elizabeth conducts research into the processing characteristics of natural fibres alone or blended with synthetics. A most important feature of the research programme is the imparting of easy-care properties to fabrics where a modern society, with little time to spare for domestic maintenance, demands fabrics capable of being cleaned in a washing machine and worn without ironing without the drudgery of special care.

Textile research also aims at the more efficient processing of the different fibres. This involves the redevelopment of existing processing machinery and the design of new machines to suit the new processing functions.

9.

NATIONAL TIMBER RESEARCH INSTITUTE

Director — DR D L BOSMAN

The aims of the National Timber Research Institute (NTRI) are —

the effective utilisation of South African timber resources

the development of satisfactory wood-base products and

the effective use of timber products.

The Institute offers a wide variety of specialised research services to both producers and consumers of forest products, and assists in the application of research results.

Approximately one half of the income of the NTRI is derived from sources outside the CSIR. In the 1977-78 financial year the Forestry Council granted the NTRI approximately R109 000, which was a portion of the funds derived from a levy on all timber marketed in the Republic.

20.

TECHNICAL SERVICES DEPARTMENT

Director — DR T HODGSON

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

The training of instrument-makers forms an important part of the Department's contribution towards industrial development in South Africa.

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

21.

INFORMATION AND RESEARCH SERVICES

Director — D G KINGWILL

As a central service within the framework of the CSIR, Information and Research Services (IRS) has the following functions:

- providing publishing and publicity services
- establishing liaisons with all sections of the community
- maintaining international relations and representing South African science
- undertaking techno-economic studies, which include the economic aspects of scientific research.

22.

CENTRE FOR SCIENTIFIC AND TECHNICAL INFORMATION

Head — DR R VAN HOUTEN

The functions of the Centre for Scientific and Technical Information (CSTI) are to

- develop and maintain the Central CSIR Library and the information services associated with it
- undertake research and development in the communication sciences related to the transfer of scientific and technical information
- develop and apply techniques for the storage, retrieval and dissemination of scientific and technical information in collaboration with CSIR laboratories and institutes.

23.

CO-OPERATIVE SCIENTIFIC PROGRAMMES

The objective of the group for Co-operative Scientific Programmes is to enable the CSIR Executive to identify and define local problems amenable to scientific solution by means of co-operative national programmes. Scientific co-ordinators, acting in consultation with scientists at the various universities and research organizations, determine the scope of the research programmes and invite and co-ordinate suitable contributions. The group is required to keep the Executive informed of all research activities related to existing or proposed national programmes and to promote South African participation in international programmes, particularly those sponsored by the International Council of Scientific Unions (ICSU).

The national scientific programmes organised by the CSIR are joint undertakings in which official agencies, universities and laboratories in the private sector co-operate in a co-ordinated research endeavour to contribute to international programmes in which South Africa has agreed to take part or to achieve scientific goals of particular

national importance.

These national observation and research programmes are normally associated with international endeavours launched from time to time by ICSU or its member unions to encourage large-scale co-operative enterprises directed towards the solution of problems of world-wide scientific interest and importance which, on account of their magnitude and complexity, are unlikely to be solved by separate organizations or even nations working alone.

24.

FISHING INDUSTRY RESEARCH INSTITUTE

Director — DR R J NACHENIUS

The Fishing Industry Research Institute (FIRI), which is affiliated to the University of Cape Town, is situated on the university campus.

The Institute is financed by voluntary contributions from the fishing industry and a subsidy from the CSIR. Firms which are indirectly connected with the fishing industry are eligible for associate membership of the Institute.

The affairs of the Institute are managed by a Board of Control on which the fishing industry, the CSIR, the Minister of Economic Affairs and the Universities of Cape Town and Stellenbosch are represented. The research programme is planned and executed in consultation with specially appointed committees, the members of which are prominent technical personnel of the inshore and white fish industries.

The principal role of the Institute is to undertake fundamental and applied research on behalf of the fishing industry. This involves a variety of different products and processes, such as refrigerated and frozen whole rock lobster and rock lobster tails, canned pilchards and mackerel, fish meal, fish oil and the like.

The Institute acts also as a technical adviser to the industry on the purification of effluent, the control of odour, the testing of packaging material and the purification of water for use in factories. Co-operation with international organizations such as the International Association of Fish

real Manufacturers and the International Institute of Refrigeration ensures that the industry keeps pace with the progress taking place in every sphere of fish processing.

LEATHER INDUSTRIES RESEARCH INSTITUTE

Director — DR D R COOPER

The Leather Industries Research Institute (LIRI) in Grahamstown is regarded as the pioneer of industrial research for South Africa's secondary industry. From its early beginnings in 1935 in the Chemistry Department of Rhodes University, the Institute has maintained a steady pattern of growth.

A feature of LIRI's work is the balance maintained between basic research and the application of science to the everyday technical problems of the industries served.

A high rate of technology transfer has been achieved due to the close personal contact maintained with its many subscribers and the frequency of factory floor contacts at all levels between research and production staff.

SUGAR MILLING RESEARCH INSTITUTE

Director — DR M MATIC

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

In addition to all South African sugar mills, a number of sugar factories in neighbouring countries are also affiliated members of the Institute.

The main functions of the SMRI are as follows:

- *Research:* A study of the fundamental aspects of processes such as the milling, diffusion, juice clarification and crystallisation of sugar and the utilisation of by-products, steam and power generation, and the engineering aspects of the design and performance of mills, carriers, evaporators and vacuum pans.
- *Services:* Advisory work, troubleshooting, analysis of sugar — particularly for export — and the statistical compilation of manufacturing data for the sugar industry.
- *Training:* A three-year full-time course in sugar technology is offered in collaboration with the Natal College for Advanced Technical Education and the M L Sultan Technical College. The cost of the course is borne by SASMAL, and students are employed by the Institute while pursuing their studies.

[The sugar industry maintains a research station at Mount Edgecombe, Natal, where the cultivation of sugar cane is studied.]

27.

UNIVERSITY RESEARCH DIVISION

Head — W J WEIDEMAN

In terms of the Scientific Research Council Act, the CSIR is entrusted with the function of awarding grants for the promotion of academic research in the fields of engineering and the basic natural sciences.

Research grants are awarded from a trust fund annually voted for this purpose by the Treasury and administered by the University Research Division (URD).

The trust fund may only be used for research at or by universities and museums and not to augment the budgets of CSIR institutes and laboratories.

During the 1977-78 financial year the Council awarded more than R2 318 000 for the promotion of research at South African universities and museums. A breakdown of this amount shows that the better part of the funds was allocated to researchers in the biological sciences. These cover a very wide field, however, and includes such disciplines as zoology, botany, nature conservation, marine biology, microbiology and various disciplines in the agricultural, environmental and nutritional sciences.

In the same way, the amounts allocated do not reflect the extent of research activities undertaken at the different universities. Some university departments, for instance, are so involved in projects which form part of national or international programmes and which are financed from other sources that they currently require little or no financial support from the University Research Division. A case in point is that of the Geology departments of the local universities which undertake mapping projects for the Geological Survey; in addition to receiving remuneration for this work, most of the departments involved are also working on a national programme for which they are financed by the CSIR's group for Co-operative Scientific Programmes. The following figures are therefore no guide to merit or performance, but merely a record of actual moneys spent:

Biology	R675 794
Chemistry	R517 932
Engineering	R406 763
Geology	R209 006
Mathematics	R138 222
Physics	R313 950
Nuclear Physics	R 57 021

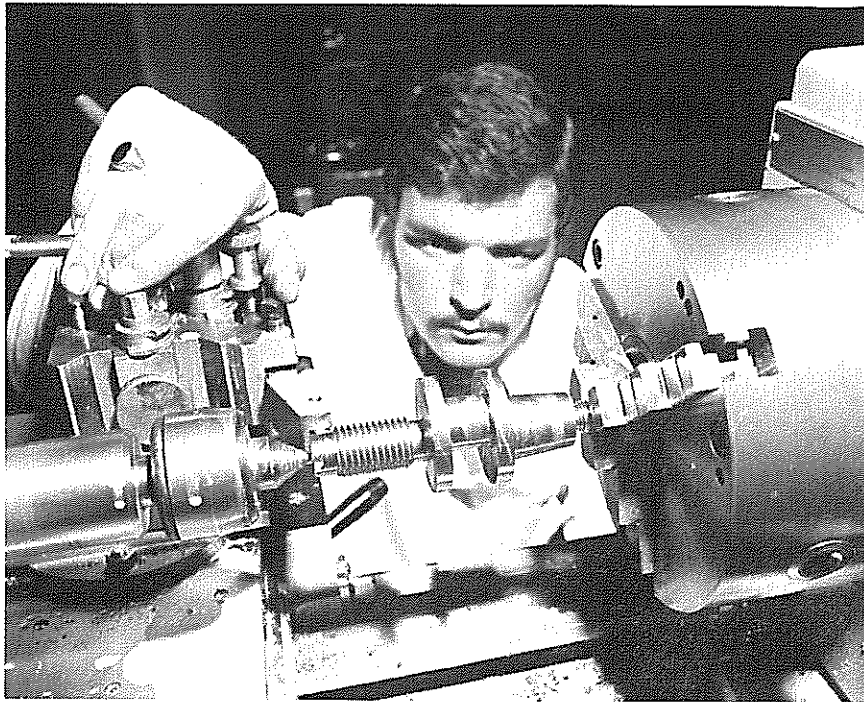
28.

AIR POLLUTION RESEARCH GROUP

Head — DR G P N VENTER

The basic aims of the Air Pollution Research Group (APRG) are to determine which pollutants are found in the atmosphere, what their concentrations are, and the possible reactions and transformations which may occur; to monitor specific pollutants (such as smoke and sulphur dioxide) on a local, regional and hemispheric scale in order to study trends; to study the physical and chemical properties and behaviour of pollutants in the atmosphere, as well as the underlying processes; and, finally, to advise the relevant authorities and industries on air pollution matters.

Financial statements



STATEMENT 1

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
BALANCE SHEET AS AT 31 MARCH 1978

	General Fund	Building Fund	1978	1977
	R	R	R	R
<i>Accumulated Funds</i>				
Balance brought forward	46 392 977,45	28 245 460,82	74 638 438,27	65 430 517
<i>Additions:</i>				
Appropriation from Income Statement	365 546,00	562 500,00	928 046,00	765 370
Capital income (Note 1)	4 954 632,12	2 382 304,98	7 336 937,10	8 446 125
Physical assets acquired	671 440,67	-	671 440,67	605 351
Excess of income over expenditure	725 519,95	-	725 519,95	312 093
	53 110 116,19	31 190 265,80	84 300 381,99	75 559 456
<i>Reductions:</i>				
Physical assets relinquished	614 029,64	-	614 029,64	921 018
Physical assets written off	614 029,64	-	614 029,64	136 634 †
	1 228 059,28	-	1 228 059,28	784 384
TOTAL	R52 496 086,55	31 190 265,80	83 686 352,35	74 638 438 *
<i>Utilization of Funds:</i>				
Fixed assets (Note 2)			79 240 179,76	71 513 748
Balance brought forward		71 513 748,58		
Net additions		7 726 431,18		
Investments			674 313,01	674 313
Shares in S A Inventions Development Corporation		200 000,00		
RSA Stock: 5,25 per cent 1978		474 313,01		
Net current assets			3 771 859,58	2 450 377
Current assets		7 322 682,96		6 060 180
Saleable stock		-		40 093
Debtors and debit balances		3 381 156,82		2 423 319
Advances and deposits				
Research grants		1 061 742,76		579 948
Other		1 816 745,19		2 668 500
Cash:				
Public Debt Commissioners		580 334,64		37 279
S A Reserve Bank		418 905,34		258 909
Other banks		40 000,00		32 000
Petty cash imprests		23 797,21		20 132
Current liabilities		3 550 823,38		3 609 803
Advances for investigations and services		1 855 994,87		1 965 428
Creditors and credit balances		1 694 828,51		1 644 375
TOTAL			R83 686 352,35	74 638 438

REMARKS:

* At 31 March 1978 contractual obligations against the General and Building Funds were R4 893 481 and R976 078 respectively.

† Value of NITR building relinquished to the University of the Witwatersrand.

Pretoria, 30 October 1978

(Sgd.) C v d M BRINK
President(Sgd.) J D VAN ZYL
Secretary

The above Balance Sheet has been audited in accordance with the provisions of section 42(4) of the Exchequer and Audit Act, No. 66 of 1975, as read with section 14(1) of the Scientific Research Council Act, No. 32 of 1962, and in my opinion it has been drawn up so as to reflect a true and fair view of the financial affairs of the Council for Scientific and Industrial Research.

Pretoria
30 November 1978(Sgd.) W G SCHICKERLING
Auditor-General

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

NOTE 1 : CAPITAL INCOME

	General Fund	Building Fund	1978	1977
	R	R	R	R
PARLIAMENTARY GRANTS	3 417 600,00	2 006 400,00	5 424 000,00	5 587 600
CSIR	3 417 600,00	2 006 400,00	5 424 000,00	5 557 600
Grants	-	-	-	30 000
CONTRIBUTIONS	1 012,97	-	1 012,97	24 091
CSIR	1 012,97	-	1 012,97	24 091
Grants	-	-	-	-
INTEREST	-	338 055,98	338 055,98	258 663
SALE OF ASSETS WRITTEN OFF	60 372,77	-	60 372,77	27 528
INVESTIGATIONS AND SERVICES	1 475 646,38	37 849,00	1 513 495,38	2 548 244
	<u>R 4 954 632,12</u>	<u>2 382 304,98</u>	<u>7 336 937,10</u>	<u>8 446 126</u>

NOTE 2 : FIXED ASSETS (AT COST)

	Land and buildings	Books and journals	Furniture and equipment	Prefab. structures	Laboratory equipment	Vehicles	Stores stock	TOTAL
	R	R	R	R	R	R	R	R
BALANCE BROUGHT FORWARD	30 054 226,69	2 186 563,58	2 508 028,87	22 332,37	34 114 606,27	1 414 407,53	1 213 583,27	71 513 748,58
PURCHASES								
CSIR	2 519 029,70	301 638,08	446 447,94	1 954,00	3 974 532,01	288 064,68	-	7 531 666,41
Grants	-	306,29	136,37	-	1 268,00	-	-	1 710,66
ADJUSTMENTS FOR PREVIOUS YEAR								
CSIR	-	-	122 840,43	-	-	13 138,71	-	135 979,14
Grants	-	-	-	-	-	-	-	-
ACQUIRED	-	370,00	49 177,30	-	571 182,52	50 710,85	-	671 440,67
STORES INCREASE	-	-	-	-	-	-	204 740,71	204 740,71
	<u>32 573 256,39</u>	<u>2 488 877,95</u>	<u>3 126 630,91</u>	<u>24 286,37</u>	<u>38 661 588,80</u>	<u>1 766 321,77</u>	<u>1 418 323,98</u>	<u>80 059 286,17</u>
LESS REDUCTIONS	-	10 042,54	45 891,30	818,00	648 293,52	114 061,05	-	819 106,41
RELINQUISHED WRITTEN OFF								
CSIR	-	-	-	-	-	-	-	-
Grants	-	10 042,54	45 874,80	818,00	418 047,28	114 061,05	-	588 843,67
	-	-	16,50	-	25 169,47	-	-	25 185,97
ADJUSTMENTS FOR PREVIOUS YEAR								
CSIR	-	-	-	-	205 076,77	-	-	205 076,77
Grants	-	-	-	-	-	-	-	-
BALANCE	<u>R 32 573 256,39</u>	<u>2 478 835,41</u>	<u>3 080 739,61</u>	<u>23 468,37</u>	<u>38 013 295,28</u>	<u>1 652 260,72</u>	<u>1 418 323,98</u>	<u>79 240 179,76</u>

STATEMENT 2

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

INCOME STATEMENT FOR THE YEAR ENDED 31 MARCH 1978

	Grants R	CSIR R	Total R	1976/77 R
<i>Income</i>				
Parliamentary grant	2 151 300,00	26 720 272,00	28 871 572,00	26 486 958
Contributions to CSIR projects	46 848,00	1 128 294,05	1 175 142,05	963 802
Investigations and services	-	25 191 279,62	25 191 279,62	23 746 027
Publications	1 780,19	114 169,18	115 949,37	94 108
Sundry	7 118,00	191 829,54	198 947,54	216 322
<i>Total</i>	R2 207 046,19	53 345 844,39	55 552 890,58	51 507 217
<i>Less: Expenditure</i>	2 219 269,23	51 680 055,40	53 899 324,63	50 429 754
Salaries, wages and allowances	90 691,22	34 969 967,47	35 060 658,69	31 389 528
Consumable stores and services	9 484,35	17 057 849,30	17 067 333,65	17 119 531
Subsistence and transport	22 328,43	1 834 169,35	1 856 497,78	1 668 833
General expenses	1 196,07	2 796 997,80	2 798 193,87	2 856 714
Extraordinary expenses	-	6 612,21	6 612,21	-
Grants	2 040 528,67	965 861,54	3 006 390,21	3 036 426
Subsidies: Research by industry	-	540 613,84	540 613,84	505 900
Levies and depreciation	56 090,16	6 116 867,57	6 172 957,73	5 480 592
	2 220 318,90	64 288 939,08	66 509 257,98	62 057 524
<i>Less: Income internal services</i>	1 049,67	12 608 883,68	12 609 933,35	11 627 770
<i>Sub-total</i>	R(12 223,04)	1 665 788,99	1 653 565,95	1 077 463
<i>Transfer to other funds</i>	-	928 046,00	928 046,00	765 370
Equipment fund	-	365 546,00	365 546,00	205 370
Building fund	-	562 500,00	562 500,00	560 000
<i>Excess income transferred to Accumulated Funds</i>	R(12 223,04)	737 742,99	725 519,95	312 093

Pretoria

(Sgd.) C v d M BRINK
President(Sgd.) J D VAN ZYL
Secretary

STATEMENT 3

CSIR BUDGET
1978/79

A. OPERATING EXPENDITURE

ACTIVITIES	EXPENDITURE				FUNDS		
	Salaries	Direct running expenses	Awards and Subsidies	Total	Parliamentary grant	Recoverable Internal	Expenditure External
	R	R	R	R	R	R	R
CSIR laboratories and departments	35 067 244	20 783 884	-	55 851 128	28 601 630	8 830 630	18 418 868
Grants and subsidies.	405 946	531 532	4 168 206	5 105 684	3 920 770	354 692	830 222
Subtotal	35 473 190	21 315 416	4 168 206	60 956 812	32 522 400	9 185 322	19 249 090
Less Internal Revenue	-	9 185 322	-	9 185 322	-	9 185 322	-
Total	35 473 190	12 130 094	4 168 206	51 771 490	32 522 400	-	19 249 090

B. CAPITAL EXPENDITURE

ACTIVITIES	EXPENDITURE						FUNDS		
	Books/Journals	Technical equipment	Furniture/Office equipment	Vehicles	Stores stock	Buildings	Total	Parliamentary grant	Recoverable expenditure
	R	R	R	R	R	R	R	R	R
CSIR laboratories and departments	352 430	5 657 020	196 020	-	-	2 473 000	8 678 470	8 247 870	430 600
Grants to universities etc.	2 000	66 042	3 000	-	-	-	71 042	45 130	25 912
Total	354 430	5 723 062	199 020	-	-	2 473 000	8 749 512	8 293 000	456 512
GRAND TOTALS A & B							60 521 002	40 815 400	19 705 602

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