

CSIR
1977
33rd
ANNUAL REPORT

Members of the Council for Scientific and Industrial Research

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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.

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Dr the Hon. S W van der Merwe
Minister of Planning and the Environment

Sir

I have pleasure in presenting to you the thirty-third Annual Report of the Council for Scientific and Industrial Research. This report covers the period 1 January 1977 to 31 December 1977.

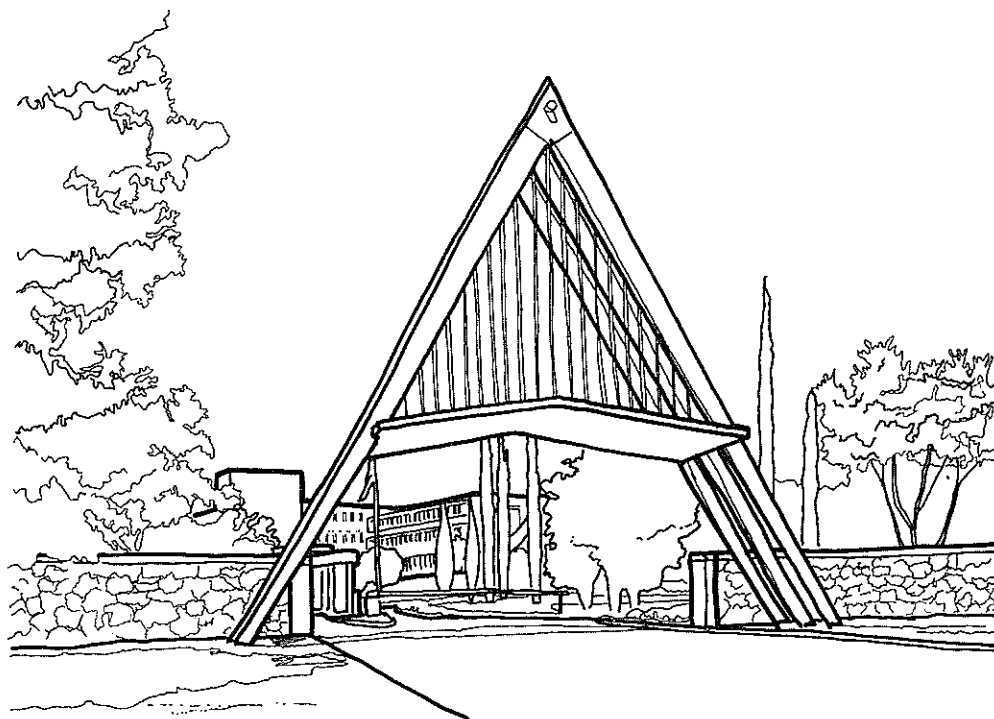
Balance sheets and statements of income and expenditure for the financial year ended 31 March 1977, certified by the Controller and Auditor-General, are included.

Yours faithfully

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

1 May 1978

The year in retrospect



A statement by the Prime Minister on the occasion of the first meeting of the re-constituted Scientific Advisory Council during April 1977, in which he pointed out that it is the Government's constant endeavour to increase the level of national expenditure on research and development, which is regarded as an investment with a high economic and social return, was noted with appreciation.

The more ideal level of expenditure could understandably not yet be realised because of the adverse economic climate of the last few years. The Prime Minister did, however, stress the fact that it would be unwise to neglect expenditure on research and development in difficult times. It is in these very circumstances, as he pointed out, that research and development is a matter of such importance to the country's economy that it cannot be set aside until conditions improve — or deteriorate.

By means of sustained research, both basic and applied, expertise is developed in various directions and preparations made for the future, both to solve new problems and to make the best use of the country's opportunities.

Because the CSIR is a multi-disciplinary national research organization, its activities cover a wide field of natural science research and technological developments and incorporate many projects, from basic research to the investigation of actual problems confronting the industries and related organizations every day. Since it is not possible to deal with all these activities within the scope of a publication of this nature, a selection of projects is discussed under broad headings pertaining to the aims and functions of the CSIR.

Some of the year's scientific developments — and trends — are mentioned in this review, while others are discussed in greater detail elsewhere in the report.

DEVELOPMENT AND APPLICATION OF KNOWLEDGE

A research organization of the CSIR's stature cannot restrict itself to the problems of the present, but must be constantly attuned to the future. In addition to the obvious advantages, in terms of import replacement and export promotion, which emerge from the development and improvement of products and processes in our own country, the long-term benefits of new knowledge and expertise must not be ignored. It is not generally known how much South Africa has to pay for imported expertise, nor what restrictions are often attached to the use of the results.

In addition to its eventual economic advantages, the increase of knowledge and expertise also improves the country's international standing while promoting the creativity, objectivity and logical enquiry which is all so necessary in a country as complex as ours.

Since advanced research is entirely dependent on adequate modern facilities, it was decided during the year under review to commence work on a national accelerator centre. The decision to erect a central facility with an open sector cyclotron of 200 MeV in the Western Cape was the outcome of an extensive investigation involving a number of interested bodies. The new facility has been planned for multi-disciplinary use and will primarily be applied in cancer therapy, the production of radio-isotopes, and basic research. The centre will serve as a forum for physicists, chemists, biologists, medical scientists, and technologists from every part of the country who may have an interest in the use and operation of accelerators and the application of accelerator products.

It was realized, even during the previous decade, that South Africa's cyclotron facilities were inadequate, but the investigation that followed revealed that, because of the enormous cost of such a project, only one modern accelerator could be built in the country. Since the medical profession would also have an interest in a facility for isotope production, particle therapy and radiography, it was decided to create one central facility which would satisfy the requirements of everyone concerned. The operation of the new national accelerator centre was entrusted to the CSIR because of its many years of experience in this field: the country's first cyclotron, which was built by the CSIR in 1950, has been in use for the past 27 years for research and training as well as for the production of radio-isotopes for diagnostic and other purposes. It will be possible, with the new cyclotron, to produce a larger quantity and a wider variety of isotopes and, for the first time, to employ particle therapy and proton radiography in South Africa.

Contributions to basic knowledge and the development of new techniques include the following:

Astronomers from the CSIR played a major role in recent observations that led to the discovery of five rings around the planet Uranus. The greater part of the occultation, or eclipse, of a star by this planet could be observed only from the southernmost tip of Africa and from an airborne observatory belonging to the USA. ●

The CSIR made an important contribution to the development of a new length standard based on the wavelength of the light emitted by a helium-neon laser — a joint venture involving a number of countries. A laser designed and developed by the CSIR compares excellently with a similar instrument developed in Britain. ●

The standard base line for the calibration of instruments used in distance measurement, constructed in co-operation with the Director-General of Surveys, has been officially recognized as a national standard and is now at the disposal of surveyors and engineers. By means of locally manufactured infrared measuring equipment, the basic length standard of 432 m was extended to standard measures of 864 m and 1 728 m. ●

An improved method for the separation of radio-active cadmium-109 from silver cyclotron targets, which was developed by the CSIR, will be of great significance to the South African gold mining industry. ●

A reduction in the cost of water desalination is envisaged through the development of improved reverse osmosis and ultrafiltration membranes, the outcome, indirectly, of the CSIR's discovery that reverse osmosis offers an economic and technically feasible method of water desalination. ●

During the year the CSIR developed a method for the diagnosis of vocal cord abnormalities by means of acoustic wave measurement. This method enables vocal cord abnormalities to be detected at an early stage without any discomfort to the patient. ●

DEVELOPMENT OF THE INFRASTRUCTURE

An important section of the CSIR's work is devoted to the development of a sound infrastructure for economic progress. It involves, *inter alia*, research into roads, transport, harbours, pipelines and other communications, as well as building construction methods. Some of the contributions from the CSIR are listed below:

- Measurements taken after the completion of the breakwater at Saldanha Bay confirmed the accuracy of the CSIR's predictions, established by means of a hydraulic model, of wave movements at the entrance to the bay and at the loading jetty. The various authorities expressed their gratitude for the thorough and scientific manner in which the investigation was conducted.
- The CSIR's investigation into the effects of extremely heavy loads on traffic flow and the highway system will be of particular importance to future development. It is envisaged that some of our roads will have to carry more than 1 000 tons by the end of the century, and accurate analytic techniques are needed to assess the effects of such superloads on bridges so that every reserve of strength may be utilised.
- Another important road research project entails the assessment of wear on existing road pavements. With the heavy vehicle simulator developed by the CSIR, with which 10 to 15 years' normal wear can be simulated within approximately 10 weeks, altogether 30 tests have so far been carried out on existing road surfaces.
- The CSIR renders an increasingly valuable service to the building industry with its research and advice on the use of building innovations, especially on the application of new products and materials in industrialized building methods. An important development in this regard is the establishment of a liaison committee to ensure closer contact between the interested bodies and to promote the utilisation of industrialized building methods and related techniques.
- The CSIR investigated various methods with which to restrict the presence of nutrients such as phosphorus and nitrogen compounds, which cause excessive plant growth in rivers and dams, in water coming from treatment plants. It has been found that biological removal without the addition of chemicals produces the best results, even though the costs are slightly higher.

INDUSTRIAL DEVELOPMENT

The manufacturing industry is very much alive to the application of scientific and technological developments, and progress in one industry tends to penetrate to other sectors as well. The CSIR's activities in this regard entail, *inter alia*, 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. The following are some of the recent developments:

- A computer program has been developed, with the aid of comprehensive technoeconomic industrial surveys, to determine the various trends active in the importation and exportation of certain products as well as the local market for these products. The program will be of great value in the identification of key technologies with a view to the consolidation of research activities.
- The CSIR's production facility for integrated circuits, opened during the previous year, went into production early in 1977. Considerable success has already been achieved with the uncommitted integrated circuit (a standard item of which the final production step is adapted to the requirements of a particular client) with significant savings in the direct development costs of custom-made integrated circuits.

The pulse galvanostatic analyser, an instrument developed by the CSIR a few years ago for a quick and accurate assessment of the suitability of manganese dioxide for dry cell application, as well as the new light subsequently shed by it on the complex reaction mechanism taking place in dry cells, is not only of importance to the local industry, but also enjoys international recognition.

The CSIR has launched an investigation into the use of plasma reactors in the upgrading of South African ores and coals. This technique, which has hitherto been put to limited use overseas, holds great promise for the future. The CSIR will concentrate on its application in the conversion of coal while the National Institute for Metallurgy will be investigating its metallurgical application.

A technique, which was developed by the CSIR for the production of high-precision fibreglass autogiro rotor blades of particularly high mechanical strength, can now be applied to the production of helicopter rotor blades as well.

A new model of the CSIR's successful timber grader (an inexpensive device first developed in 1971 for the determination of mechanical strength grades) and an alternative method for the production of fully water-resistant stocklam timber are both developments of great importance to the timber industry. The latter development is particularly important because it enables cheaper stocklam to be manufactured by means of a warm curing adhesive produced from South African wattle bark extract.

During the past year two important developments in the field of textile technology were announced. The first is a new method for the simultaneous dyeing and crease-resist finishing of cotton, the simplicity and economic advantages of which have created considerable interest. The second is the discovery that phormium fibre can be refined and softened by a simple process which renders it suitable for spinning into a yarn that can be used for the production of wall furnishings and other products. This development should be of particular interest to the phormium producing areas of Transkei and KwaZulu.

The development of a technique for greater accuracy in the evaluation of dietary protein has prepared the field for a complete re-investigation into the present state of assimilable protein production in South Africa.

The three industrial research institutes which are partly financed by the CSIR, and which undertake their research on behalf of the fishing industry, the sugar milling industry, and the leather and footwear industries, have been working on a number of projects, including the following:

After the discovery that the corrosion of fish cans is primarily caused by the high chloride content of sterilised cooling water, particular attention is being paid to the improvements of the cooling water quality and the application of protective coatings to the cans.

Further progress is being made on research into the removal of impurities from raw sugar melts in the sugar production process.

Research into the removal of pollutants from tannery effluent has brought to light information that will permit the design of substantially cheaper effluent treatment plants, a matter of particular economic importance.

PROMOTION OF THE GENERAL WELFARE

Work done by the CSIR to promote the welfare of the community in general entails, amongst others, research into urban development (including housing schemes), the design of hospitals and other specialised buildings, the prevention of air pollution, the removal of waste products, and the utilisation of the water supply. Some of the projects are mentioned below:

- An experimental solar air-conditioning system designed and constructed by the CSIR is expected to produce acceptable comfort conditions in most parts of the Republic, with an energy consumption rate approximately 50 per cent lower than that of conventional air-conditioning systems.
- Continuous air pollution research is of the utmost importance in ensuring realistic control measures. While it is always the endeavour to eliminate the release of pollutants into the atmosphere, the cost of industrial control measures has to be taken into account. In this regard it is considered important to avoid unproductive confrontation between authorities and industry, which is a common occurrence in some of the developed countries, by means of mutual consultation and the use of the best technology available.
- In view of the possibility of harmful side-effects arising from the use of herbicides to combat the troublesome water hyacinth on the Hartbeespoort Dam, the CSIR is conducting investigations in co-operation with the Department of Water Affairs and with support from the Water Research Commission on the effect of the relevant herbicide on other life forms in the area, and of the decomposing weed on the ecosystem. The information thus obtained should be very helpful in establishing a code of practice for the use of herbicides against water hyacinth. Close co-operation is maintained with the South African Bureau of Standards.
- The increasing demand for psychological tests suitable for the classification and selection of industrial personnel, which the CSIR has been designing since 1946, indicates that this service is a valuable contribution to the optimum employment of the country's manpower. The CSIR is at present one of the largest distributors of this kind of test in the country. By law only registered psychologists may use certain tests, and the Professional Board for Psychologists is advised on the various types of tests by a test commission consisting of representatives from the CSIR and the Human Sciences Research Council. A combined register of test users registered with the two organizations is at present being compiled and computerized.

TRANSFER OF SCIENTIFIC AND TECHNICAL INFORMATION

Technologically developing countries have a need for their own scientific and technical information systems which are tailored, on the one hand, to the nature, capacity and particular requirements of the producers and consumers of such information, and, on the other, to the type of information most necessary for social and economic progress. Such internal information systems must be efficiently linked to the information networks of the more advanced countries. By dint of its legal obligations in respect of the collection and dissemination of scientific and technological information, the CSIR performs an essential national function with its information dissemination and exchange systems, which are just as important as its research activities.

Conference Centre

Conferences and other such meetings play an important role in the transfer of information by creating an opportunity to communicate fresh research results to interested persons, without the delays of publication. Through the years the CSIR acquired a high degree of expertise in the organization of conferences, symposia, seminars and short courses in particular fields. These activities were always restricted, however, by the lack of a suitable venue, so that conferences frequently had to take place far from the main centre of the CSIR, often at venues lacking in facilities for scientific and technical conferences. The modern, well-equipped Conference Centre, which has just recently been completed at the CSIR in Pretoria, will satisfy a requirement that has been urgent for some time.

The new Centre was designed to offer functional, internationally acceptable accommodation with adequate, efficient facilities for regional, national and international conferences. It consists of three auditoria with seating for 450, 150 and 100 people respectively, with full air-conditioning and equipment for simultaneous interpreting, audio-visual presentations and the like, and includes offices and other facilities for the administration of meetings, space for registration and temporary exhibits, and a restaurant. The Centre's situation, close to Pretoria's eastern by-pass, facilitates access from Jan Smuts Airport where delegates usually arrive from other parts of the Republic and from abroad. Adequate parking space is also provided.

The list of personages present at the official opening of the Centre in October 1977 included the President of the Canadian National Research Council, Dr W G Schneider, who gave an illuminating lecture on developments in the field of energy utilisation.

Although the Centre is intended, in the first place, for the CSIR's own use, it is also available to the country's scientific community as a whole. In this way, the CSIR offers a comprehensive conference service to organizations co-operating with it, and during the year under review meetings were held on a wide variety of subjects, both here and at various other venues throughout the country. More particulars in this regard may be found in a later part of this report.

Information and library services

The CSIR's information and library services are constantly being expanded to satisfy the growing national demand for information on scientific and technological subjects. Expansion of the library collection was curtailed by the rapidly escalating prices of books and journals, the surcharge of 15 per cent on imported goods, and a reduction in the budget. In view of the importance of a sound central collection of literature to satisfy the needs of the country's scientific and industrial communities, it is hoped that the situation will improve in the future.

Further progress has been made with the development of the specialised information services which, together with the library, constitute the CSIR's Centre for Scientific and Technical Information. In addition to the computerized literature current awareness services, which have been in existence for a number of years, a computerized retrospective literature searching service was established, with a teleprinter terminal and long distance telephone links with a large number of bibliographic services in North America and Europe. Although this service became operational just over a year ago, it is already in great demand.

The services of the South African Water Information Centre, operated under contract on behalf of the Water Research Commission, have also been expanded.

SUPPORT OF RESEARCH

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 academic or 'free' research at universities and museums by means of annual grants allocated on the grounds of applications received from individual researchers, institutes, units and groups. 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 take turns to serve.

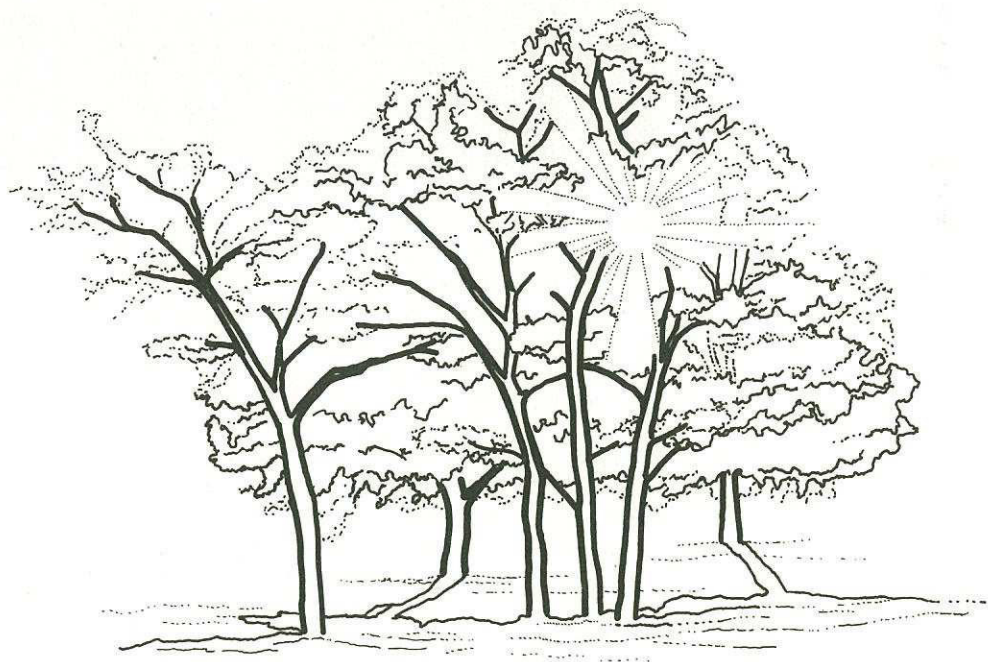
During the past year more than 1 300 grants were made, representing a total expenditure of more than R2 180 000. The vast field covered by this research is reflected in the names of the various units, groups and institutes that receive support at present. There are two main categories: those which receive 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.

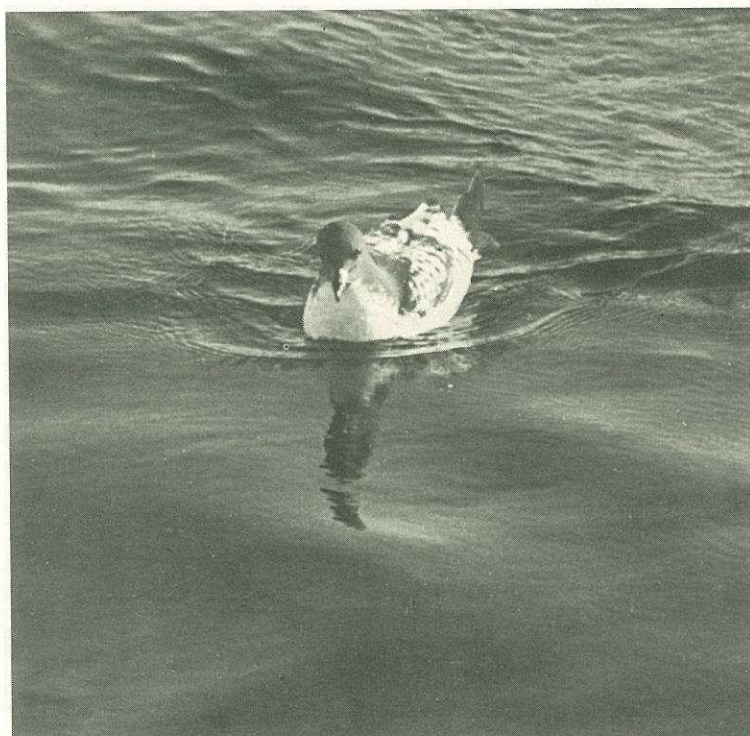
Amongst the organizations in the first group are the Geochemistry Research Unit, the Chromatin Research Unit and the Carbohydrate Chemistry Research Unit at the University of Cape Town; The Polyene Chemistry Research Unit at the University of Stellenbosch; the Flavanoid Chemistry Research Unit at the 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 Semi-conductor Physics Research Unit at the Rand Afrikaans University; and the Desert Ecological Research Unit at the Namib Research Institute (attached to the Transvaal Museum).

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, and the Mammal Research Institute at the University of Pretoria; 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 at the University of Cape Town; the Southern Universities Nuclear Institute at Faure; and the Institute for Petrochemical Research at Potchefstroom University.

Further information on some of the projects of these units, groups and institutes will be found in a later section of this report.

Co-operative scientific programmes





To meet the challenges facing science, now and in the future, the skills acquired in an ever-increasing variety of disciplines have to be mobilized and brought to bear on problems most urgently needing attention. Where the problems are too wide and complex for individuals or organizations working alone, the different disciplines must make common cause to enable scientists and scientific institutions to work together more closely 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 has established mechanisms, by means of its co-operative scientific programmes, to share the responsibility of planning, setting up, executing, synthesizing and financing research projects of common interest. With the help of this organizational structure, scientists from different disciplines and organizations can be brought together to focus the best available expertise on problems which might otherwise defy solution. The CSIR's contribution to the promotion of co-operative research of this nature is directly related to its function as the Republic's 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 and to enable individual scientists from all over the world to participate in such activity.

There are at present approximately 80 bodies — including sixteen universities and museums, fourteen government departments, and six statutory bodies — participating in the national co-operative scientific programmes. An estimated number of 600 scientists are involved, in one way or another, in these programmes.

The present co-operative scientific 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 these programmes are in the hands of a group of scientists at the CSIR who are divided into units for marine and earth sciences, environmental sciences, and technological programmes.

Marine and earth sciences

This group contains co-operative programmes in the fields of oceanography (sub-divided into sections for marine biology, physical and chemical oceanography and marine geology), geology, and Antarctic research.

Oceanography — The advising body for co-operative programmes in this field is the South African National Committee for Oceanographic Research which liaises with the international Scientific Committee for Oceanographic Research (SCOR). Projects for observation by means of floating buoys and remote sensing observation by means of satellites are examples of international co-operation.

Altogether four universities, two museums, one government department, and one research institute are involved in projects in the marine biology section. The aim of these projects is, *inter alia*, to collect information for the effective control, exploitation and conservation of live resources in the coastal zone. Projects in physical and chemical oceanography, in which two universities and an institute of the CSIR co-operate, involve a study of ocean currents, waves and circulation patterns of the eastern seaboard. The results will hopefully contribute to safer and more economic shipping along the South African coast. In the marine geology section, the marine bed is being investigated by two universities in selected areas along the South African coast. The primary aim of these investigations is to come to a better understanding of the geological history of the sub-continent. There are, in addition, certain submarine deposits which may have potential economic value.

Geology — The responsible body in this field is the national committee of the International Union of Geological Sciences (IUGS). One of the most important activities of the IUGS is the co-ordination of the International Geodynamics Project. The South African contribution to this project is largely financed by the CSIR. It entails a study of deep seated past and present movements in the lithosphere, and is aimed at an improved understanding of the natural processes underlying mineral deposits which may be economically exploitable. Participants from ten university departments are co-operating on a total of 22 different facets of the project, which will be completed in 1980. Significant information has already emerged on the geology of the areas of intensive investigation, and the work is now entering its final stage. During the year under review the Sub-Commission for Pre-Cambrian Stratigraphy of the IUGS held a very successful meeting in Cape Town, which was attended by members from eleven different



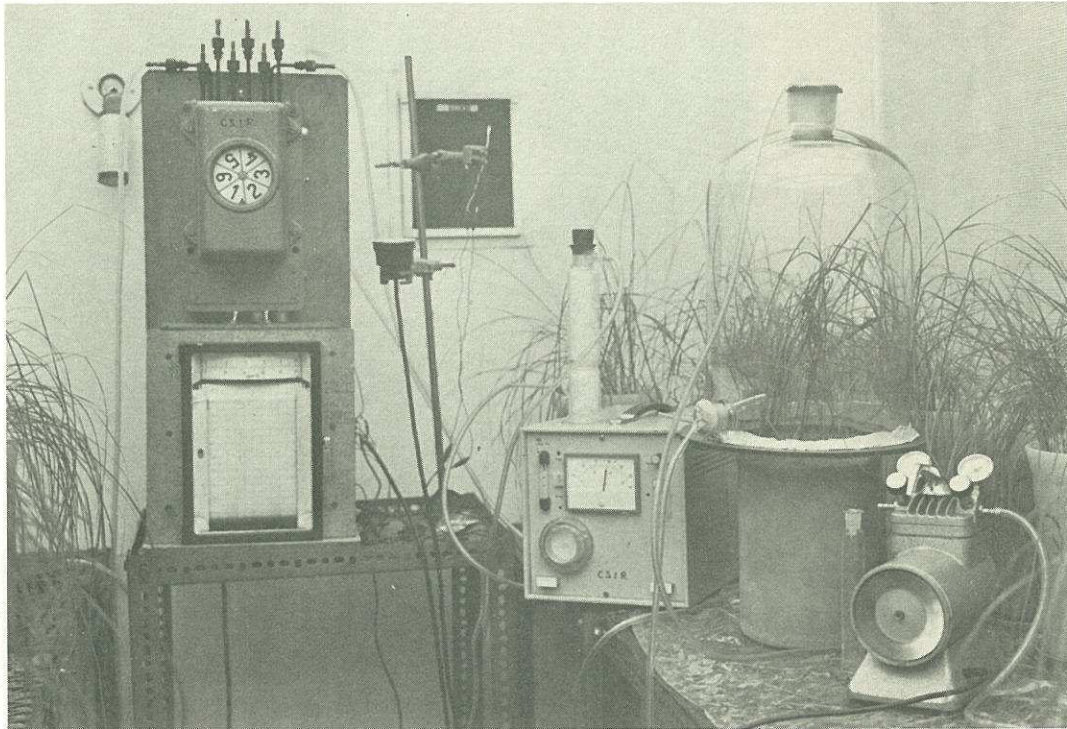
countries. The CSIR organized and partly financed the meeting as well as the preceding excursion.

Antarctic research programmes — This research (on Marion Island, Gough Island and at Sanae in the Antarctic) is financed by the Department of Transport, but the CSIR acts as adviser, through the South African Scientific Committee for Antarctic Research, on the scientific aspects of the programme. This Committee is also South Africa's representative on the international body, the ICSU's Scientific Committee on Antarctic Research.

Altogether eight university departments and two institutes of the CSIR participate in this programme, which covers mammal research, ornithology, marine biology, plant ecology and upper atmosphere physics. A publication featuring a comprehensive review of the activities in the geological programme between 1960 and 1975, and of the South African scientists' participation in the international project for the study of the magnetosphere, is being prepared at present.

Environmental sciences

The National Programme for Environmental Sciences is in itself a co-operative research undertaking involving some 46 government departments, statutory bodies and other research institutions, and 14 universities. More than 100 senior scientists are directly involved in research projects that form part of the programme, which is divided into the following sections: (1) inland water ecosystems, with programmes on mineralising, aquatic weeds, eutrophication, coastal lakes, man-made lakes, the Pongolo Floodplain, cattle-biting flies (*Simuliidae*), and heavy metals; (2) terrestrial biology, with pro-



grammes on a savanna ecosystem, fynbos, the areas affected by the Kuiseb River, fire ecology, threatened biota, pesticides in the environment, invasive exotic plants, and vegetation changes; (3) marine pollution, with a national marine pollution survey and programmes on coastal currents, heavy metals, and ecotoxicology; (4) the atmosphere, with programmes on mesometeorology, urban heat islands, the atmospheric transport of pollutants, climate cycles, and the monitoring of atmospheric pollutants.

The advisory body, which is the National Committee for Environmental Sciences, is also the South African committee for SCOPE (the ICSU's Scientific Committee on Problems of the Environment).

The Pongolo Floodplain Project involves the area below the Pongolapoort Dam and the area of the Makatini Flats planned for irrigation. It contains some 35 pans and a complex of natural aquatic and semi-aquatic ecosystems which are closely dependent on the dynamics of periodic flooding and drying out. The interrelations of this system are being investigated with a view to assessing the present and potential value of the floodplain, predicting the consequences of the area's development, and discovering strategies for development which will preserve as much of the natural system as possible while permitting the best exploitation of the floodplain's natural resources.

This research has already revealed that the pans and the grass meadows, which result when the water recedes, both represent valuable sources of food production which can be better utilised. The floods also control the breeding and productivity of the river system's fish populations, which at present represent the major source of animal protein for the human population of the area. Realising the



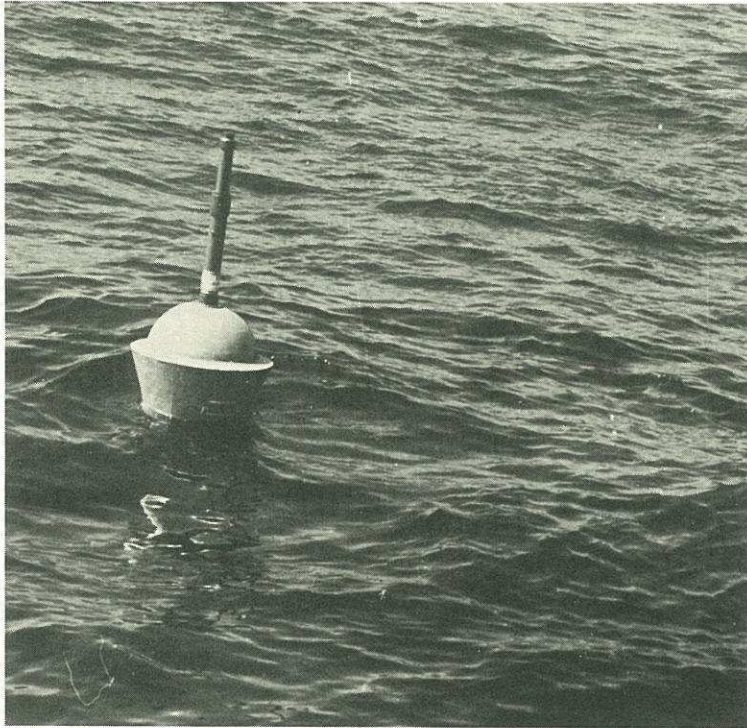
potential of the floodplain should involve no loss in the potential of the planned irrigation development. It will, however, require careful planning and management of the area to avoid destructive hydrological conditions and salt pollution.

As far as the ecosystem is concerned, the most ambitious project is undoubtedly the Savanna Ecosystem Project currently being undertaken at Nylsvley in the Northern Transvaal bushveld. This project is aimed at a better understanding of ecosystem structure and function necessary to prevent changes in stability induced by various natural and man-made stresses. During the past year the first phase of the research programme, which is a pilot study of the Nylsvley research site, has been completed. This study, comprising over 30 projects, provided the most comprehensive quantitative account of any savanna yet studied. During the past year a start was also made with the study of key components and processes, which constitutes the second phase, and planning was started on the third phase which entails an investigation of the ways in which the information obtained in phases one and two might be used towards improved land use practices.

Technological Programmes

The Technological Programmes Unit involves itself in co-operation with industry. Co-operating organizations at present include twelve universities, a number of government departments and one statutory body – in addition to three industrial organizations and two research institutes of the CSIR.

Representatives of the industrial sector are involved in identifying



fundamental problem areas of importance to particular branches of industry, and five joint projects were started in the past year.

An analysis was made, in co-operation with the Human Sciences Research Council, the Department of Planning and the Environment, Iscor and the University of South Africa, of the circumstances and attitudes of people in the Ellisras area to determine their psychosociological adaptability to rapid industrial development. The enquiry is expected to result in the development of a model which will permit elucidation of the most important influences on successful adaptation to rapid industrialization in South Africa.

A conceptual model for the optimum location of metropolitan refuse disposal and processing sites has been developed by the University of Stellenbosch in co-operation with local authorities. In the light of the constantly increasing demand for urban land, the increases in transportation costs, and the growing volume of urban refuse, there will be many advantages in the successful application of optimisation techniques and the planning of metropolitan refuse removal on a regional basis. With the co-operation of the Cape Provincial Administration and a number of municipalities in its area, the conceptual model is now being tested in practice.

In the remote sensing field, a demonstration project was undertaken in the Krugersdorp area to determine the relative advantages and costs of various airborne and satellite remote sensing techniques suited to geological and engineering geological applications. The project, in which various organizations participate, is being conducted under the auspices of a mining house. Arrangements have also been made with

the Department of Agricultural Technical Services for a mutual study of the application potential of remote sensing in agriculture.

By request of the South Africa Institute of Physics, the establishment of a national committee for materials research and development is receiving attention. Co-operative investigations in the fields of energy and fermentation research received attention in 1977, and the necessary planning has now been completed.

In the field of atmospheric studies, altogether 48 publications and reports appeared during the past year. An investigation into the general inversion climatology of South Africa was completed, as well as the first phase of the so-called Pretoria Project which involves the influence of a town on its environment. The Air Pollution Research Group of the CSIR, the Departments of Geography, Environmental Studies and Chemical Engineering at the University of the Witwatersrand, the Atomic Energy Board, the City Council of Pretoria and Iscor all co-operated on the latter project.

A study of South African rainfall records strongly suggests a cycle of 20 years in the rainfall pattern of the summer rain area. The practical implications, as well as the development of models of harvest yields, are being investigated by the University of the Witwatersrand and the Department of Agricultural Technical Services.

Various departments at the Universities of Cape Town and Natal, as well as the Atomic Energy Board, are involved in the development of models of the atmospheric pollution of Greater Cape Town and Duinefontein, the site of South Africa's first nuclear power station. A station has been erected at Cape Point for the monitoring of atmospheric pollutants in the Southern Hemisphere, while carbon monoxide and freon gases are monitored in co-operation with two outside institutions, one in the United Kingdom and one in Germany.

Reports on specific activities

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In this section specific activities are dealt with under headings reflecting broad aims. The superior numbers in the text, e.g. 15, refer to the relevant institutes, the functions of which are outlined on pages 52 to 62.

Knowledge – development and application

BIOSYNTHESIS OF TOXIC FUNGAL METABOLITES

Mycotoxins are secondary fungal metabolites which originate in nature through the polyketide and terpene routes, and through biosynthesis from amino acids.

The availability of mutants and suitably labelled precursors facilitated a detailed study of the biosynthesis of several mycotoxins¹. It was therefore possible to identify building units in the biosynthetic process, and to study mechanisms of linkage and the transformation of intermediates. Recently, the structure and biogenesis of intermediates in the biosynthesis of aflatoxin, a potent hepatoin, were elucidated and a generalized biosynthetic scheme formulated. Growing cultures of the fungi were pulse-labelled by means of the addition of singly and doubly ¹³C-labelled acetate. The distribution of labels and of intact acetate units was established with the aid of ¹³C-nmr spectroscopy. The acetate-polymalonate origin of aflatoxin was verified.

MAPPING OF BIOLOGICALLY ACTIVE PROTEINS

Phospholipase A₂ from the gaboon adder, *Bitis gabonica* hydrolyses phospholipids such as lecithin to the lyso-derivative and free fatty acid. According to kinetic data, Ca⁺⁺ binds first, through the agency of a carboxyl group, bringing about a small conformational change in the enzyme, thereby allowing productive binding with the substrate. Chemical modification studies pinpointed His-45 as the nucleophile in the hydrolytic process itself while lysine residues 11, 33, 58 and 111 participate in active dimer formation¹.

RUMINANT DIGESTION

A knowledge of the metabolic pathways of bacteria in the rumen of sheep and cattle is of interest since they determine the efficiency of energy production for the synthesis of microbial protein, which is normally the main source of protein for the animal. A study of the lactate

dehydrogenase of *Butyrivibrio fibrisolvens*, an important bacterium in the rumen which produces lactic and butyric acids, has been completed¹. It was shown that the enzyme which produces lactic acid is active only in the presence of fructose 1,6-diphosphate (FDP). Since FDP is produced at an early stage in the breakdown of glucose, this requirement serves to prevent the formation of lactic acid, which is an energy-wasting process, when carbohydrate is limited. This benefits both the bacterium and the animal.

THEORETIC BASIS FOR SELECTIVE EXTRACTION

Selective reagents in metal extraction are of obvious importance and a fundamental study to establish the primary causes of selectivity is being undertaken in collaboration with the National Institute for Metallurgy. To investigate the structural aspects of synergism in the liquid extraction of base metals, an extensive series of appropriate adducts has been synthesized and investigated crystallographically¹.

Another aspect of selectivity which is closely related to the stability of metal complexes is being studied by computer simulation. The results, which indicate that the differences in the stability of ring systems relate to steric factors, are also being assessed in relation to practical metal extraction systems.

IMPROVED SEPARATION OF RADIOACTIVE CADMIUM-109

Cadmium-109 is an important radioactive source for X-ray fluorescence spectrometry because its 88 KeV γ -ray is selective in the determination of the heavier elements.

The cyclotron of the CSIR supplies a considerable part of the cadmium-109 used in the Western world, and South African cadmium-109 was used in the X-ray fluorescence instrumentation of the American Viking Mars probe. As a spin-off of the systematic study of anion exchange distribution coefficients in hydrobromic-nitric acid mixtures, a much improved method was developed for the separation of radioactive cadmium-109 from silver cyclotron targets¹.

This new method uses a resin column of only 5 ml instead of the 25 ml resin column used previously. It needs only small elution volumes to separate trace amounts of cadmium quantitatively from gram amounts of copper and other elements, and the cadmium produced is of improved purity. Less than 1 microgram of copper and about 2 micrograms of zinc were found with the cadmium when 1,5 grams of these elements were present originally. The separation is also of considerable importance to the South African gold mining industry because cadmium-109 is a promising source for the selective *in situ* determination of gold in mines by means of small portable instruments.

PLATINUM METAL COMPOUNDS

A study of the reactions of five-co-ordinate iridium(I) complexes was undertaken to determine whether the nature of the activation step is associative or dissociative¹. The results show that reaction only proceeds after dissociation has taken place. Further results have been achieved in studies of rhodium(I) systems. The details of the mechanism of cyclometallation were disclosed in an interesting study, and the results have found direct application in the organometallic synthesis programme.

The chemistry of ruthenium(II) has been further developed, and resulted in an industrially useful reaction for the production of dithiocarbamates. Many of the reactions show catalytic promise and will be developed.

ACOUSTIC DIAGNOSIS OF VOCAL CORD ABNORMALITIES

The possibility has been investigated of diagnosing vocal cord abnormalities by means of information derived from an analysis of acoustic waves produced by the vocal cords.²

It was found that this method permits the early detection of abnormalities in the vocal cords while at the same time making it possible to arrive at an accurate description of the condition.

An important advantage of the new method is that the patient suffers no inconvenience during its administration. All he is called upon to do is to place his lips over the opening of a tube and then to utter certain prescribed sounds. This tube is lined with an acoustically absorbent material and constitutes a matched termination for the vocal tract, thus eliminating voice formants which are normally generated here. Consequently, the form of the pressure wave produced by the vocal cords in the larynx is transmitted faithfully into this tube where it is detected by a microphone.

The waveform of the microphone signal is then subjected to Fourier analysis and the parameters so obtained are compared statistically with those of normal speakers. Strong evidence has been found that differences between these sets of parameters are characteristic of the various types of abnormality involved.

A CLOSER LOOK — WITH NEW ELECTRON MICROSCOPE

The CSIR² recently acquired a 200 kV electron microscope which features above-average penetrability.

With this machine, which is one of the two most powerful in the country and which can be used for both transmission and scanning-transmission investigations, it is possible to obtain an electron diffraction pattern of a single particle as small as 20 nm ($1 \text{ nm} = 10^{-9} \text{ m}$). In most cases the crystal structure of the particle can be identified in this way. Thus, recently, it was possible to determine the nature of extremely small precipitate particles on the grain boundaries of a sample of stainless steel for an industrial organization. It is unlikely that this identification could have been done by any other known method.

THE LASER AS NEW LENGTH STANDARD

A number of countries are working on the development of a new length standard based on the wavelength of light emitted by a helium-neon laser stabilised on iodine-127. Such a laser has been designed and built by the CSIR² and its accuracy has recently been compared with that of a similar British laser. Although the design of the South African laser differs considerably from that of the British one, the reproducibility of the wavelengths of the two devices was comparable.

Our present ability to measure lengths is limited by the properties of the existing length standard, namely the wave-length of light emitted by a krypton lamp. The stabilised laser not only offers the possibility of an improvement by a factor of at least one hundred in attainable accuracy, but can also be used to measure very great lengths. It should therefore be possible to use it to calibrate measuring standards such as surveyors' tapes and the standard one-kilometer baseline constructed by the National Institute for Telecommunications Research.

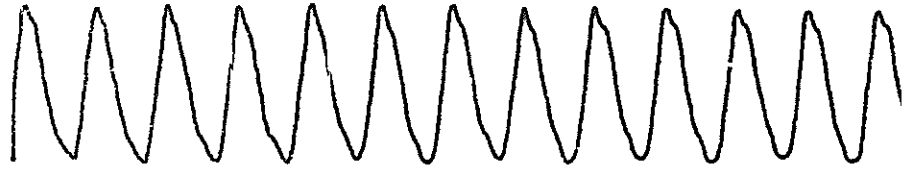
MEASUREMENT OF HAILFALLS

To determine the intensity of a hailfall, measurements of the size distribution of hailstones, their concentration at the surface and the duration of the fall are required. Such information is also needed for the objective evaluation of hail suppression experiments.

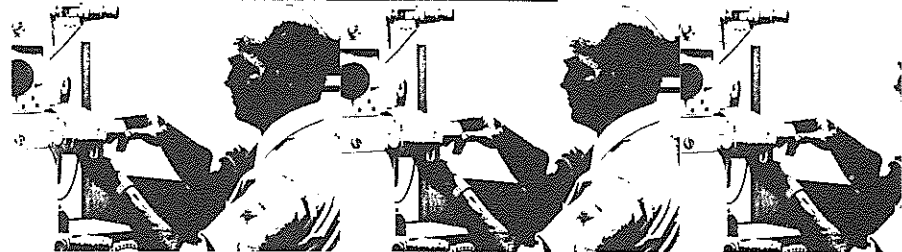
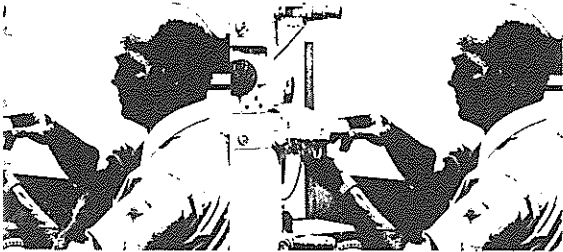
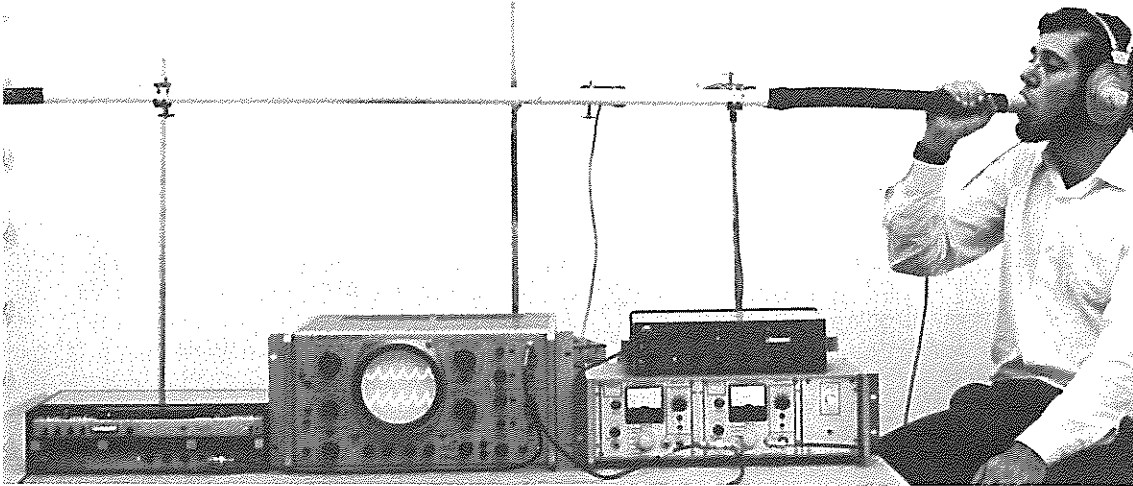
Hailpads, consisting of a polystyrene block covered with aluminium foil as a sensor, are commonly used to register hailfalls. However, the measurements are difficult to make and the results can be ambiguous. A new technique has been developed by the CSIR² in which cold rolled aluminium sheet replaces the foil. It gives more reliable results, even for non-spherical hailstones. Hailstone sizes and kinetic energies can be estimated from the size of the dents. An auxiliary piece of equipment known as a hail cube may be used to estimate the angle of impact of the hailstones in order to obtain accurate measurements of kinetic energy when a strong wind is blowing.

Because of the melting process, hailstones on the ground are smaller in size and fewer in number than they were in the cloud. The sizes and concentrations aloft, required for correlation with radar observations, are approximated from values at the surface by means of an empirical formula developed for the purpose.

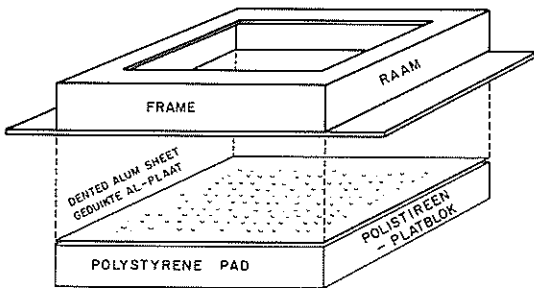
Normal voice



Vocal cord abnormality



Acoustic diagnosis of vocal cord abnormalities (p. 11): An apparatus in experimental form used to detect vocal cord abnormalities at an early stage (top).

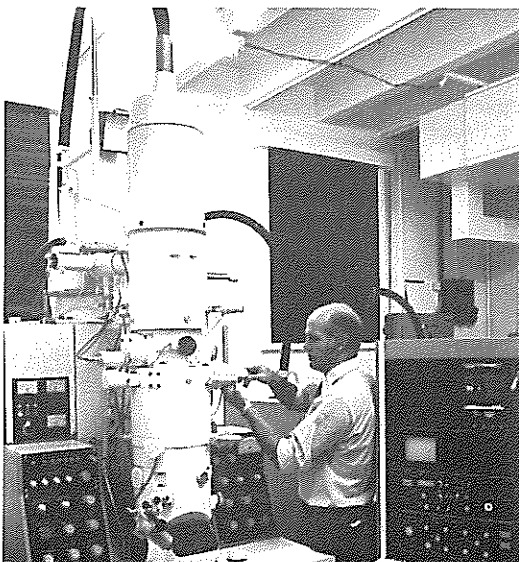


Measurement of hailfalls (p. 12): Diagram showing a hailpad used to register hailfalls. The number of hailstones falling on a given area can be determined by counting the dents in a cold rolled aluminium sheet (left).

A closer look – with new electron microscope (p. 12): This 200 kV electron microscope which features above-average penetration, was recently acquired by the CSIR (bottom left).

Improved reverse osmosis and ultrafiltration membrane (p. 17): Electronmicrograph of a cross-section through an asymmetric reverse osmosis membrane showing typical structure gradation from a coarse under-layer to the dense surface desalting layer (bottom).

This small reverse osmosis plant, which utilises spiral-wound membrane modules contained within the pipe-like pressure vessels, delivers 5,8 m³ of drinking water per day (bottom right).



NUMERICAL WEATHER PREDICTION

In numerical weather prediction, numerical solutions are found for the initial and boundary value problems of the non-linear partial differential equations which describe the behaviour of the atmosphere on a global and cyclonic scale. Research in this field is concentrated on the development of new numerical methods which are both accurate and economical.

Two methods have been investigated: the flexible finite-element method based on Galerkin's principle, and a new finite-difference method which is implicit in alternating directions³. It was found that the latter method can compete with the semi-implicit method in dealing with the time variable. In the space-horizontal direction a baroclinic model of the atmosphere has been approximated by a fourth-order space difference scheme, which results in considerably smaller phase and truncation errors than the old second-order scheme. A semi-implicit version of an explicit hemispherical prediction model is being developed.

This research is being done in co-operation with the Weather Bureau to improve computerized forecasting techniques.

OPTIMAL ESTIMATION AND CONTROL

In the solution of problems related to optimal estimation and control, insight into the theory of the matrix Riccati equation — a generalization to higher dimensions of the classical quadratic equation — is of fundamental importance.

As a result of research undertaken it was possible to determine necessary and sufficient conditions for the existence of real symmetric solutions of the algebraic Riccati equation, and to characterise the solutions in respect of ordering and stability properties³. In addition, the possibility of an infinite/finite number of solutions was investigated and a count of the number of solutions could be determined.

These results were applied to the theory of the linear-quadratic regulator and linear-quadratic differential games.

DIVERGENT INTEGRALS

In many branches of classical mathematical analysis and theoretical physics there is a need for methods of dealing with divergent integrals. Numerous techniques are available: analytic continuation, deformation of the integration contours, Hadamard's 'finite parts', fractional integrals, Mikusinski's operational calculus, Schwartz's theory of distributions, and others. Although all these methods are closely related and largely equivalent, their various fields of application are limited, and their theoretical basis rest on different mathematical disciplines.

As a result of an extensive investigation into a general and unifying approach to divergent integrals, attention is now being concentrated on the theory of hyperfunctions³. There are indications that it will be possible to develop a calculus for hyperfunctions which will embrace all existing methods dealing with divergent integrals.

THE RINGS OF URANUS

The CSIR⁴ played a major role in recent observations that led to the discovery of five rings around the planet Uranus. Such rings had previously been thought unique to Saturn.

The observations were made simultaneously from a US airborne observatory over the South Indian Ocean and from ground observatories in India, Western Australia and Cape Town, during the occultation of a star by the planet Uranus. Most of the occultation could only be seen from South Africa and from the airborne observatory. Observations from both of these two stations were essential to establish the reality of the rings.

ASTRONOMICAL INSTRUMENTS AT SUTHERLAND

An 'electronographic camera', recently developed at the Royal Greenwich Observatory, UK, has been installed on the 1,0 m telescope at Sutherland. It has been in considerable demand by CSIR staff⁴ and by UK astronomers, in terms of the CSIR's agreement with the Science Research Council of the UK.

Control of the 1,9 m reflector has been greatly improved by the provision of a computer controlled encoding system. A photo-electric radial velocity spectrometer with computer control has also been added to the 1,9 m reflector. This enables stellar velocities to be determined much more rapidly and accurately than in the past. Amongst its initial uses has been a joint programme of the CSIR and the Royal Observatory, Edinburgh, to study the nature of stellar pulsations.

INFRARED DETECTION OF CELESTIAL MICROWAVE SOURCES

In recent years the existence has been discovered of a number of apparently stellar sources of microwave emission by maser action. Many of these sources are unidentified optically.

In a recent survey by Australian radio astronomers 15 such sources were found, all of them optically unidentified. A CSIR⁴ survey at 2 microns now shows that in 13 of the 15 cases there is an infrared object at the radio position. This opens up a much greater scope for our understanding of these stellar objects.

GEOMAGNETIC AND OTHER OBSERVATIONS

Routine geomagnetic observations were continued at the magnetic recording stations at Hermanus, Tsumeb, Grahamstown, Hartebeesthoek, on Marion Island and at the South African Antarctic base Sanae⁵. In addition to geomagnetism the Hermanus and Tsumeb stations take continuous readings of cosmic rays and the ionosphere. The Hermanus station is also responsible for certain other services, including ozone, cosmic radio noise and meteorological observations. Aurora observations are conducted at Sanae.

During the year methods of observation were improved and instrumentation modernised wherever possible. A recording proton magnetometer was designed and built locally, and was successfully commissioned at Marion Island, while a tilting filter photometer for the recording of proton excited aurora was completely rebuilt and modernised for use at Sanae.

Routine data and calibration services were continued as in the past. Data are routinely supplied from a number of the South African magnetic recording stations to overseas data centres. Such data are then used on a supporting basis in international projects. As the South Atlantic Area is very sparsely covered by magnetic recording stations, the stations operated by the CSIR serve as essential reference points in these world-wide projects.

GEOMAGNETIC RESEARCH ACTIVITIES

Research on geophysical phenomena and solar-terrestrial relations led to nine publications in local and overseas journals.

Research projects included various analyses of the magnetic quiet day variation. Anomalous behaviour of this quiet day variation is found at a number of the recording stations of the CSIR⁵. Because these stations are such important reference points in international projects, it is very necessary that such anomalous behaviour be defined and its origin determined, in order to compensate for it when the data are used. Such data are then more accurate and therefore more useful.

The analyses produced some interesting results. It was established, for instance, that the anomalous daily variation observed at Hermanus and Grahamstown can be ascribed to the effect of the coastline on the electrical conductivity in the earth's upper mantle. At Marion Island, on the other hand, the large phase shifts that occur in the daily variation of the magnetic vertical intensity seem to be brought about by a semi-diurnal lunar variation. This lunar variation appears to be enhanced by the ocean at Marion Island.

In a further research project the relationship between P12 magnetic pulsations and the commencement of magnetic substorm activity was investigated at Sanae. The conditions under which a relationship exists between these two phenomena were successfully identified.

The Magnetic Observatory at Hermanus is one of a small group of magnetic recording stations that contribute data for the determination of the so-called magnetic K-indices. These indices are used extensively in all facets of research on solar-terrestrial physics, but the hand, or visual, method used internationally for measuring the indices is subjective to say the least. A computer program for the determination of K-indices has now been developed at the Observatory, and it has been shown that the agreement between the indices obtained by computer and those obtained by the hand method is at least as good as the agreement between the indices determined by different experienced observers.

TELEMETRY SYSTEM FOR BIOMEDICAL APPLICATIONS

In biomedical research it is often necessary to transmit physiological data to a remote recorder by means of a radio link. This is especially the case in experiments where the subject is mobile and where an umbilical conductor would be a hindrance.

Since suitable telemetric equipment was not commercially available, the CSIR⁹ developed a two-channel radio telemeter to be used in a biomedical experiment on the effect of drugs on sleep. The two channels permitted two physiological variables, such as patient temperature and breathing rate, to be transmitted to a recorder in the laboratory.

The system has now been expanded to provide seven channels for data transmission, and can, for example, be used to observe and record the traditional three-lead form of electrocardiogram in mobile subjects.

A modular design was used to render the system adaptable to a wide range of applications by the simple expedient of selecting and combining the appropriate modules. The cost of the equipment has been kept down by the use of commercial off-the-shelf components wherever possible.

This telemetry system is primarily intended for biomedical applications, but has already proved itself of value in other applications such as the transmission of strain measurements from the rotating blades of the CSIR autogyro.

ELECTROMAGNETIC COMPATIBILITY

Sporadic failure of computers and other modern electronic equipment is often caused by line-conducted or radiated interference surges and other unwanted electromagnetic signals. The ability of equipment or systems to function as designed, without degradation or malfunction in their operational electromagnetic environment, is known as Electromagnetic Compatibility (EMC). On the one hand such compatibility is achieved by the suppression of surges at their source, and, on the other hand, by increasing the resistance of the equipment to the surges. Specialised knowledge, experience and equipment is required in the investigation of these factors.

During 1976 an EMC Group was established within the CSIR⁹ to render assistance to organizations experiencing trouble with electromagnetic interference. This Group has at its disposal special instruments with which to measure these interferences. Some of its instruments can, in addition, produce surge pulses to determine the efficiency of the precautions taken.

The need for this kind of service is evident if one considers that 14 requests have already been received from computer firms to have their computer installations investigated and the EMC improved. In most cases the interferences were found to have been caused by incorrect planning or deterioration in the ground system since its installation, usually due to building alterations and the installation of additional equipment. This enabled external surges to permeate through to the sensitive electronic circuits of the computer, thus causing damage or malfunction.

Lightning discharges are one of the sources of surges which can cause considerable damage to electronic equipment.

The EMC Group also assists clients by investigating the existing protection of their installations against lightning and by suggesting improvements. Advice is also given on installations still in the planning stage.

IMPROVED REVERSE OSMOSIS AND ULTRAFILTRATION MEMBRANES

Wastewater reclamation and the desalination of sea and brackish water are becoming increasingly important ways of augmenting existing freshwater supplies. A disadvantage of reclamation is that it leads to a build-up of dissolved minerals in the water which may, with continuous recycling, reach unacceptable levels.

Research conducted by the CSIR¹² has shown that reverse osmosis is economically and technically feasible for water desalination. With financial support from the CSIR and the Water Research Commission, research is being conducted at the University of Stellenbosch on the development of new and improved reverse osmosis and ultrafiltration membranes, as well as membrane support systems and modules. This work has led to the filing of three preliminary patent specifications — one on composite membranes and two on dynamic membranes based on vinyl polymers.

Composite membranes consist of a microporous support and an interlayer to which the ultra-thin desalting skin is crosslinked. An interesting spin-off from the development of a suitable support was the discovery that some of the membranes produced are potentially useful ultrafiltration membranes with good chemical and temperature stability. This field is being actively investigated.

Highly successful work has been done around the concept of coating membranes with water soluble vinyl polymers, subsequently rendered insoluble by chemical means, as a way of improving membrane characteristics during manufacture or as a means of extending the life of desalting membranes which have degenerated in use. A number of commercially available polymers and polymers developed by the research group at Stellenbosch has proved very promising and should do much to reduce the overall cost of desalination.

MEASURING DISTANCES

The CSIR¹⁴ is, *inter alia*, concerned with the development of radio and infra-red systems of long-distance measurement. The ever increasing accuracy of such systems has brought about the need for a calibration line against which they can be tested.

The CSIR, in collaboration with the Director General of Surveys, has constructed such a calibration line to the north of Pretoria. During February and March, 1976, this line was measured by the Finnish Geodetic Institute, who used an optical interferometer to multiply the length of a standard measuring rod up to 432 m with an accuracy finer than a tenth of a millimetre.

Subsequently the Institute made use of locally produced infra-red equipment to extend the basic length into standard lengths of 864 and 1728 m.

The calibration line has recently been declared a national standard, and it is available as a national facility to surveyors and engineers for the calibration of their instruments.

RECOMBINANT DNA RESEARCH

The National Committee for the International Union of Biological Sciences appointed an advisory committee to report on recombinant DNA research in the Republic. The advisory committee, consisting of Prof. O W Prozesky of the National Institute for Virology (Chairman), Prof. W Gevers of the University of Stellenbosch, and Prof. D R Woods of Rhodes University, has recently completed its report.

The committee recommends that genetic experimentation be performed in South Africa and that expertise in this field be developed in view of the scientific value and practical advantages to be gained. It further recommends that a Standing Committee on Genetic Experimentation be appointed under the auspices of the CSIR²⁰ to advise on matters relating to genetic experimentation in this country.

The need for the South African report resulted from the world-wide interest in a new and far-reaching scientific technique in genetic experimentation. Guidelines governing research in this field were considered essential in the light of reports from the National Institutes of Health of the USA and from related bodies in the United Kingdom, the Federal Republic of Germany, the Netherlands, Australia and Canada.

Development of service infrastructure

SIMULATED TRAFFIC INTERSECTIONS

A computer model of the flow of traffic through four-way intersections is being developed in collaboration with the National Institute for Transport and Road Research.^{3,13} Two forms of intersection are simulated: the 'four-way stop' and the 'mini-roundabout'. The purpose of the model is to provide a tool for the comparison of the flows through each of these types of intersection under a very wide variety of conditions, thus eliminating the need for expensive field studies (including the cost of physically modifying the intersections). The model is close to completion, and it remains only for it to be verified against actual observations before it can be taken into full use.

INVESTIGATION OF PROPOSED ELANDSBERG SCHEME

The proposed Elandsberg pumped storage scheme near Tulbagh is expected to deliver an additional 1 000 MW of electric power during peak demand periods while the Koeberg nuclear power station, which is under construction at present, will supply average power requirements. The cardinal feature of such a scheme is that special reversible pump turbines are used to generate electricity during peak demand periods, while during off-

periods (nights and weekends) the turbines are reversed to act as pumps, storing water in an upper reservoir for use during the next peak demand period.

The proposed scheme consists of large underground caverns and tunnels for which design data can only be obtained from specialised tests and investigations. For this reason the Electricity Supply Commission requested the CSIR⁸ to undertake rock mechanics investigations which would include the planning of a site exploration programme, rock mechanics tests in the field and in the laboratory, assessment of the rock mass quality, provision of design parameters for tunnels and caverns, and design recommendations for the spacing, shape, reinforcement and construction sequence of the various excavations.

Exploratory excavations, including test tunnels and enlargements at the location of the proposed underground power station, were started in 1975 and all underground tests and measurements were completed early in 1977. The total cost of the design study, including excavations, was only 2,5 per cent of the estimated civil engineering costs of the scheme.

As a result of the investigations conducted by the CSIR, data are now available for the design of safe and economic excavations. Because the rock conditions are accurately known, the element of risk is reduced and the contractors' allowance for 'unforeseen circumstances' minimised. Considerable savings should be possible through the resultant reduction in tender prices.

WAVE CONDITIONS IN SALDANHA BAY

It was previously reported that certain investigations pertaining to the development of Saldanha Bay were being carried out by means of a hydraulic model (scale 1:140). Investigations by the CSIR⁸ dealt with wave conditions which could be expected at the entrance of the bay and at the loading jetty.

After the completion of the breakwater, Iscor carried out wave measurements in the bay and found good correlation between the model wave conditions predicted and actual wave conditions encountered. The authorities concerned expressed their gratitude for the thorough, scientific manner in which the investigation was conducted.

INDUSTRIALIZED BUILDING TECHNOLOGY AND PERFORMANCE CRITERIA

The CSIR¹¹ renders an increasingly valuable service to the building industry with research and advice on innovations in the building industry, especially on the application of new building products and materials in industrialized building construction.

Particular emphasis is placed on the evaluation of building systems in order to contribute to the solution of the country's housing and other building problems. It has been felt from time to time that there should be closer liaison between the interested parties, and this has led to the establishment of an Industrialized Building Liaison Committee. This liaison committee, in collaboration with the National Building Research Institute, the Agrément Board and the Industrialized Building and Components Manufacturers' Association of South Africa, encourages the acceptance and use of industrialized building and the relevant techniques. It also endeavours to remove any possible obstacles.

Equally important are the activities of the Agrément Board's General Purposes Liaison Committee which functions in the field of performance criteria but has also been expanded to help the Board implement its quality control scheme.

ENGINEERING SERVICES IN HOSPITALS

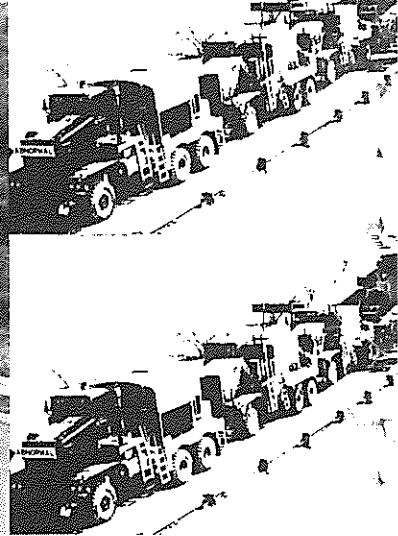
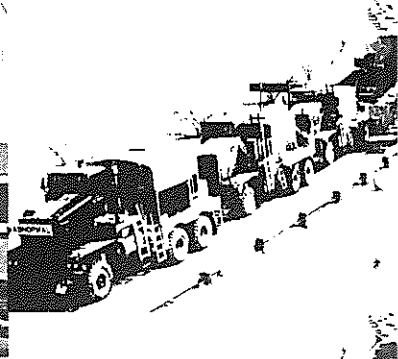
A recent survey of four large hospitals in the Republic revealed that engineering services represent between 33 and 44 per cent of the total expenditure. There are, however, few nationally accepted installation design standards at the disposal of hospital engineers.

A study carried out by the CSIR¹¹ in five hospitals has revealed, for instance, that lighting levels in some exceed acceptable standards by a factor of five, whereas the lighting in some of the others is so badly positioned that it results in a serious imbalance of lighting levels. These and other findings indicate a need for nationally acceptable interim design parameters.

The need for air conditioning in nursing units is now being investigated, but a large field of investigation still lies untouched. In the meantime the engineering services of hospitals are being planned on clearly inadequate design norms.

BIOLOGICAL NUTRIENT REMOVAL

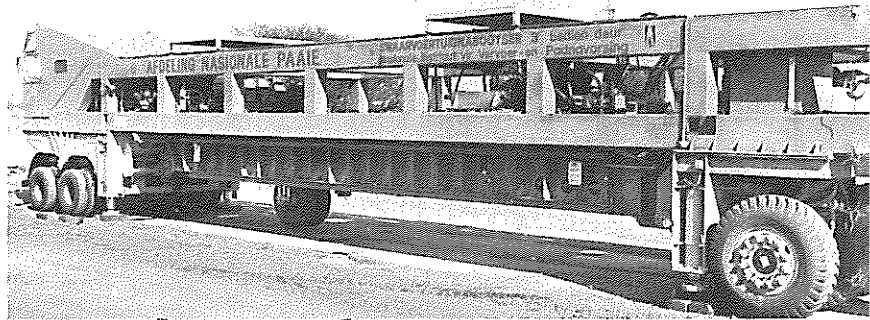
To protect impoundments and rivers against excessive aquatic growth it is essential that the inflow of nutrients be limited. The contribution of phosphorus and nitrogen compounds from wastewater treatment facilities currently represents approximately 90 per cent of the total load of these nutrients entering certain eutrophic dams in South Africa. Several methods of nutrient removal during wastewater treatment have been examined by the CSIR¹² and particular attention has been devoted to biological removal without the addition of chemicals.



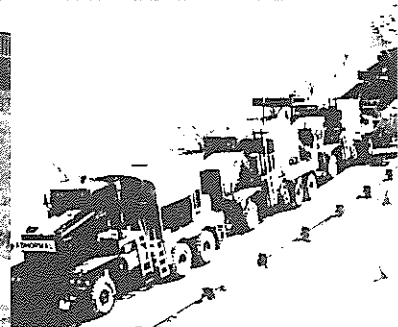
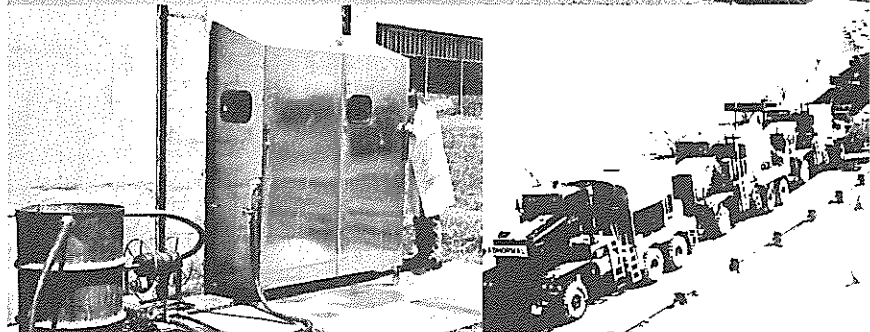
Industrialized building (p. 19): Prefabricated full-size brick panels, developed by the CSIR, here being used in the construction of a house (top).

Superloads project (p. 21): The effect of extreme loads such as this on the highway system and on traffic flow is being investigated by the CSIR (above).

Heavy vehicle simulators (p. 22): This heavy vehicle simulator, which was developed by the CSIR, can apply 1 300 wheel passes per hour at any wheel load from 30 kN to 100 kN over a test section of road pavement measuring 8 m by 1,5 m (right).



Performance criteria (p. 19): Measuring moisture penetration in a building component by means of a simulated rain apparatus (bottom right).



The results obtained to date with a 100 kℓ/d pilot plant show that nitrogen and phosphate can be removed continuously for long periods, resulting in an effluent with less than 5 mg/ℓ total nitrogen and less than 1 mg/ℓ phosphate (as phosphorus) while the chemical oxygen demand (COD) was less than 30 mg/ℓ. In comparison, average values for the feedstock were total Kjeldahl nitrogen (TKN) 30 mg/ℓ, total phosphates (as phosphorus) 6 mg/ℓ and COD 250 mg/ℓ. These results have been used in establishing tentative criteria for the design of future wastewater treatment plants.

It is anticipated that the gradual introduction of this process to all wastewater treatment plants in critical catchment areas will ensure that acceptable trophic levels are maintained. The estimated cost of biological nutrient removal will be only slightly higher than conventional wastewater treatment, and the improved quality of the effluent amply compensates for this.

STUDY OF URBAN BUS TRANSPORT

Following the recommendations of the Driessen Committee in its report on urban transport facilities, the CSIR¹³ undertook a combined study of subsidies and of a management information system for urban bus transport undertakings in South Africa.

Subsidised bus transport for White commuters will help to relieve urban congestion; but Non-White schemes must not be neglected, for it is important to maintain high public transport usage by this section of the population. The basis for subsidies is left to the discretion of the National Transport Commission (NTC).

On investigation, the CSIR recommended that a combination of suitable subsidies could be offered simultaneously: a grant on capital expenditure plus subsidies on current operations based either on the number of passengers (on established routes) or on the service (in the case of new routes).

Present management practices in urban bus transport undertakings in South Africa have been reviewed and compared with management information systems used overseas. From this study, the CSIR was able to propose that urban bus undertakings applying for or receiving subsidies from the NTC should supply the Commission with certain information on a regular basis. Forms were drawn up for this purpose, and the new management information system will be tried out in the near future by several undertakings in metropolitan areas. Eventually, the CSIR will prepare a detailed bilingual manual on the use of the new system by bus transport undertakings and the NTC.

SUPERLOADS PROJECT

Larger and heavier industrial components are being used today than ever before. In South Africa superloads on consignment to the heavy industries have to be moved from the harbours to their inland destinations along the public road system. It is anticipated that some roads may have to carry gross loads of over 1 000 t by the end of the century.

The CSIR¹³ is currently engaged on a superloads project to assess the effect of these extreme loads on the highway system and on traffic flow. Although new bridges will be constructed for superloads in excess of 500 t gross, it is possible that many existing structures may support or be strengthened to support lesser loads.

Accurate analytic techniques are needed to assess the effects of superloads on bridges, so that every reserve of strength may be utilised. However, the multiplicity of structural configurations, construction materials and original design specifications of bridges in South Africa prevents the development of simple generalized methods of analysis. Each structure must be investigated individually.

Assessments involving critical stresses can be made more rapidly and precisely by means of a computerized influence surface technique. To facilitate such rapid assessments, the CSIR is at present developing the so-called Generate-Simulate-Compare (GSC) system, which was originally conceived for abnormal load investigations. It is also working on recommended working stresses, load factors, and inspection techniques for roads and bridges involved in the transport of superloads.

HEAVY VEHICLE SIMULATORS

One of the CSIR's difficult but important tasks¹³ is to verify the new design methods for road pavements that it is constantly developing. To avoid having to wait 10 or 20 years (the normal life of a pavement) for this verification, the CSIR developed a Heavy Vehicle Simulator (HVS). This instrument accelerates the traffic process so that a pavement's lifetime wear can be simulated in about 10 weeks. The new model, commissioned in 1976, can apply 1 300 wheel passes per hour at any wheel load from 30 kN to 100 kN over a test section measuring 8 m by 1,5 m.

Together, the prototype HVS (commissioned in 1971) and the first of the new HVS models have completed 30 tests on existing pavements. The behaviour of each test pavement has been recorded by measuring the transient deflection and curvature and the permanent deformation (or 'rut depth') on the road surface at various stages under traffic. Amongst other things, the test results illustrate the accuracy of the CSIR's recently developed theory on the behaviour of cement-treated material.

Industrial development

CORROSION OF GALVANIZED HOT WATER PIPES

The overall mechanism of the corrosion processes involved in the deterioration of galvanized pipes in hot water systems has now been established¹.

Although, in general, the composition of the supply waters and the quality of the galvanizing are contributory factors, the design and operating parameters, such as average temperature, hydrostatic pressures and flow rate for the particular system, have proved to be of major importance in determining the durability of such galvanized pipes.

During the corrosion of galvanized pipes, dissolved oxygen is consumed. In circulating hot water systems the rate of corrosion and therefore the rate of dissolved oxygen depletion depends on the operating conditions, especially the hydrostatic pressures and temperatures involved.

Once the dissolved oxygen concentration falls below a critical level, the active evolution of hydrogen commences at the cathodic areas. The rate of this hydrogen evolution, and thus the rate of the anodic dissolution of zinc, is directly related to the type and concentration of minor foreign metal impurities such as the zinc/iron alloys present in the surface of the galvanized coating, which can act as cathodic areas of low hydrogen overpotential for the liberation of hydrogen.

In addition to being responsible for the corrosion of zinc even in the absence of oxygen, this liberation of hydrogen has other deleterious side-effects such as the embrittlement and blistering of the galvanized coating, especially at higher temperatures. These blisters are frequently observed and, being brittle, are easily eroded away to expose the steel substrate surface.

Under normal conditions such locally exposed steel surfaces should be protected galvanically by the surrounding galvanized surfaces. However, electrochemical potential surveys conducted on corroded hot water pipes both from Durban and the Reef revealed that a potential reversal, due to the formation of a zinc oxide film, had occurred during service, and that the bared steel surfaces had become anodic to the surrounding zinc surfaces. This intensification of the corrosion of exposed steel at gaps in the galvanized coating was observed in practice and subsequently confirmed in the laboratory.

Furthermore, where large areas of the galvanized coating had been removed by blistering or corrosion and the steel substrate bared, the presence of sulphate reducing bacteria was established both in the Durban and in the Reef hot water pipes. The galvanic corrosion of the exposed steel was therefore, due to potential reversal, and in some cases, enhanced by microbiological corrosion.

Galvanized pipes are clearly not compatible with the hot waters encountered in circulating closed systems subjected to high hydrostatic pressures. Both copper and stainless steel of the correct grade are available as alternatives.

FIBREGLASS ROTOR BLADES

The first test flights of an autogyro fitted with fibreglass rotor blades (reinforced with a small amount of carbon fibre) were carried out during October 1976. The blades were designed and manufactured by the Aeronautics Research Unit⁸ of the CSIR, using a moulding technique developed by the Unit itself. This technique ensures an accurate blade profile and very high mechanical strength. Tensile tests on a blade section complete with hub attachment showed that it could withstand a load ten times the normal operating stress without failure.

Tests on the new blades proved most successful and confirmed the advantages of fibreglass blades over conventional metal blades. The results are applicable not only to autogyro blades but equally well to helicopter blades.

INTEGRATED CIRCUITS

The production facility for integrated circuits at the CSIR was officially opened in 1976 and the first integrated circuit manufactured in wafer form early in 1977.

As a special service, the CSIR⁹ designs integrated circuits that are suitable for production manufacture. Nine such designs have already been completed on a contract basis, five of which were for a contract project undertaken on behalf of a state department, and the remaining four for an industrial organization. In the latter case, an existing subsystem was largely replaced by three integrated circuits. This reduced the number of components in the subsystem from 130 to 33, thereby considerably simplifying the manufacture of the subsystem for the company concerned, at the same time increasing reliability and reducing power consumption.

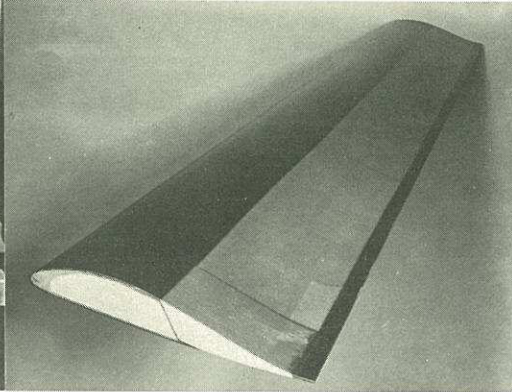
It often happens in a country like South Africa that a manufacturer requires a relatively small number — hundreds, rather than thousands — of custom-designed integrated circuits for limited production runs of a particular type of new equipment. The design cost for a custom-designed integrated circuit usually amounts to about R10 000, which is uneconomical for small quantities. The CSIR has already developed a number of design aids to help overcome this problem and to enhance the usefulness of integrated circuit production to potential clients.

Considerable success has been achieved with the 'uncommitted' integrated circuit, which is a near-standard item of which only the last production step is adapted to suit the requirements of each specific client. This reduces the direct development cost of a custom-made integrated circuit by an order of magnitude. This approach not only stimulated the design of integrated circuits at various South African universities, but set the local electronics industry thinking along the same lines. In one particular case the producer of a small electronic instrument became so much more competitive that a considerable export potential developed.

TRACING DISTURBANCES IN POWER SYSTEMS

The CSIR⁹ receives a considerable number of requests to investigate disturbances in switching and distribution systems supplying power to industrial installations. This service, rendered by the CSIR on a contract basis, consists of both investigations and the taking of specialised measurements in situ to determine the causes of such disturbances.

During the past year this service has been expanded to include a comprehensive analysis of switching and distribution systems. A recently acquired digital computer program proved a useful adjunct, for it can be used either as a diagnostic aid or to determine the effectiveness of proposed corrective measures in any given installation.



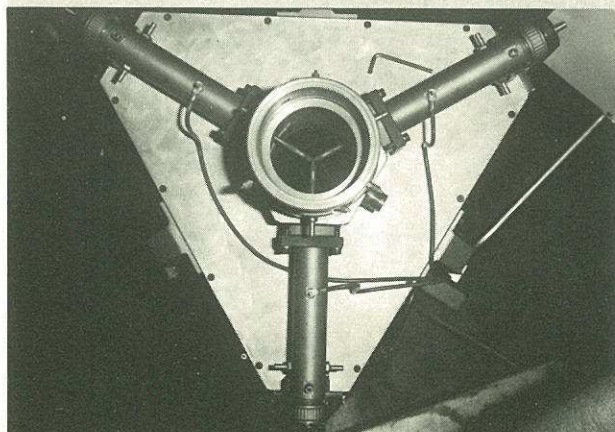
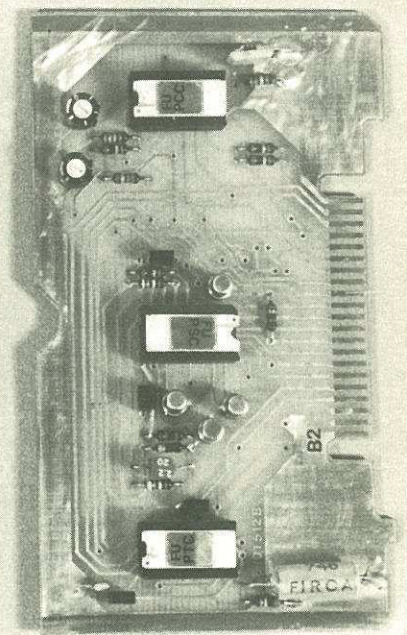
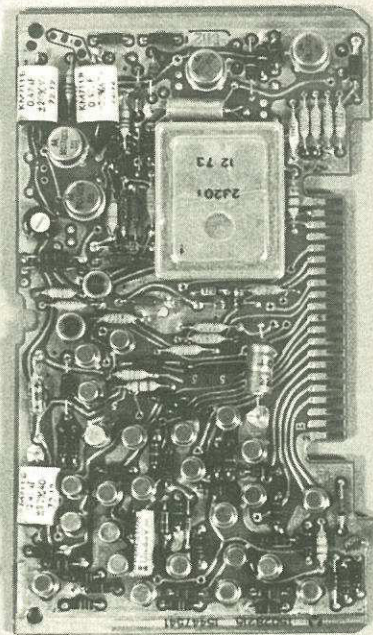
Fibreglass rotor blades (p. 24): The outer skin of a rotor blade being made up of glass fibre cloth (*top left*).

Cross-section of the fibreglass rotor blade designed and manufactured by a moulding technique developed by the CSIR (*top centre*).

Battery-driven vehicles (p. 26): Two battery-driven vehicles that are being evaluated under local conditions (*top right*).

Integrated circuits (p. 24): By using custom-made integrated circuits, the composition of the circuit board on the left can be greatly simplified, as is shown by the right-hand board on which the number of components has been substantially reduced (*right*).

Plasma reactors (p. 26): Reaction chamber (with electrodes) of a laboratory type plasma reactor (*bottom*).



BATTERY-DRIVEN VEHICLES

The CSIR⁹ has concluded an agreement with the Johannesburg-based subsidiary of a well-known electrical company and a German organization to participate in the evaluation and testing of battery-driven vehicles under local conditions.

Two vehicles, a light delivery van and a mini-bus, were delivered to the CSIR in terms of the agreement and have been incorporated in its normal transport fleet, where their performance is being carefully recorded. The loading capacity of the delivery van is 450 kg, and that of the mini-bus 1 400 kg. Both vehicles are equipped with electric drives and the batteries can be replaced in a matter of minutes by fully charged units, if required.

The two vehicles are sturdily constructed and capable of normal short-distance city travelling extending from 60 to 80 km on one battery charge, and would therefore be capable of taking over many of the duties of light delivery petrol vehicles.

PLASMA REACTORS

The CSIR¹⁰ initiated investigations into the potential use of plasma reactors (a type of electric arc reactor with ionised gas) in the upgrading of South African ores and coal.

Plasma reactors have so far only been used in a few commercial plants overseas, but may enjoy wider application in the future.

Contact with overseas organizations operating in this field led to an invitation to read a paper on plasma technology in the USA and to a lecture at the CSIR by a Canadian authority on plasma technology, which was well attended by outside organizations interested in this field.

On the strength of initial findings it was decided that the application of plasma reactions in the metallurgical field be considered by the National Institute for Metallurgy while the CSIR would look into applications for the conversion of coal.

MANGANESE DIOXIDE FOR DRY CELLS

The CSIR's research efforts in the field of manganese dioxide for small batteries (dry cells), which led to the development of the pulse galvanostatic analyser, were continued¹⁰. With this instrument the suitability of manganese dioxide ores for dry cell application can be determined rapidly and accurately, and industry avails itself of the service.

The instrument enjoys international recognition and has been put to use not only in South Africa, but also in Australia, Germany, Greece and Thailand. Due to its expertise in this specialised field, the CSIR contributes to the characterisation of manganese dioxide samples which serve as international reference materials.

The pulse galvanostatic analyser was put to use to gain new insight into the complex reaction mechanism occurring in dry cells. The presentation of this work at an international conference, and its publication in a scientific journal, was well received.

Alkaline dry cells (containing a hydroxide electrolyte) have a substantially higher discharge capacity than the less expensive normal dry cells of the Leclanché-type with ammonium/zinc chloride electrolyte, particularly when a high current is being drawn off. The discharge conditions in an intended dry cell application should therefore be considered when selecting the appropriate dry cells. A brief report was published to enlarge on practical applications.

LOCAL FOOD DEVELOPMENT

The CSIR¹⁶, in collaboration with the Research Institute for Citrus and Subtropical Fruit (RICSF) of the Department of Agricultural Technical Services, is investigating the development of the macadamia industry and the local cultivation of ginger.

Until recently macadamia nuts were imported mainly from Australia and Hawaii, but in the past few years the crop has been cultivated on a large scale in the Transvaal Lowveld and Natal. The CSIR evaluates the nut quality of new selections and has also studied processing methods, especially roasting. Research is further carried out on a more suitable method of nut grading to ensure the biggest yield of high quality roasted nuts.

Ginger is imported to a large extent for preserves and as a flavouring, and suitable plant material is being selected by the RICSF for the establishment of an industry in the Republic. The CSIR investigates suitable methods of processing which will fit in with the local product and conditions.

DIETARY PROTEIN EVALUATION: ACCURACY INCREASED

In the evaluation of protein the nutritive value of the protein component of a foodstuff is determined. This includes assessment of the digestibility of the protein and the assimilability of the digestible fraction by the body: the so-called biological value.

Information on these properties in the proteins in our diet is of considerable importance. From such information estimates can be made of the assimilable protein contents of foods, what quantity of a given food should be consumed to meet the protein needs of the individual, the present or potential assimilable protein production of the country, how such figures compare with national requirements and the extent to which the nutritive values of proteins are changed by technological food treatment.

Conventional techniques for the assessment of dietary protein value have certain serious limitations, however. From investigations made overseas and at the CSIR¹⁶ it appears that these techniques grossly over-estimate the values of certain proteins, particularly those occurring in cereal foods. For wheat gluten, for example, a value of about 50 per cent is obtained, whilst it appears from closer scrutiny that the assimilability of this protein is only about 25 per cent. The reason for the over-estimation lies in a phenomenon which, until recently, has been ignored in protein evaluation trials by workers in this field. Under certain conditions the experimental animal has the ability to set into operation certain conservational mechanisms which enable it temporarily to utilize some proteins of inferior quality more efficiently than would be possible on a long-term basis.

The CSIR has just completed an intensive study which was aimed at the conditioning of the experimental animals (rats) used in protein evaluation trials in a way that would essentially eliminate the effects of conservational mechanisms on the values obtained. The desired effect has been achieved by the inclusion in the experimental diet of a specific amino acid mixture which reduces the induction of conservational mechanisms to a minimum. Full particulars of the work are at present being documented in a monograph by the leader of the project.

A more reliable technique now furnishes the basis for a full investigation of the current status of assimilable protein production in the country.

FOOD FLAVOUR RESEARCH

In the analysis of food flavours, aromatic compounds are extracted by means of low boiling point solvents. This is usually done in a special coldroom at -30°C , but various practical problems are encountered. The CSIR¹⁶ has consequently developed and built a simple, inexpensive apparatus which can be used on a routine basis at room temperature.

An additional advantage of the new apparatus is that a larger quantity of food can be treated with a smaller volume of solvent, which simplifies the separation of the flavour components.

The flavour components in the mixture are separated by gas chromatography, using specially prepared glass capillary columns. It has been found, however, that some of the important flavour compounds — particularly those occurring in very small quantities — are adsorbed by the walls of the glass tubes and are thus never detected and characterised. The inner surface of the glass tubing was changed by using a combination of methods and was made 95 per cent inactive against the adsorption of flavour compounds. The possibility of patenting this technique is being investigated.

VARIATIONS IN SOUTH AFRICAN COTTON CULTIVARS

The CSIR¹⁷ has concluded its investigation into variations in the staple length, micronaire, and bundle tenacity of South African cotton cultivars.

The qualities of the samples used were well within the specifications laid down by the official grader. The bundle tenacity of the better quality samples was, however, somewhat below normal. It was also found that the fibre strength of 50 per cent of the 1974-75 crop (the Deltapine type) was lower than that required by local industry. It is therefore desirable for producers to concentrate on cultivars of a higher fibre strength than the Deltapine cultivar — provided that they receive financial compensation, for the Deltapine has a relatively high yield.

SIMULTANEOUS SHRINK- AND FLAME-RESIST FINISHING OF WOOL

The CSIR¹⁷ has established that the chemical compound THPOH (tetrakis-hydroxymethylphosphonium hydroxide) has the ability to render wool both shrink- and flame-resistant in a single process. Only about 5 per cent THPOH is required for shrink-resistance, while flame-resistance requires all of 25 per cent to ensure that it passes the strict United States vertical flame test after at least 25 washing cycles. Twenty-five per cent resin on wool is usually very detrimental to the handle of the fabric, but in the THPOH process the handle is virtually unaffected.

The economic advantages of such a multi-purpose treatment are obvious.

SIMULTANEOUS DYEING AND CREASE-RESIST FINISHING OF COTTON

The CSIR¹⁷ has succeeded in developing a new method for the simultaneous dyeing and crease-resist finishing of cotton fabrics. The method consists in pretreating the goods with a pehnol-formaldehyde resin to give a crease-resist finish and the subsequent coupling of a diazonium salt of the dyestuff to the resin to give a fast colour. This two-stage process can be run on a continuous basis.

The range of shades obtained by this method is at present still limited, but the simplicity of the technique and the economic advantages are creating considerable interest.

THE KNITTING PERFORMANCE OF BLENDED YARNS

With a view to its textile research programme, the CSIR¹⁷ spun wool-rich blends of polyester/wool, cotton/wool and acrylic/wool on the worsted system and cotton- and synthetic-rich blends on the cotton system.

The spinning performance of these blends was satisfactory, and the knitting performance of the resultant yarns on a circular 28 gauge single jersey machine was subsequently evaluated. The results of these tests show that the polyester-rich wool blends are best for knitting, followed by the cotton-rich blends. The acrylic/wool blends have the worst knitting performance.

The differences in performance of the various yarns can be ascribed to differences in their tenacity and extension. Polyester/wool appears to be best, followed by cotton/wool. The acrylic/wool yarns are not only poor in terms of tenacity, but are also relatively inelastic (with low extension at break).

THE SEWABILITY OF KNITTED FABRICS

The CSIR¹⁷ has now entered the making-up field by giving attention, initially, to the sewability of knitted fabrics. It is already known that in the case of synthetic knit goods the needle becomes so hot that the loops begin to melt. Poor sewability is also characterised by repeated breaks of the sewing thread.

In order to measure sewability, a commercially available sewability tester was purchased. The sewability of a large range of knitted fabrics is currently being measured, before as well as after extraction with a solvent, to study the effect of the amount of lubricant on sewability. It is already apparent that the results of this investigation

are going to be of considerable use to the making-up industry. Companies coming to the CSIR with sewability trouble have received immediate recommendations on possible solutions to their problems.

PHORMIUM PROCESSING

The price of phormium fibre was recently substantially increased. At the same time it was decided that grain bags would in future be manufactured from a blend of phormium and synthetic fibre (e.g. polypropylene). Overproduction of phormium fibre for grain bag production therefore remains a real problem and new end uses for phormium are of vital importance.

The CSIR¹⁷ has found that phormium fibre can be split, bleached and softened by a simple process using caustic soda and sodium hypochlorite. Such processed phormium can now be spun into yarns suitable for wall furnishings as well as other new uses. There is also the possibility of blending it with synthetic fabrics. These developments should be of considerable interest to the producing areas of Transkei and KwaZulu.

TIMBER GRADING APPARATUS

The TRU timber grader was designed by the CSIR¹⁸ to fill the need in industry for a reliable method of grading timber according to strength. It is the practical culmination of several years of research.

The CSIR's research on mechanical stress grading – a non-destructive test whereby the strength of a piece of timber is determined according to its stiffness – was undertaken for the first time in 1965. The results of tests on a nation-wide sample of structural timber were used as a basis to determine a series of stress grades which would enable the available strengths of South African pine to be utilised in the best possible way.

The manufacturers of roof trusses would have gained the best advantage from this work, but none of them were prepared or in a position to pay R30 000 for an imported stress grading machine. Machines of such high capacity were, in fact, unnecessary.

The first TRU Timber Grader was developed in 1971 by mechanising a simple static machine which had been designed as a control for the bigger machine. With the help of the South African Inventions Development Corporation 53 timber graders have thus far been manufactured under licence and have been sold chiefly to consumers in South Africa and Rhodesia at an average price of R1 000 each.

This method of grading is gaining ground and is becoming more established in both the stocklam and the roof truss industries. While the present type of grader works well, a new model has been developed to fulfil the ever-increasing need for increased capacity and automation.

CHEAPER STOCKLAM

In view of the recurrent shortage and ever-increasing price of imported resorcinol, which is a petrochemical product, the CSIR¹⁸ investigated alternative methods to produce stocklam beams which are fully water resistant.

A warm curing adhesive, with wattle bark extract as base, was developed, complete with a curing kiln with automatic temperature and moisture controls. This method allows stocklam and other straight laminated beams to be produced more cheaply than by the conventional cold curing methods. The adhesive is furthermore manufactured chiefly from South African raw materials.

WOODEN PALLETS

When establishing the research needs of the timber industry, the CSIR¹⁸ undertook a techno-economic investigation into the pallet manufacturing industry. Since 1972 the annual growth of this industry has been about 15 per cent, and currently about 10 per cent of the total sawn softwood production is being used for pallets.

It seems that the industry's biggest problems have been of a technical nature, and if the growth rate is to be maintained, positive marketing and promotion of the pallet systems will be necessary.

UTILISING WASTE PAPER

A study to predict the probable future use of waste paper was undertaken by the CSIR¹⁸. If the present trend continues for the next ten years, sufficient waste paper will be collected on a voluntary and industrial basis. This estimate implies an improvement in collection methods.

About 25 per cent of the paper used in South Africa is collected for re-use; by 1990 — according to the present trends — this rate will have increased to 30 per cent. The recovery of waste newsprint, however, will have to be stepped up. This will require an increase in the recovery of domestic waste paper and better co-operation between industry and large municipalities.

Approximately R90 million will have to be invested in waste paper processing by 1990 if the available waste paper is to be processed.

INDUSTRIAL RESEARCH FELLOWSHIPS

The results of the pilot scheme for industrial research fellowships, introduced in 1976, have been most encouraging. The main objectives of the scheme are to encourage manufacturers to undertake more research, to provide science and engineering graduates with research experience in the industrial environment, and to encourage academic staff members towards greater involvement in industry²⁰.

Under this scheme, interested companies propose suitable projects to the CSIR. If such a proposal is accepted as the basis for an industrial research fellowship, the company is requested to find and appoint a suitable candidate to their staff. The company is reimbursed by the CSIR with an amount equivalent to the salary the candidate would have received had he been employed by the CSIR. The progress made by the candidate is reviewed at six-monthly intervals (or more frequently if deemed necessary) by the project steering committee. The normal period of such a bursary is usually up to three years.

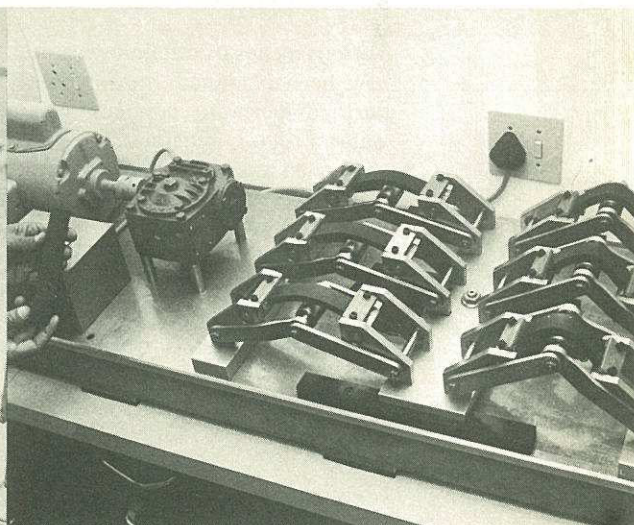
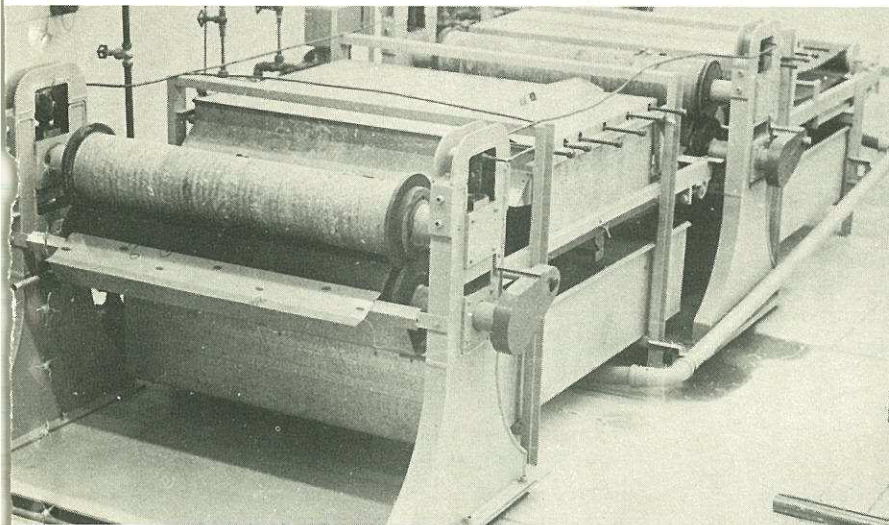
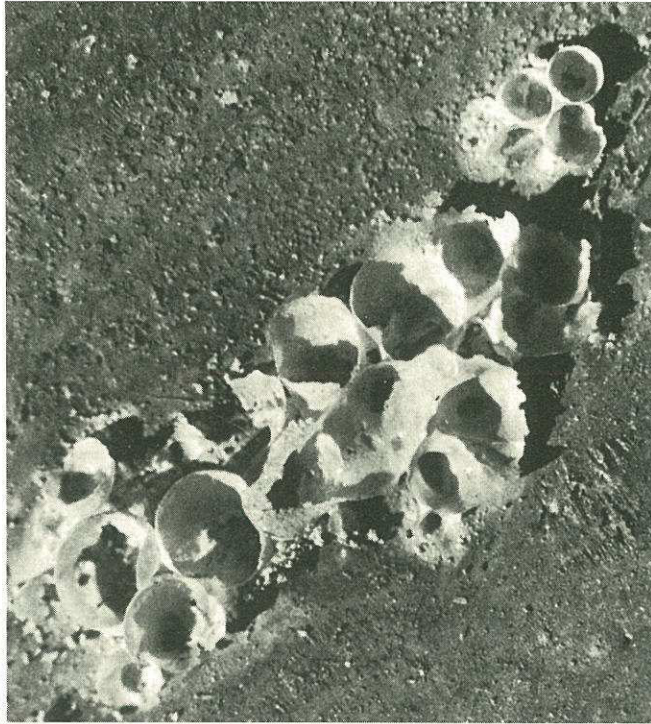
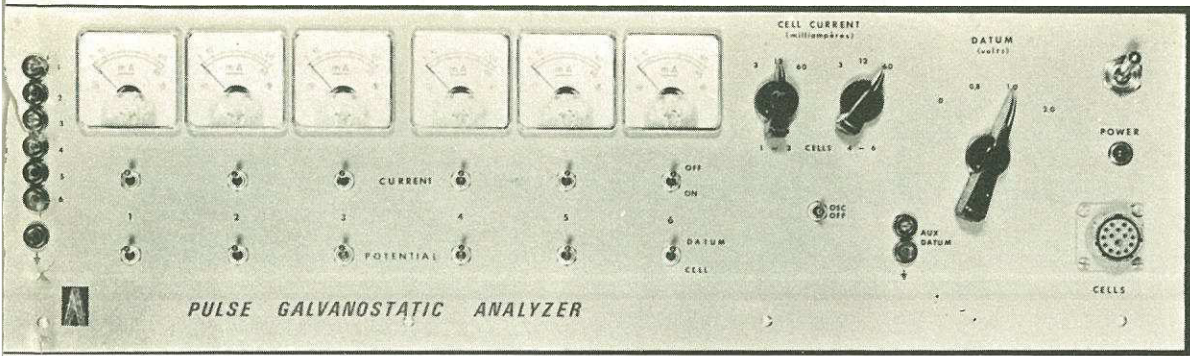
Four bursaries were awarded in the pilot scheme and in every case these arrangements proved to be entirely satisfactory. In most cases the sponsoring firms increased their commitment to the research projects, for which the CSIR contributions thus served as seed money to initiate further development. University representatives have expressed their satisfaction with the standard of work achieved and the opportunities provided for contact between their universities and industry.

The CSIR has decided, on the basis of this experience, to proceed with the scheme by awarding at least four new bursaries each year, representing a commitment of about R100 000 per annum.

INDUSTRIAL RESEARCH

The relatively poor showing of manufacturing industries both in performing and in financing research (as revealed by analyses of research expenditure undertaken by the CSIR's Group for Techno-Economic Studies²⁰, is a source of continuing concern.

Techno-economic reviews of the research needs and opportunities of the industrial sector have revealed the need for the means to determine, on an ongoing basis, trends in imports, exports, and the local market for specific products. Starting with basic and refined chemicals, the CSIR has for this purpose developed a computer program which will



Manganese dioxide for dry cells (p. 26): The control panel of the pulse galvanostatic analyser, used for rapid and accurate assessment of the suitability of manganese dioxide ores for dry cell application (*top*).

Corrosion of galvanized hot water pipes (p. 23): Corrosion product cups formed by hydrogen evolution in a galvanized hot water pipe (*centre*).

Phormium processing (p. 29): Plant designed and built by the CSIR for the washing of phormium fibre (*bottom left*).

Footwear (p. 34): Apparatus built by the Leather Industries Research Institute for conducting sole flexing tests (*bottom right*).

now be applied to other industrial materials and products as well. This will be a valuable aid in identifying key technologies, i.e. technologies which are expected to be of crucial importance during a particular phase of the development of the country. One of the more important outcomes of this approach will be that the identification of such key technologies will provide useful guidelines for the concentration of research efforts through co-operative national programmes.

CORROSION IN SOUTH AFRICAN FISH CANS

Research into fish can corrosion at Walvis Bay indicates the primary cause of corrosion to be the high chloride content of the retort cooling water, which is of the order of 500 parts per million.

This research, done by the Fishing Industry Research Institute²³, is concerned with two aspects of the problem: improving the quality of the cooling water and evaluating the use of protective can coatings.

Various means of obtaining water of better quality have been examined: one possibility is the use of purified stickwater condensate as retort cooling water. Fish oil, mineral oils and castor oil have all been tried as can coatings and were shown to be effective in reducing corrosion. Experimental work is directed towards methods of application and involves the use of emulsions, spraying, and solvent wetting of the cans. The project has now reached the stage where pilot scale operations can be adapted to factory working conditions.

NEW USES FOR ROCK LOBSTER

Considerable quantities of rock lobster waste are commercially recoverable after the meat is mechanically deboned. Two products can be prepared from this waste: a pink pigment concentrate and chitin, the structural material that holds the shell together.

Rock lobster waste contains fat, protein, chitin and probably carotenoid astaxanthine, the pigment responsible for the pink colour in krill, coral, flamingo feathers and salmon. Salmon farming is a thriving industry in America with a price improvement of up to two dollars per kilogram for pink as compared to white salmon. In their natural habitat the salmon derive their customary pink colour from their diet. In artificial feeding the pigment is derived from red crab shells and euphausiids. The Fishing Industry Research Institute²³ has recently conducted exploratory research to determine whether the pigment can be extracted from South African rock lobster shells. Chitin is insoluble in water and all organic solvents and has properties similar to cellulose. Chitosan, closely related to chitin, is a modified natural carbohydrate polymer that forms ionic bonds and films resistant to the transpiration of water vapour. Chitosan is non-toxic and biodegradable. Specific applications of chitin and chitosan range from their use in improving the wet strength properties of newsprint, to being employed as an additive in baby food and a biodegradable moisture-proof package coating for cigarette box wrappings.

PET FOOD FROM UNDER-UTILISED FISH

Due to the reduction in recent pilchard catches, pet food made from minced headed and gutted pilchards is becoming increasingly scarce and correspondingly more expensive. To fill the gap created by the current pilchard shortage, trial packs of pet food have been prepared from maasbanker and anchovy as well as from under-utilized white fish²³.

Preliminary tests were carried out at Onderstepoort on canned whole anchovy which was fed to a fairly large group of cats. The results proved promising as the product was well accepted.

In another test carried out by one of the largest pet food firms in the USA, a fatigue test proved satisfactory in that there was a fair average daily consumption of the product without apparent loss of appetite. On the adverse side, however, the product was not rated very high in palatability when compared with certain other pet foods already on the American market.

To improve the appearance of the local product, gelling agents have been used to bind the free liquid so that the fish turns out of the can in an attractive moulded loaf form.

HIDE AND SKIN PRESERVATION

Due to the fact that the salt used in conventional hide and skin curing causes pollution, the need for effective substitute preservatives is becoming increasingly urgent. The Leather Industries Research Institute²⁴ is engaged in a large-scale evaluation of commercial and other biocides which may be suitable for short-term hide and skin preservation. Laboratory studies using antiseptic mixtures with moderate reactivity towards hide protein have pinpointed a number of treatments for field evaluation. Preliminary trials gave indication of satisfactory hide storage for periods up to 4 weeks, and extended trials are under way to assess the effects of antiseptic pretreatment of hides on final leather quality. This process involves changes in established forms of raw material, and is essentially a gradual development requiring attention to a number of factors such as marketing, raw material handling, hide and leather quality, and the pollution aspect.

Other research, done in collaboration with the Department of Microbiology at Rhodes University, has led to the development of a simple and sensitive laboratory procedure for the identification of collagenolytic (or hide-destroying) bacteria in mixed bacterial populations encountered on hides. Methods of detection and estimation of these bacterial types are of particular importance to the leather industry in its quest for improved methods of controlling the damaging effects of the bacteria.

POLLUTANTS IN TANNERY EFFLUENT

In an attempt to curtail leather effluent pollution, the Leather Industries Research Institute²⁴ has developed an effluent-free hair-saving unhairing system. It has also investigated the problem of clarifying hair-burning unhairing liquors for recycling. This involved a study of salt transfer from the soaking process and the consequent build-up of salt in recycled unhairing liquors. The maximum amount of salt acceptable in a standard hair-burn liquor was accordingly established.

Methods have also been developed for recycling chrome tanning liquors in the production of upper leather, while a single and a double colouring vat system has been successfully incorporated in a closed Liritan process for the manufacture of sole leather. The problems associated with high iron contamination of chrome tanning salts on wattle retanned leather were overcome by sequestering the iron with a strong complexing agent before retannage.

Significant progress has been made with the handling of liquid effluent from fellmongering and tanning operations through the construction of two effluent treatment pilot plants in terms of contracts signed between the Water Research Commission, the Leather Industries Research Institute and the industries concerned. This operation clearly shows how well research and development organizations can co-operate with industry on the solution of industrial production problems.

The first phase of the study established optimum parameters for biological treatment through the use of activated sludge and tannery and fellmongery effluent. Laboratory studies were also started on sludge removal from liquid effluent and on sludge conditioning prior to removal. The design, chemical, and biological data being accumulated in this work will have a significant economic impact on industry by reducing the cost of designing effluent treatment plants.

FOOTWEAR

Since modern footwear production methods rely heavily on adhesives, the Leather Industries Research Institute²⁴ has devoted considerable time to a study of the wide range of materials (leather, synthetics and fabrics) being used in present-day footwear manufacture and the different adhesives required to bond them.

One of these projects involved the vapour cleaning of PVC sole units, prior to the application of the adhesive, to remove surface contaminants such as migratory plasticisers, oil and grease. The current method of manual solvent wiping is inefficient, with inconsistent results.

In another project, the correct design of moulds for the preparation of thermoplastic rubber sole units was studied in conjunction with the selection of suitable adhesives.

With the wide variety of man-made materials used in the production of both soles and uppers, and the many different sole pattern designs available, the Research Institute is conducting research into the slip resistance of the various materials in order to determine the sole design best suited to each.

THE PRESENCE OF SOIL IN CANE AND BAGASSE

It is well known that excessive quantities of soil in sugar cane entering the factory have a detrimental effect not only on preparation and extraction equipment (including boilers) but also on the processing operation. As no practical method was available to determine the degree of contamination, an ashing method was developed in which the ash content of a shredded cane or bagasse sample could be used to determine soil content²⁵. A representative sample must have a mass of at least 50 g, which determines the size of the dish, and to limit ashing time the incineration temperature should be high enough to ash the sample completely within one hour. This was found to be 800 °C. Of the various dish metals tested for their stability at this temperature, stainless steel (type 316) proved most promising.

In tests to compare this new method of ashing with the more time-consuming micro laboratory method the new method gave a consistently higher reading. The discrepancy was traced to the loss in mass of the metal container itself. A vitreosil basin of type B11 was then used and found to be adequate, but the temperature of incineration had to be raised to 850 °C to achieve complete ashing within an hour. Preliminary comparative tests between the micro laboratory method and this new method showed the two to have similar accuracy, with a precision of approximately 7 per cent.

MELT PHOSPHATATION IN SUGAR MILLING

The Sugar Milling Research Institute²⁵ investigated the extent to which the phosphatation-flotation refining process removed impurities from the raw sugar melt in the sugar production process. Provided the process was run at a favourable air to solids ratio, an almost clear liquor was produced. The removal of colour was, on average, 25 per cent while 10-15 per cent gums and about 30 per cent starch were eliminated. In contrast to refinery carbonation, the removal of ash in the phosphatation process was negligible.

The phosphate content of the clear liquor either remained as in the raw melt or else showed an increase. Chemical analyses showed that this increase was caused by the presence of starch. In addition, the filterability of clear liquor samples showed a progressive deterioration with increasing phosphate concentration. It would thus appear that starch is capable of preventing a small fraction of the phosphate particles formed in the process from participating in the coagulation reaction prior to flotation.

Tests were carried out to determine what effect the addition of varying amounts of amylose and amylopectin (the main components of starch) to a raw sugar melt would have on the phosphate content of the clear liquor. From these results it would appear that amylopectin is the compound responsible for the deleterious influence of starch. Interaction between amylopectin and calcium phosphate particles involves chemical bonding between the particle surface and the phosphate ester groups on the long, branched-chain amylopectin molecule. In this manner, the amylopectin stabilises the small crystallites in suspension, resulting in clear liquor with a high phosphate content and a low filterability. The uncharged nature of amylose apparently makes it unsuitable as a protective colloid.

The removal of impurities by the conventional phosphatation process can be improved by the use of certain cationic surfactants which enhance the removal of colour and starch, improve the filterability and lower the phosphate content of the clear liquor. A study of the effects of these cationic surfactants on a raw sugar melt with a high starch concentration nevertheless indicated that, in spite of the above improvements to the clear liquor, the surfactants could not reproduce the quality of liquor yielded by a corresponding melt with a low starch concentration.

Promotion of general welfare

MATHEMATICAL MODELS FOR MANPOWER PLANNING

Large organizations often have a hierarchical structure in which each rank implies a level of seniority, and an officer of a given rank is in a position of authority over lower ranks. In such organizations the rate of promotion is of importance: on the one hand promotion which is too slow leads to frustration, whereas too rapid promotion, on the other hand, may result in incompetence through insufficient experience.

While psychological and other aspects obviously have to be taken into account in solving these problems, it is in the case of large organizations possible to create a mathematical model of the average effect of recruitment, promotion and retirement policies. Two such models have been developed for the South African Defence Force and are now being tested³. When these models are in use, they will assist planners by giving them, for instance, an indication of the effect that immediate measures, taken to fulfil short-term requirements, will have on the behaviour of the organizational structure in the long term.

SOLAR ENERGY FOR AIR CONDITIONING

A large portion of energy consumed in modern buildings is used for air conditioning.

Solar energy can be utilised to provide heating and cooling for year-round air conditioning systems. Such systems do not require refrigeration compressors and, with the exception of fans and pumps, can be powered entirely by solar energy.

The CSIR⁸ has designed and installed an experimental solar air conditioning system with a view to testing and evaluating its performance under actual operating conditions. This type of system is expected to provide acceptable indoor environmental conditions in most areas of the Republic, and to have an annual energy consumption some 50 per cent below that of an equivalent conventional air conditioning system.

The system makes use of a drying process and subsequent evaporative cooling as a means of conditioning the air. In the drying stage, liquid absorbent is sprayed into the air stream. A cooling coil, with cooling tower water inside the tubes, prevents the temperature of the air from rising as a result of the heat generated during the drying process. In the evaporative cooling stage, cooling down to about 12 to 14 °C is achieved by the evaporation of water into the air stream.

By varying the relative efficiency of the drying and evaporative cooling stages, independent control of space temperature and relative humidity is possible.

After absorbing moisture from the air, the absorbent has to be regenerated. This is done in solar collectors where water is evaporated from the hot absorbent.

Winter space heating is accomplished by spraying solar heated absorbent directly into the air stream. Water heating for domestic or industrial purposes can be incorporated in the system at little extra cost.

SOFT FLOOR COVERINGS IN HOSPITALS

The use of soft floor coverings in hospitals can be advantageous for various reasons. The most important of these is the absorption of noise to ensure more comfortable conditions for patients and staff. Because there is a lack of applicable experience and research information, the CSIR¹¹ has studied the advantages and disadvantages of soft floor coverings.

An extensive series of practical tests was introduced at the H F Verwoerd Hospital in Pretoria and attempts were made to correlate the results with laboratory tests. A wide variety of floor coverings was used in the hospital experiment and it was found that soft carpetlike floor coverings soon became unattractive through stains and cleaning problems. In addition it was found that the advantages of these materials in absorbing the noise of footsteps and trolley wheels

were offset by the noise made by the cleaning apparatus. These machines make more noise than polishers with revolving brushes used for cleaning vinyl floor finishes. Floor finishes also have no effect on the clatter of crockery on trolleys.

A further aspect, not arising directly out of this experiment but nevertheless relevant to the selection of floor coverings, is the fact that heavy apparatus, such as X-ray units, is not easily moved over soft floor coverings.

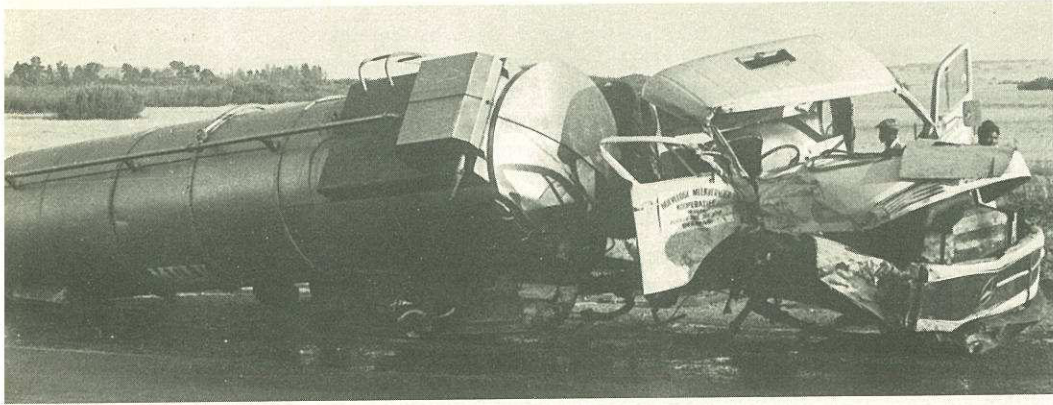
The use of soft coverings can therefore not be recommended without reservation, because consideration has to be given to such factors as appearance in use, ease and efficiency of cleaning, aspects of sound absorption, and durability.

SIDE-EFFECTS OF HERBICIDE IN HARTBEESPOORT DAM

The South American water hyacinth which has become established on Hartbeespoort Dam would become an even greater nuisance should it succeed in covering the whole surface of the dam. The Department of Water Affairs therefore decided to kill the weed with a herbicide spray.

The CSIR¹², in collaboration with the Hydrological Research Institute of the Department of Water Affairs and with financial support from the Water Research Commission, has started a research programme to monitor, first of all, the effects of the herbicide on non-target organisms and, secondly, the effects of the decay of the water weed on the ecosystem.

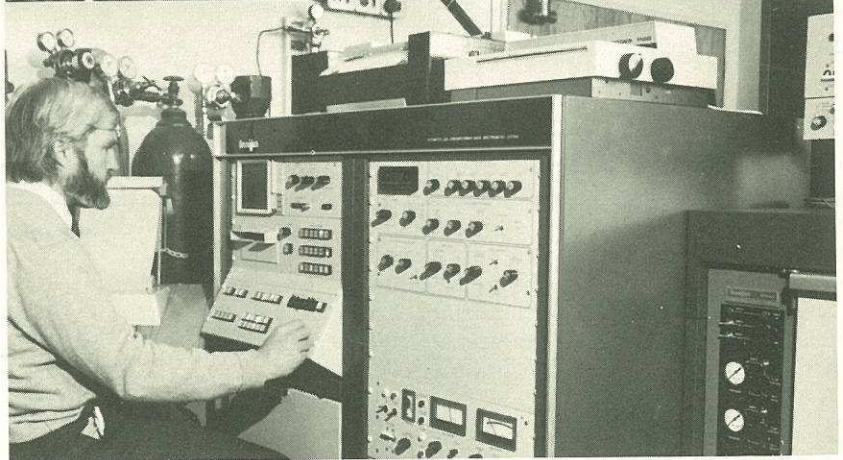
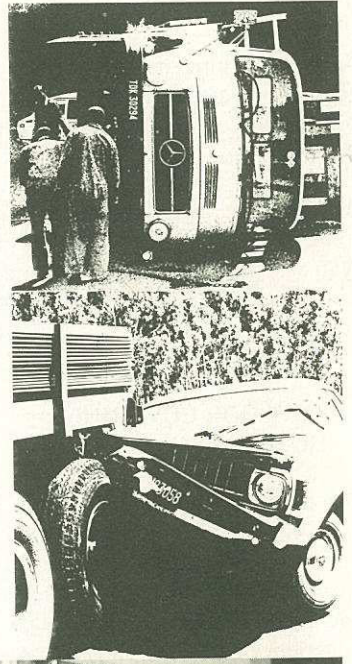
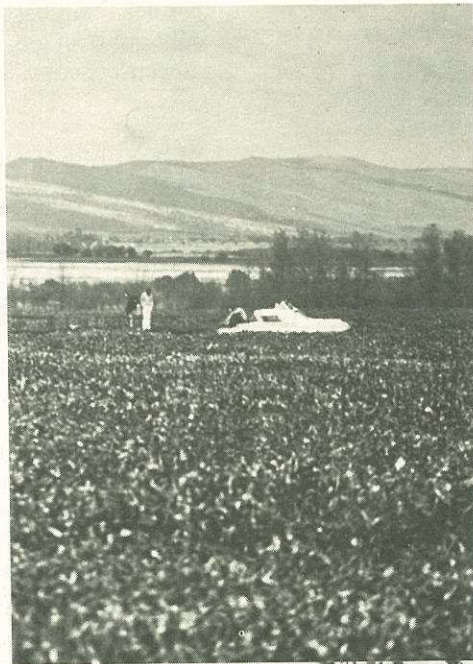
With the assistance of the South African Bureau of Standards, herbicide levels will be measured in the water and in the fish. Ecosystem effects will be monitored before the application of the herbicide and probably for about three months afterwards. A particularly close watch will be kept on dissolved oxygen levels in the dam.



On-the-spot accident investigations (p. 39): In recent years a large number of accidents were investigated in Pretoria, Durban and Cape Town, with special attention being paid to the three main accident components, namely the person, the road and the vehicle (*top*).

Side-effects of herbicide in Hartbeespoort Dam (p. 37): A research programme has been started to monitor herbicide effects on non-target organisms and the effects of water hyacinth decay on the ecosystem (*right*).

Air pollution research (p. 40): Analysis of organic pollutants from car exhausts and industrial processes (*bottom*).



The herbicide is a registered compound and as such its direct toxicity to man and a number of other living organisms is known. The particular importance of this study is that it will provide data on the direct and indirect effects of the herbicide under field conditions. This information will obviously be pertinent in defining guidelines and a code of practice for the future use of herbicides in hyacinth control.

ON-THE-SPOT ACCIDENT INVESTIGATIONS

On-the-spot accident investigations carried out by the CSIR¹³ over a period of about 10 years in and around three urban areas in the Republic were recently terminated. During this time 526 accidents were investigated in Pretoria, Durban and Cape Town, with special attention to the three main components in any accident, namely the person, the road and the vehicle.

There appears to be a definite pattern of occurrence with the following as the most important contributory causes of accidents:

- Excessive speed was a contributory factor in about one-third of the accidents. Drivers often drove too fast for the traffic situation, although they may or may not have been exceeding the speed limit.
- Insufficient driver training was reflected in the drivers' lack of driving skill in dangerous situations and their inability to predict traffic situations correctly.
- The influence of alcohol on drivers is an important contributing factor to road accidents in South Africa.
- In nearly 90 per cent of the accidents investigated one or more traffic offences had contributed to the accident.

JOB GRADING AND TEST INSTALLATION SYSTEM FOR SMALLER ORGANIZATIONS

In view of the need for a general system of job grading and test installation, the CSIR¹⁵ attended to the development of a rapid and inexpensive method suitable for introduction by an industrial organization itself. Existing systems were either too costly, labour-intensive and time-consuming or not scientifically acceptable after adaptation for general use.

The new method had to satisfy two requirements. First it had to offer a satisfactory solution where the size of the organization or other factors excluded all other systems, in which case it would be the only general programme. Secondly, it had to be the logical first stage for organizations that would subsequently require additional and more advanced programmes for personnel placement and development.

The system was designed to allow the grading of jobs against sample jobs chosen to represent selected levels of complexity. The choice of selection test, the calculation of norms for the organization in question, and the determination of cut-off points on the range of test scores for each grade of job complexity, are all explained in an accompanying manual.

In this way a rational system is made available to organizations which are not in a position to spend large sums on job grading and test installation. The high costs associated with such systems are eliminated by the functional and streamlined nature of the new system.

Even at this early stage the results indicate a promising future for the new system in personnel placement. It covers occupation levels from labourer to foreman, clerk or artisan. Since it contains the same industrial psychological principles as the CSIR's job evaluation system for posts of a higher level, the two systems can be readily combined to cover the entire spectrum of occupation levels.

DISTRIBUTION OF PSYCHOLOGICAL TESTS

Soon after its foundation in 1946 the National Institute for Personnel Research¹⁵ began its development of psychological tests for the classification and selection of personnel in the industrial sector.

It was soon realised that the use of certain tests should be restricted to qualified persons. The classification system of the American Psychological Association was therefore adopted and adapted to control the distribution of tests to ensure that they were correctly used and for the right purposes and that they did not lose their validity through unnecessary exposure.

During the past decade sales of psychological tests have greatly increased and the Institute remains one of the two largest distributors in the country.

The control of tests was simplified by the introduction of registers of psychologists by the South African Medical and Dental Council. Registration of clinical, counselling, industrial and research psychologists has in terms of Act 56 of 1974 become compulsory. The Act provides for the use of prescribed tests to be restricted to registered psychologists.

The need for more specific definitions of the different classes of tests resulted in the establishment of the Test Commission of the Republic of South Africa, consisting of representatives of the CSIR and the Human Sciences Research Council. Shortly after its establishment the Test Commission was acknowledged by regulation as the organization to advise the Professional Board for Psychology on psychological tests. A combined register of test users registered by the two organizations is now being compiled and will be computerized.

It is within this framework that tests are now made available for use by psychologists, psycho-technicians and persons trained by the CSIR¹⁵ to use achievement tests. The steadily increasing demand for tests shows that this service to industry is regarded as a valuable contribution to the more efficient use of the manpower of the country.

AIR POLLUTION RESEARCH

Until April 1965, air pollution research by the CSIR²⁷ consisted, in the main, of the collection of information on the state of pollution in South Africa, the expansion of the national network for the determination of smoke and sulphur dioxide, and the first mesoclimatic studies of local areas with an eye to future planning. The initial emphasis was on monitoring. This function, which is regarded by some as a mere routine task, serves an important purpose, for without it the authorities would not know how effective their control measures are. In a broader sense monitoring serves as a barometer of the impact of technological developments on the environment.

In 1965 the Air Pollution Prevention Act was promulgated. This act makes provision, at various levels, for the control of pollutant emissions which result from the activities of industry — most frequently involving the use or generation of energy. Although legislation of this nature may well be applied through confrontation, the consultative approach is preferred in South Africa, by reason — amongst others — of the emphasis placed on the use of the best available technology. This approach is in marked contrast to that of the USA, where the emphasis is placed on control through the establishment of clean air standards which may under no circumstances be exceeded. Such control frequently results in confrontation and its concomitant expenses.

From an industrial point of view the control of pollutant emissions is an expensive and unproductive process. To facilitate sober and realistic decisions and guidance on such control, it is essential for the necessary knowledge and expertise to be locally available — hence the CSIR's sustained activity in this vital field of environmental research.

Transfer of scientific and technical information

FIRE SAFETY RECOMMENDATIONS FOR HIGH-DENSITY SCHEMES

In high-density housing schemes, with their increasing number of dwellings per unit area, one can no longer depend on the distance between separate buildings to prevent the spread of fire.

In the planning stage attention should be given to the positioning of dwelling units and other buildings in relation to one another and to the approaches to and routes within the development. The placing of fire hydrants and other fire equipment and the amount of water and water pressure required for fire control, as well as the choice of materials for the construction of buildings and their effect on overall fire safety, should also be considered.

Investigations have shown that, particularly in the case of large schemes, provision for the access of fire engines is largely inadequate¹¹. Recommendations in this respect have been made to the authorities.

Further surveys of the water requirements for fire fighting have led to a recommendation that a minimum water flow of 900 litres per minute per hydrant be ensured for three hydrants simultaneously. In the past the water supply was designed to provide this flow for fire fighting over and above the maximum domestic water requirement.

If, however, the water reticulation network is designed so that those parts of the development that are not threatened by fire can be shut off, it will only be necessary to make provision for the greater demand, whether for maximum domestic use or for fire fighting. This allows savings without sacrificing safety.

CONFERENCES ON WATER

Through its close association with the International Association on Water Pollution Research (IAWPR) and the International Water Supply Association (IWSA), the CSIR¹² continues to play a leading role in both local and international water forums.

At the 8th International Conference of the IAWPR, held in Sydney, four papers were read by CSIR staff members.

In June 1977, the South African and Israeli National Committees of the IAWPR held a specialised conference in Johannesburg on Advanced Treatment and Reclamation of Wastewater. The CSIR was intimately involved in the organization of this conference, which attracted some 50 overseas delegates out of an attendance of 250. Sixteen of the papers were presented by members of the CSIR staff.

During September 1977, the Director of the National Institute for Water Research presented two more papers: one at Essen, at the IAWPR's specialised conference on River Basin Management, and one in London at a symposium on New Processes of Wastewater Treatment and Recovery, arranged by the Society of Chemical Industry.

Two scientists from the CSIR were invited to present papers on water research at the Third Iranian Chemical Engineering Conference held in Shiraz during November 1977. One of them also attended a symposium on water reclamation in Tehran. It was made clear that Iran has urgent need of the CSIR's expertise in the field of water research.

SYMPOSIUM ON TIMBER HARVESTING AND TRANSPORT

A symposium dealing with the harvesting and transport of roundwood timber was held by the CSIR¹⁸ in Durban on 14 and 15 February 1977. It was well attended, amongst others by delegates from overseas. This was the first symposium of its kind to be held in South Africa and it filled a long-felt need, especially in view of the rapid development in this field overseas. The problems confronting the industry were identified.

TERMINOLOGY

By dint of its activities, the CSIR is often required to make a contribution to scientific and technical terminology, particularly in providing Afrikaans equivalents for foreign technical terms. A noteworthy fruit of this function was the publication in 1973 of the CSIR's bilingual list of textile terms²⁰ which was subsequently revised and substantially enlarged. The new *Textile Dictionary* with 21 000 entries (English-Afrikaans and Afrikaans-English) is due to appear in the near future.

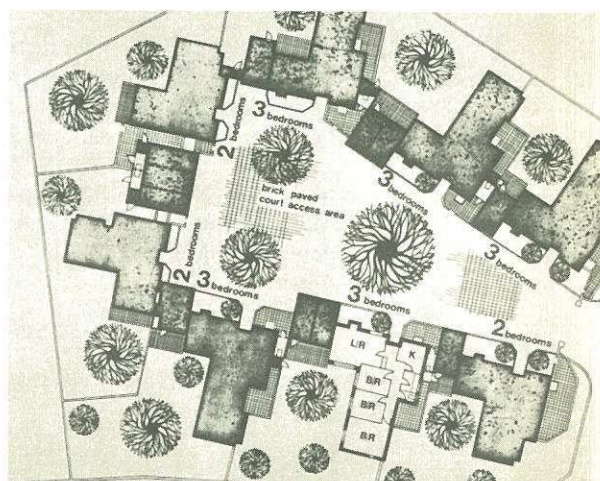
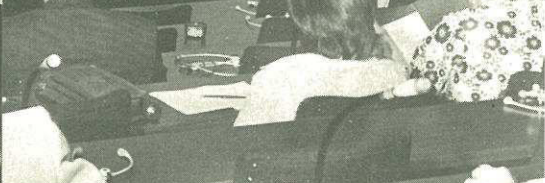
The CSIR's activities in the more general field of technical terminology, stemming as they do from its research and publishing activities, are aimed at co-ordinating the creation by its own staff of new scientific and technical terms. The project may in due course be integrated with the computerized national terminology bank being planned by the Terminology Bureau of the Department of National Education.

The scope of this terminology project was recently further expanded by the establishment of an interpreting service for CSIR conferences.

INTERPRETING SERVICE

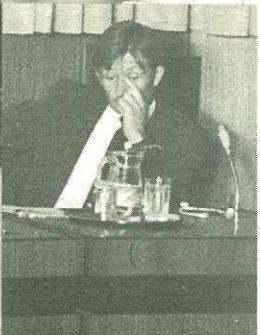
An interpreting service has been established to interpret the proceedings of CSIR conferences — particularly those in the new CSIR Conference Centre — from Afrikaans into English²⁰. For both practical and economic reasons, freelance interpreters will be extensively employed; to this end the CSIR is indirectly involved in the establishment of a freelance pool.

To comply with international conference requirements, simultaneous interpreting facilities for four separate languages (in addition to that of the speaker) are provided at the Conference Centre. The CSIR places these facilities at the disposal of outside organizations, subject to certain conditions, and can assist on such occasions by providing the services of interpreters for the required language combinations.



Fire-safety recommendations for high-density schemes (p. 41): In cluster-house designs the provision of access roads for firefighting vehicles is critical. Courtyards must be paved and be capable of supporting heavy loads, while the placing of fire hydrants is also important. Where there are common roofs over dwelling units, the space under the roofs must be divided by fire-resistant partitions above the party walls (top).

Conference services (p. 44): The new CSIR Conference Centre comprises three well-equipped auditoria — one to seat 450 people, with stepped floor, another of the same type designed to seat 150, and one with a level floor, which seats 100 people (left).



CONFERENCE SERVICES

The CSIR not only arranges its own conferences, but also provides conference services to organizations involved with the CSIR and, in certain cases, to outside industrial bodies.

During the twelve-month period between October 1976 and September 1977, conferences on the following subjects were held throughout the country:

- non-conventional coatings;
- practical training of electronics technicians;
- rock mechanics;
- harvesting and transporting timber;
- bio-engineering;
- advanced treatment and reclamation of waste water;
- pre-cambrian stratigraphy;
- new developments in fabric manufacture;
- chromatography;
- plastics in the service of man.

Particular attention was given to the planning and use of the CSIR Conference Centre, and a new division created to take charge of the Centre's management.

VISITORS

There has been a significant increase in the number of visitors to the CSIR during the past year. Compared to a total of 1 800 in the previous year, approximately 2 500 visitors were this year received by the Liaison Division of the CSIR. More than 170 of these were either from abroad, or had come with a particular purpose in mind.

REGIONAL RESEARCH LIAISON COMMITTEES

The CSIR's regional research liaison committees for Natal, South West Africa, the Eastern Cape and the South Western Cape meet once a year to review CSIR research in these regions²⁰. Much of this research is sponsored by agencies of the central and provincial governments and by major municipalities, and is, in one way or another, concerned with regional development.

Although individual projects are reviewed by project steering committees, they are interrelated and it is found useful to review them jointly once a year with representatives of all the authorities directly or indirectly concerned, in order to ensure that there is no conflict of interests.

LIBRARY AND INFORMATION SERVICES

Further progress has been made with the various information services provided by the Centre for Scientific and Technical Information²¹, in spite of a levelling off in the number of subscribers to some of these services, which is due mainly to the limited number of available personnel and the general economic situation. The total number of subscribers comprised well over 500 industrial firms and over 1 100 'interest profiles' from individual scientists and engineers. These information services resulted in an appreciable increase in the use of library services.

Apart from a literature current-awareness service and a field liaison service to industrial subscribers, special computerized information services are provided to individual scientists and engineers. These specialised services are based on the so-called bibliographic data bases which contain in magnetic tape or disk form, the same bibliographic references to the latest scientific literature as are mentioned in printed scientific indexing and abstracting journals. When the fields of interest of individual scientists are known, it is possible, by means of the computer, to retrieve from the magnetic tapes or disks those literature references that fall within such fields of interest. This can be done for both current and retrospective literature searching purposes.

Although the computerized literature current-awareness services (also known as selective dissemination of information because they are tailored to individual needs) have been provided locally since 1973, a computerized on-line retrospective literature searching service became operational locally only in 1976. It has already proved to be very popular.

While this service is based on a few bibliographic data bases that are held on disk at the CSIR Computing Centre (covering only a small number of scientific and engineering disciplines) it is now possible to search a large number of bibliographic data bases, covering a wide spectrum of scientific and technical fields, in North America and Europe. This is done via long-distance telephone links, using a teletype terminal.

In order to provide the particular information required by those active in the field of water research, a South African Water Information Centre was established a few years ago. Good progress has been made by this Centre, which is operated on contract to the Water Research Commission.

In the same way that leading literature indexing and abstracting publications publish their bibliographic data bases, large national libraries in the USA and UK put their new book catalogue information on magnetic tape for the benefit of other libraries. Ideally, this should lead to a situation whereby every book is only catalogued once, instead of many times over by individual libraries. This is known as the MARC (MACHINE Readable Catalogue) system, in which South Africa participates.

Under the aegis of the National Library Advisory Council, the CSIR has played the leading role in applying the MARC system in this country.

The project is devoted to an investigation of the possibilities of establishing a collective cataloguing system as part of a national computerized library network. If successful, such a system may ultimately result in appreciable library manpower savings. In the interim the CSIR provides certain MARC cataloguing services to interested libraries on a subscription basis.

The rapidly escalating prices of books and journals, the temporary 15 per cent surcharge on imported goods, and budget limitations have all resulted in a difficult library situation. Unfortunately, fairly drastic cuts in journal subscriptions and book purchases had to be made.

Support of research at universities

THE LIMNOLOGY OF THE ORANGE RIVER SYSTEM

The Institute for Environmental Sciences of the University of the Orange Free State gives special attention to the Orange River system, including the limnology and catchment area of the H F Verwoerd Dam (which includes the high mountain area in Lesotho) as well as the limnology of the P K le Roux Dam.

It was determined that the bogs (or 'sponges') which occur above 2 500 m in the Lesotho mountains and which are about 8 000 years old filter the rain and run-off water. The water leaving the sponges is somewhat acid and low in plant nutrients. Excessive grazing of these sponges leads to their erosion and decreases their ability to retain silt and water, thereby contributing to the siltation of the large impoundments.

The hydrochemistry of the feeder streams of the Verwoerd Dam (the Kraai, Caledon and Orange Rivers) shows significant variation between wet and dry seasons. Mechanical erosion in the catchment areas increases the silt content of especially the Caledon River during wet seasons. The concentration of dissolved solids in the rivers is highest during the dry seasons. The high magnesium content in particular results in water that is less suitable for the irrigation of certain soil types.

The water of the Verwoerd Dam is highly turbid, owing to a high silt loading, which influences the whole ecosystem of the impoundment. Light penetration is much reduced, with a decrease in photosynthesis, and dissolved ions are strongly adsorbed by suspended clay particles. The low phosphate concentration of the water indicates that the impoundment is not unduly polluted. The chemical composition of the water in the P K le Roux Dam is chiefly determined by the inflow from the Verwoerd Dam rather than by the tributaries between the two impoundments.

This investigation clearly indicates that more attention should be given to the exact role of suspended silt in South African impoundments.

PLANT AND BACTERIAL POLYSACCHARIDES

The research programme of the Carbohydrate Chemistry Research Unit at the University of Cape Town includes a study of the chemical structure of acacia gums, which are of importance to the mining, pharmaceutical and food industries.

Although the gums produced by the various acacia species all consist primarily of galactose and arabinose, certain structural variations have been discovered. These variations are of value in the botanical classification of the wide variety of acacias occurring in South Africa.

Research has demonstrated that acacia gums, which are made up of complex chemical compounds, have highly uniform molecular structures containing certain 'repeating units'. The nature and degree of this regularity may have a bearing on the greater efficiency of particular gums in particular applications, such as the flotation process used in mining.

The Carbohydrate Chemistry Research Unit has also been involved, since 1971, in an international project involving the elucidation of the structures of the immunologically significant polysaccharides associated with *Klebsiella* bacteria, some of which cause particularly severe infections of the respiratory and urinary tracts. The variations in characteristics of the polysaccharides occurring in the cell walls of the different strains of *Klebsiella* — of which there are more than eighty — may facilitate identification of these strains.

A major contribution by the Research Unit to the study of polysaccharides is the development of analytic techniques to reveal the structure of the short sequence of linked sugar units which make up the polysaccharide molecules. These techniques have now been applied with equal success to a *Cryptococcus* polysaccharide isolated from meningitis patients.

MATHEMATIC MODELS OF HYDROLOGICAL SYSTEMS

Simulation of the behaviour of a hydrological system, whether a watershed, river, swamp or bay, and whether in its natural state or as affected by human interference through land use, damming, dredging, harbour construction or the like, contributes significantly to the design and operating efficiency of proposed constructions.

For this reason the Hydrological Research Unit at the University of the Witwatersrand has been developing watershed models of varying degrees of sophistication with which to determine time graphs of the streamflow at problem points in almost any catchment in South Africa.

One of these models, simulating the Jukskei River catchment north of Johannesburg, was tested against the well-known United States Stanford Watershed Model. The results were highly favourable to the model developed by the Research Unit.

In addition, the mathematic watershed model provides the basic input for several other models under development, such as St Lucia Bay and Richard's Bay, as well as flood plain management at Vereeniging and in the Natal sugar cane areas, flood gate control at the Vaal and Hartbeespoort Dams, and water circulation in the Pretoria-Witwatersrand-Vereeniging Complex.

COSMIC RAY RESEARCH

Cosmic rays are particles (mostly protons) of high energy (up to 10^{21} electron volts) which arrive at the earth from our galaxy and from the sun. These particles carry with them information on the structure of and reactions within our Galaxy and Solar System. The Cosmic Rays Research Unit at Potchefstroom University investigates these phenomena, including the eleven year solar activity cycle which is also manifested on earth, the Van Allen Radiation Belts (consisting of low energy particles trapped in the dipole magnetic field of the earth) and secondary particles produced by the collision of cosmic rays with molecules and electrons in the earth's atmosphere.

The Research Unit operates four neutron monitors which produce a continuous record of the variations in cosmic ray intensity brought about by variations in solar activity. These neutron monitors are located at Sanae in the Antarctic, and at Hermanus, Potchefstroom and Tsumeb. Although they form part of an international network of approximately one hundred monitors, these four are the only ones to cover the extensive region between South America, Australia, the Antarctic and Europe.

In addition to the data received from these four stations, sea and air surveys are occasionally conducted in collaboration with Safmarine, the South African Air Force and the South African Airways. It was during a South African Air Force flight in 1976 when solar activity was at a minimum, that recordings were made of the so-called South Atlantic Magnetic Anomaly. This is an area of abnormally low magnetic field intensity south-west of Cape Town which allows particles of the Van Allen Radiation Belt to be precipitated into the atmosphere. Such precipitation can upset the energy structure of the upper atmosphere, with resulting changes in the atmospheric ozone content. These changes may be of agricultural importance.

The Research Unit collaborates closely with the Departments of Physics of the University of Natal in Durban and of Rhodes University in Grahamstown, and also with the CSIR Magnetic Observatory at Hermanus and the National Institute for Telecommunications Research. The activities of these five research groups are co-ordinated by a national committee of the CSIR, the South African National Committee for Geomagnetism, Aeronomy, and Space Sciences (SANCGASS). Cosmic ray research is carried out in conjunction with research on air glow, the physics of the ionosphere, whistlers (radio signals caused by lightning), micro pulsations, VLF radiations, geomagnetism and auroras. The various programmes are all related to upper atmospheric and outer space phenomena and the different measurements are integrated by the exchange of recordings between the different groups.

CHEMICAL STRUCTURE OF CHROMATIN

Chromatin consists of a complex array of nucleic acids and proteins which serve, within the cell nucleus, as carriers of genetic information. This complex chemical structure is being studied by the Chromatin Research Unit at the University of Cape Town.

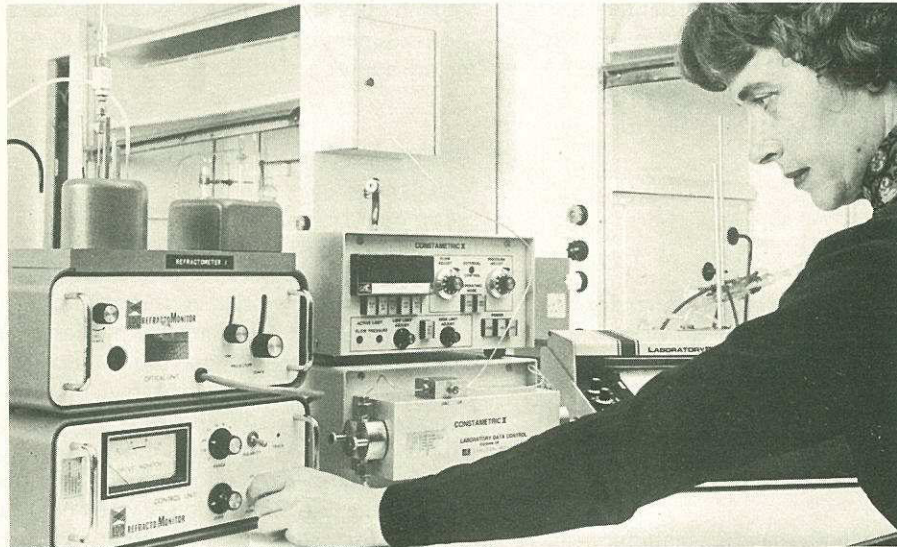
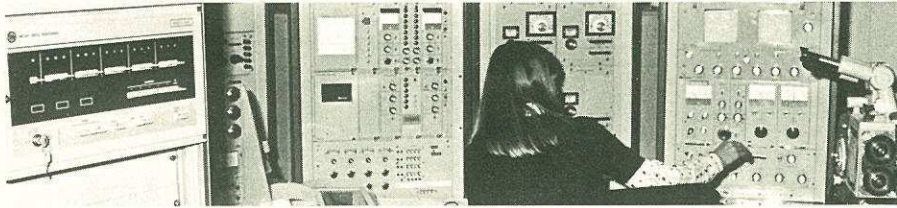
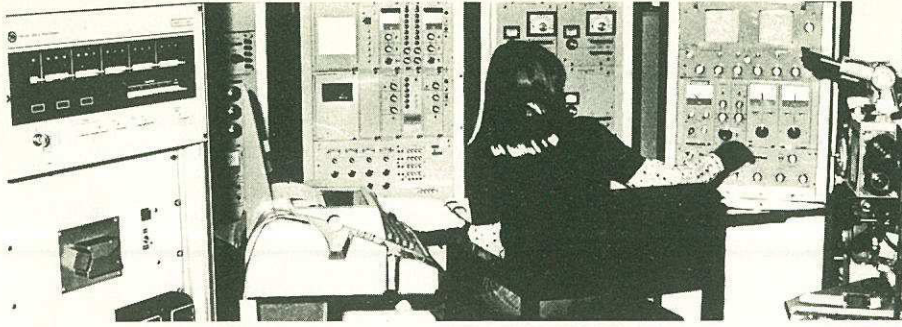
Part of the Unit's programme entails research into histones, which are tools of tissue differentiation. The recent isolation of two separate groups of histones in cell nuclei settled a long-standing controversy over the presence or absence of certain histones in yeast.

Two hitherto unknown histone families were discovered in sperm cells. Their chemical structure allows the nucleic acid to be packed into the minute head of the sperm cell while suppressing genetic activity until fertilisation. Fertilisation or hormonal stimulation partially unpacks the nucleic acid in order to allow certain enzymes to copy genetic information stored in the nucleic acids.

After purification of these enzymes, it became apparent that they influence specific regions of the histones, resulting in a localized dissociation between the histones and nucleic acid, which permits genetic copying to take place.

PHOTO-ELECTRIC PROPERTIES OF IRRADIATED DIAMONDS

The Solid State Physics Research Unit at the University of Cape Town is engaged in a study of the electronic properties of point defects in crystalline solids. Such defects, which exert a profound influence on the host material, can be introduced into a solid by irradiating it with fast particles. Diamonds are preferred for this study because flawless crystals with a high degree of purity are obtainable and because the role of the simplest defects in diamonds is not yet fully understood.

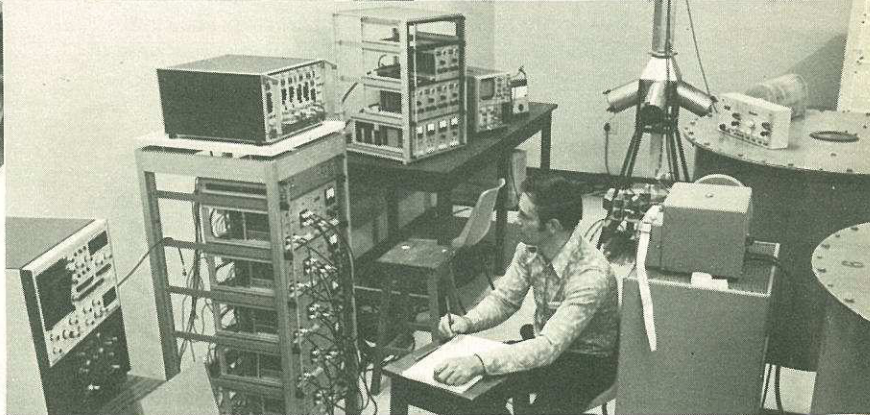
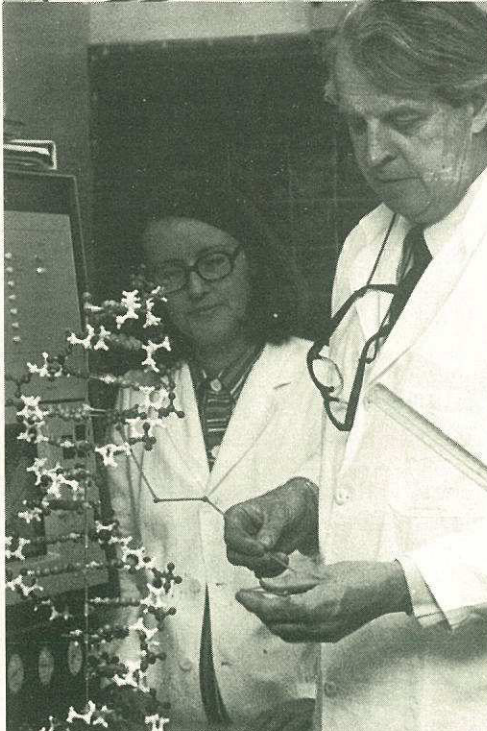


Geochemical research (p. 51): Electron microprobe system for the analysis of extremely small mineral grains (*top*).

Plant and bacterial polysaccharides (p. 47): Part of the equipment used to separate mixtures of carbohydrates without prior chemical manipulation (*left*).

Chemical structure of chromatin (p. 48): The interaction between a histone and a DNA molecule being demonstrated by means of a model (*bottom left*).

Cosmic ray research (p. 47): General view of the underground laboratory at Potchefstroom University where part of the cosmic ray research is conducted (*bottom*).



Type IIb diamonds are semi-conductors at room temperature, but become highly insulating when subjected to irradiation capable of producing atomic displacement. Such radiation, when confined to a narrow band within the crystal, produces a damaged region which, with its response time of less than 10^{-9} s, is suitable for use as a reader of fast light.

Hitherto only natural diamonds of sufficiently high quality were suitable for the manufacture of diamond particle detectors, but it has now become possible to use the relatively abundant type IIb diamonds — both natural and synthetic — for the same purpose.

GEOCHEMICAL RESEARCH

The Geochemistry Research Unit at the University of Cape Town is at present researching the origin and chemical evolution of the solar system, the composition of the earth's upper mantle and its volcanic products, the mineralogical associations of diamonds, and the evolution and composition of sediments.

Several of the Research Unit's analytic techniques (X-ray fluorescence, electron microprobe, and atomic absorption) are being applied extensively in uranium prospecting and other fields, both in this country and abroad.

During the past few years the Research Unit analysed samples brought back by the Appollo moon missions. The Unit established that certain refractory elements such as zirconium, niobium, and barium are present in the same relative proportions in the primordial material from which the meteorites and the moon accreted, which has relevance to the way in which the earth was formed. These investigations contributed to a better understanding of surface processes and rock structures on the moon.

The Research Unit's study of Kimberlite improved our understanding of the earth's upper mantle, which is 30 to 200 km deep. Volcanic basalt samples dating back 3 400 million years were investigated, and it appears that their composition bears a close relation to the general geodynamic environment.

In another direction of enquiry, techniques developed for the measurement of trace elements in pore water extracted from deep-sea sediments have indicated a greater input of metals from the sediment into the water than was previously thought.

This information is of particular importance to our control of estuarine waters. Information from Saldanha Bay sediments will serve as a base line for the assessment of future pollution resulting from the ore export activities.

PHOTOSYNTHETIC NITROGEN METABOLISM

The Photosynthetic Nitrogen Metabolism Research Unit, recently established at the University of the Witwatersrand, investigates the absorption of nitrogen by plant roots and the photosynthetic conversion of atmospheric carbon dioxide by green plants. It is well established that an increased supply of nitrogen enhances photosynthesis. At the same time, however, a photorespiratory carbon loss takes place. Research is now being done to develop plants which would minimise this essentially wasteful process.

During photorespiration, oxygen is consumed to yield glycolate which is further metabolised to form the amino acid serine with carbon dioxide as a by-product. The Research Unit is of the opinion that this serine, together with the similarly produced glycine, may be utilized for direct protein synthesis in the plant. It may well be in this area that the suggested interaction between photorespiration and nitrogen metabolism takes place.

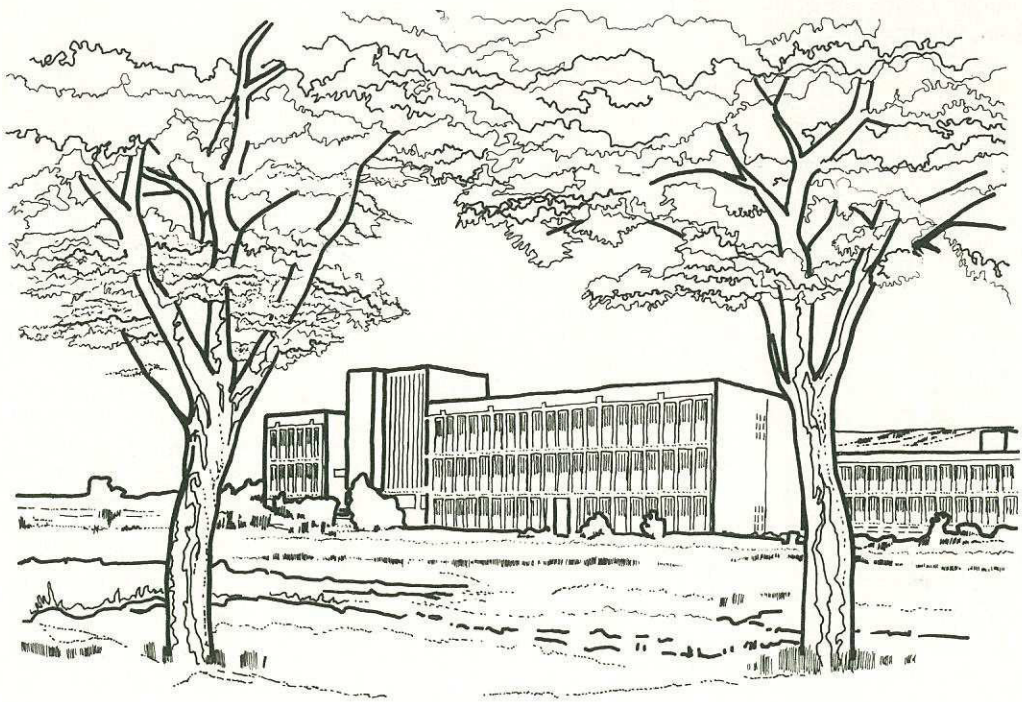
In another series of experiments it has been established that the grass type *Eragrostis curvula* requires soil nitrogen for the production of aspartic acid, which is a major intermediate in the photosynthetic sequence. In grasses that are more sensitive to nitrogen application, the photosynthetic system is markedly altered by the addition of large quantities of nitrogen.

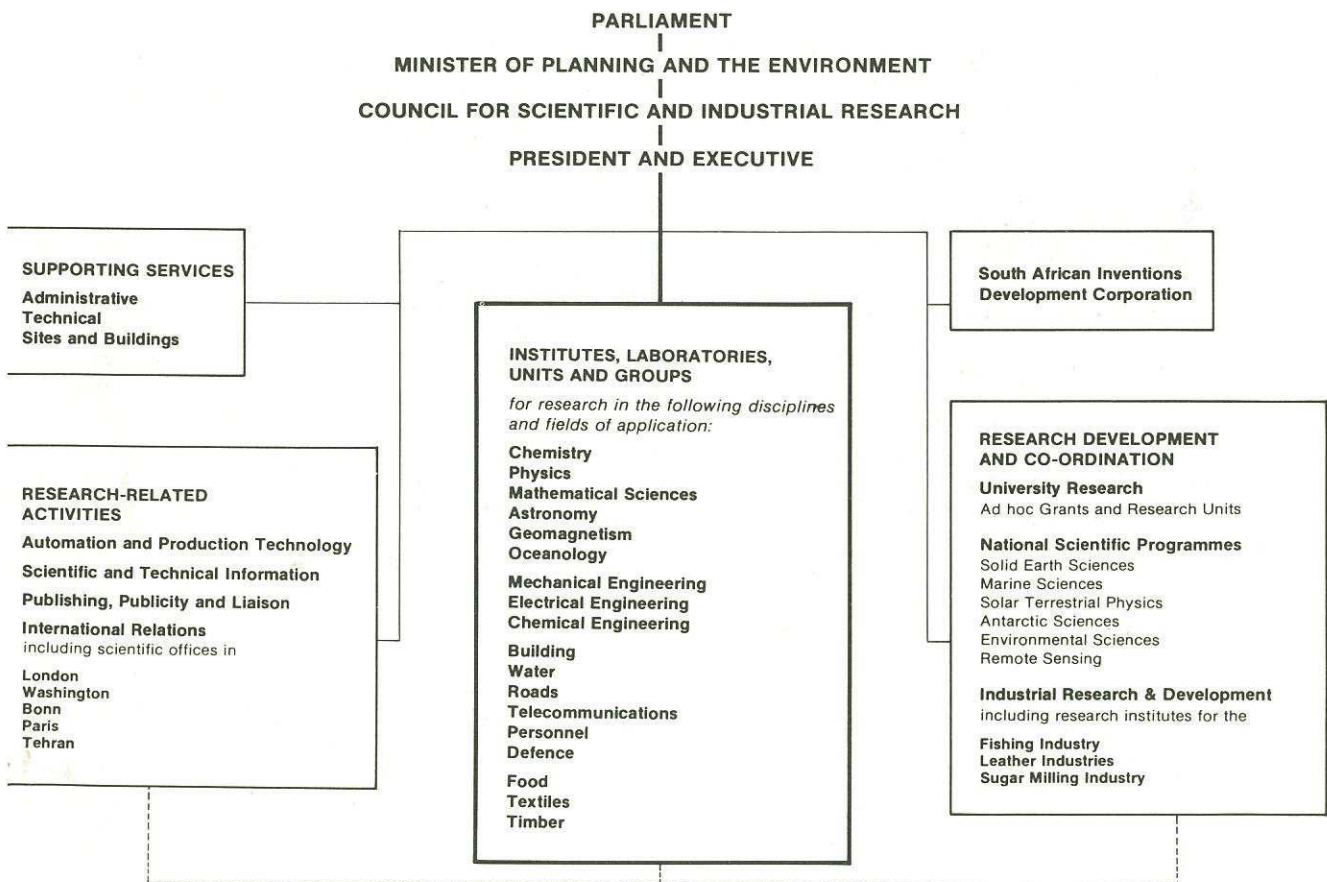
INSECTICIDES FROM INDIGENOUS PLANTS

In view of the objections to the use of chlorinated carbon dioxides such as DDT and dieldrin, the Flavanoid Research Unit at the University of the Orange Free State undertook an investigation of the possibilities of isolating natural insecticides of the rotenoid type from indigenous plants. These natural insecticides are not as detrimental to the ecology as the chlorinated compounds, and because they are readily biodegraded into harmless substances there is no long-term danger of their accumulation in the environment.

From a wide variety of toxic rotenoids isolated from plants, one proved to be as efficient as the well-known rotenone. A successful chemical synthesis of the toxin was also developed, but an efficient method is required to separate the two racemates (an optically inactive molecular compound consisting of two mirror images with opposed optical rotation) since one of them is, for all practical purposes, non-toxic.

Organization and functions of the CSIR





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 a policy of concentrating on research in fields where a need for more basic knowledge exists, many of its 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 of 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 main function of the National Physical Research Laboratory (NPRL) is to contribute to the development of physical science in South Africa through research aimed at the adaptation of existing knowledge, the discovery of new facts of value and the development of techniques in the solution of technological and industrial problems of national importance.

Proficiency is required in highly advanced techniques to make a meaningful contribution in this field, and the personnel of the NPRL must be fully conversant with those techniques which concern physical measurements and methods.

In addition, the NPRL has statutory responsibility for the maintenance of national measuring standards of mass, length, electricity, radiation, etc.

3.

**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.

4.

**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, has been established to conduct astrophysical research. The headquarters of the SAAO have been established 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').

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

5.

MAGNETIC OBSERVATORY

Head — DR G J KÜHN

Situated at the southern tip of Africa, the Magnetic Observatory at Hermanus is an important link in the worldwide network of geophysical institutions engaged in studies of physical processes occurring in the earth's magnetosphere and in the interplanetary medium. Such phenomena are closely related to the magnetic field extending outwards from the earth and to charged atomic particles incident on the earth's atmosphere, and the variations of both are thus routinely measured. Besides 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.

6.

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY

Director — F P ANDERSON

The National Research Institute for Oceanology (NRIO), with its headquarters at Stellenbosch, consists of divisions of 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 as well as to provide data and knowledge needed in the continued development of our coastal areas for economic and recreational use, and for resource exploitation.

7.

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 radio-isotopes.*

The Accelerator Centre will be available to scientists from Government organizations, provincial administrations and universities who 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.

8.

NATIONAL MECHANICAL ENGINEERING RESEARCH INSTITUTE

Director — DR H G DENKHAUS

While the National Mechanical Engineering Research Institute (NMERI) is concerned mainly with the development of new processes, techniques and equipment in mechanical engineering and the improvement of machines and materials used in industry, it is also active in fields such as mining and civil engineering geomechanics and civil engineering hydraulics.

Testing equipment, machines, instruments and qualified personnel are available for research in six divisions covering the fields of metal mechanics, strength mechanics, process mechanics, geomechanics, fluid mechanics and heat mechanics (including air conditioning and refrigeration). There are also two research units, the one dealing with aeronautics and the other with mine equipment. The six divisions and the Aeronautics Research Unit are housed in Pretoria, while the Mine Equipment Research Unit is accommodated in Johannesburg. The two units are integral parts of the Institute and are directly responsible to the Director of the Institute.

9.

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 microminiaturization; 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. Thus the activities of the Chemical Engineering Research Group (CERG) cover not only the needs of the chemical industry but also many processing aspects in the petroleum, petrochemical, mineral, food, beverage, biochemical, pharmaceutical, ceramic, paper, and textile industries, and in environmental technology (in which water, effluents and air are important). The interdisciplinary nature of chemical engineering provides a useful link in carrying out tasks undertaken in close co-operation with other institutes and organizations.

The research and development items on the Group's programme are selected according to the immediate and anticipated needs of industry. The Group provides a wide range of consulting services to industry. If necessary these services are backed by applied or fundamental research.

11.

NATIONAL BUILDING RESEARCH INSTITUTE

Director — DR T L WEBB

The National Building Research Institute (NBRI) was thirty years old in 1976, having been one of the first institutes of the CSIR when it was founded shortly after the Second World War.

With its present staff 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 less than one-tenth of one per cent of the amount spent on building and construction in South Africa every year.

About 60 per cent of its income is from Parliamentary funds and about 40 per cent is derived from research and similar investigations and services undertaken on behalf of central, provincial and local governments, private industry and individuals with particular building problems.

The emphasis is on meaningful research and on the efficient dissemination of useful information, both self-generated and derived from work done elsewhere in South Africa or in the rest of the world.

12.

NATIONAL INSTITUTE FOR WATER RESEARCH

Director – DR G G CILLIÉ

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

The Institute has a total personnel 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. Yet another group deals with the practical application of technology 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, into road safety and the behaviour of road users, and into 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.

15.

**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 and placing the right man in the right job (by means of aptitude tests, interests 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, e.g. manpower problems, social relations in the job situation, work motivation and attitudes;*
- *investigation of problems arising from maladjustment to the work, e.g. absenteeism, accidents, occupational disorders and group conflicts.*

16.

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 both 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.

17.

**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 cleansed in a washing machine without the drudgery of special care.

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

18.

NATIONAL TIMBER RESEARCH INSTITUTE

Director — DR D L BOSMAN

The aims of the National Timber Research Institute are:

- *the effective utilisation of South African timber resources;*
- *the development of satisfactory wood-base products;*
- *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 gave the NTRI approximately R120 000 which was a portion of the funds derived from a levy on all timber marketed in the Republic.

19.

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.

20.

INFORMATION AND RESEARCH SERVICES

Director — D G KINGWILL

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

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

21.

CENTRE FOR SCIENTIFIC AND TECHNICAL INFORMATION

Head — DR R VAN HOUTEN

The functions of the Centre for Scientific and Technical Information (CSTI) within the framework of the CSIR 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.*

22.

CO-OPERATIVE SCIENTIFIC PROGRAMMES

The objectives of the Co-operative Scientific Programmes group are to provide the services required by the CSIR Executive in identifying and defining problems in South Africa amenable to scientific solution through co-operative national programmes. Scientific co-ordinators, in collaboration with scientists at universities and research organizations, are responsible for defining such scientific programmes and stimulating and co-ordinating contributions within a specific programme. The group is required to provide the means required for remaining abreast of all research relevant to existing or planned national programmes and to foster South African participation in international programmes, particularly those sponsored by the International Council of Scientific Unions (ICSU).

The national scientific programmes being carried out by the CSIR are collaborative undertakings of official agencies, universities and laboratories in the private sector in planned programmes, with the object of either contributing to an international programme in which South Africa has agreed to take part, or of achieving, by means of a co-ordinated effort within the country, some scientific objective of special national importance.

These national scientific 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.

23.

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 subsidised by 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 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 for 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, etc.

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

24.

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 African secondary industry. From its early beginnings in 1935 in the Chemistry Department of Rhodes University, the Institute has maintained its steady growth.

A feature of the 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 between research staff and production staff at all levels.

25.

SUGAR MILLING RESEARCH INSTITUTE

Director – DR M MATIC

The Sugar Milling Research Institute (SMRI) is the central scientific organization for research into the manufacturing problems of the South African sugar industry. It was jointly 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. It is financed by SASMAL and the CSIR.

In addition to all South African sugar mills, eleven sugar factories in Swaziland, Rhodesia, Malawi, and Mozambique are affiliated members of the Institute.

The main functions of the SMRI are:

- *Research: A study of the fundamental aspects of processes such as milling, diffusion, juice clarification, the crystallization of sugar and the use of by-products, the raising of steam and power, and engineering aspects of the design and performance of mills, carriers, evaporators, and vacuum pans.*
- *Service: Advisory work, 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 conjunction 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 while following the course students are employed by the Institute.*

(The sugar industry maintains a research station at Mount Edgecombe, Natal, where the cultivation of sugar is studied.)

26.

UNIVERSITY RESEARCH DIVISION

Head – W J WEIDEMAN

In terms of the Scientific Research Council Act, the CSIR holds 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 which is annually voted for this purpose by the Treasury and is administered by the University Research Division.

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 1976-77 financial year more than R2 180 000 was allocated to museums and universities for research in the following subjects:

<i>Biology</i>	<i>R610 000</i>
<i>Chemistry</i>	<i>R514 000</i>
<i>Physics</i>	<i>R331 000</i>
<i>Engineering</i>	<i>R315 000</i>
<i>Geology</i>	<i>R174 000</i>
<i>Mathematics</i>	<i>R172 000</i>
<i>Nuclear Physics</i>	<i>R72 000</i>
	<hr/>
	<i>R2 188 000</i>
	<hr/>

Research undertaken by university departments in South Africa is of a high standard, in spite of the fact that researchers have to cope with heavy lecturing commitments, financial restrictions, insufficient research equipment and a shortage of post-graduate students in certain fields.

27.

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, as well as their concentrations and the possible reactions and transformations which may occur; to monitor specific pollutants (e.g. 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 and to attempt to understand the underlying processes; and to advise the authorities and industries concerned on air pollution matters.

Financial statements



STATEMENT 1

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

BALANCE SHEET AS AT 31 MARCH 1977

	General Fund	Building Fund	1977	1976
	R	R	R	R
<i>Accumulated Funds</i>				
Balance brought forward	41 097 028,50	24 333 488,41	65 430 516,91	56 701 541
<i>Additions:</i>				
Appropriation from Income Statement	205 370,00	560 000,00	765 370,00	1 595 185
Capital income (Note 1)	5 562 869,82	2 883 255,80	8 446 125,62	6 817 334
Physical assets acquired	-	605 350,70	605 350,70	-
Excess of income over expenditure	312 093,21	-	312 093,21	555 739
	47 177 361,53	28 382 094,91	75 559 456,44	65 669 799
<i>Reductions:</i>				
	784 384,08	136 634,09	921 018,17	239 282
Physical assets relinquished	-	136 634,09	136 634,09	35
Physical assets written off	784 384,08	-	784 384,08	239 247
TOTAL	46 392 977,45	28 245 460,82	74 638 438,27	65 430 517
<i>Application of Funds:</i>				
Fixed assets (Note 2)			71 513 748,58	62 310 126
Balance brought forward		62 310 125,64		52 456 356
Net additions		9 203 622,94		9 853 770
Investments			674 313,01	674 313
Shares in S A Inventions Development Corporation		200 000,00		200 000
RSA Stock: 5,25 per cent 1978		474 313,01		474 313
Net current assets			2 450 376,68	2 446 078
Current assets		6 060 179,51		6 075 484
Saleable stock		40 093,45		41 444
Debtors and debit balances		2 423 318,50		2 980 946
Advances and deposits				
Research grants		579 947,56		434 351
Other		2 668 500,01		1 739 710
Cash				
Public Debt Commissioners		37 278,66		579 361
S A Reserve Bank		258 909,32		250 277
Other banks		32 000,00		32 989
Petty cash imprests		20 132,01		16 406
Current liabilities		3 609 802,83		3 629 406
Advances for investigations and services		1 965 427,74		1 329 839
Creditors and credit balances		1 644 375,09		2 299 567
TOTAL			74 638 438,27	65 430 517

NOTES:

* At 31 March 1977 contractual obligations against the General and Building Funds were R2 982 339 and R1 988 713 respectively.

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

PRETORIA

19 September 1977

(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

24 November 1977

(Sgd) F G BARRIE
Auditor-General

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

NOTE 1 : CAPITAL INCOME

	General Fund	Building Fund	1977	1976
	R	R	R	R
PARLIAMENTARY GRANTS	3 387 600,00	2 200 000,00	5 587 600,00	3 994 840
CSIR	3 357 600,00	2 200 000,00	5 557 600,00	3 974 300
Grants	30 000,00	-	30 000,00	20 540
CONTRIBUTIONS	24 090,78	-	24 090,78	17 862
CSIR	24 090,78	-	24 090,78	17 750
Grants	-	-	-	112
INTEREST	-	258 662,90	258 662,90	256 872
SALE OF ASSETS WRITTEN OFF	27 528,09	-	27 528,09	73 242
INVESTIGATIONS AND SERVICES	2 123 650,95	424 592,90	2 548 243,85	2 474 518
R 5 562 869,82	2 883 255,80	8 446 125,62	6 817 334	

NOTE 2 : FIXED ASSETS (AT COST)

	Land and buildings	Books and journals	Furniture and equipment	Prefabricated structures	Laboratory equipment	Vehicles	Stores	TOTAL
	R	R	R	R	R	R	R	R
BALANCE BROUGHT FORWARD	25 254 332,96	1 896 562,70	2 049 386,09	21 621,57	30 892 529,39	1 268 732,99	926 959,94	62 310 125,64
PURCHASES								
CSIR	4 331 177,12	293 538,26	346 320,65	2 397,80	4 033 144,47	203 064,43	-	9 209 642,73
Grants	-	556,45	3 126,90	-	19 341,00	-	-	23 024,35
ADJUSTMENTS FOR PREVIOUS YEAR								
CSIR	-	-	135 814,29	19,00	-	20 945,82	-	156 779,11
Grants	-	-	71,10	-	-	-	-	71,10
ACQUIRED	605 350,70	-	-	-	-	-	-	605 350,70
STORES INCREASE	-	-	-	-	-	-	286 623,33	286 623,33
	30 190 860,78	2 190 657,41	2 534 719,03	24 038,37	34 945 014,86	1 492 743,24	1 213 583,27	72 591 616,96
LESS REDUCTIONS								
RELINQUISHED WRITTEN OFF	136 634,09	-	-	-	-	-	-	136 634,09
CSIR	-	4 093,83	26 590,39	1 706,00	182 337,12	78 335,71	-	293 063,05
Grants	-	-	99,77	-	491 221,26	-	-	491 321,03
ADJUSTMENTS FOR PREVIOUS YEAR								
CSIR	-	-	-	-	156 779,11	-	-	156 779,11
Grants	-	-	-	-	71,10	-	-	71,10
BALANCE R	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

STATEMENT 2

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

INCOME STATEMENT FOR THE YEAR ENDED 31 MARCH 1977

	Grants R	CSIR R	Total R	1975/76 R
<i>Income</i>				
Parliamentary grant	2 066 900,00	24 420 058,11	26 486 958,11	23 022 860
Contributions to CSIR projects	69 000,00	894 802,35	963 802,35	1 023 794
Investigations and services	-	23 746 026,51	23 746 026,51	20 017 088
Publications	2 158,04	91 949,77	94 107,81	60 138
Sundry	-	216 322,27	216 322,27	142 688
<i>Total</i>	2 138 058,04	49 369 159,01	51 507 217,05	44 266 568
<i>Less: Expenditure</i>				
Salaries, wages and allowances	79 616,15	31 309 912,31	31 389 528,46	26 865 430
Consumable stores and services	11 613,79	17 107 917,13	17 119 530,92	13 497 028
Subsistence and transport	20 467,52	1 648 365,92	1 668 833,44	1 420 030
General expenses	2 040,81	2 854 672,67	2 856 713,48	3 468 385
Grants	2 135 169,95	901 256,11	3 036 426,06	1 508 010
Subsidies: Research by industry	-	505 900,06	505 900,06	490 289
Levies and depreciation	52 291,08	5 428 300,73	5 480 591,81	5 021 329
	2 301 199,30	59 756 324,93	62 057 524,23	52 270 501
<i>Less: Income for internal services</i>	889,80	11 626 880,59	11 627 770,39	10 154 857
<i>Subtotal</i>	(162 251,46)	1 239 714,67	1 077 463,21	2 150 924
<i>Transfer to other funds</i>	-	765 370,00	765 370,00	1 595 185
Equipment Fund	-	205 370,00	205 370,00	965 185
Building Fund	-	560 000,00	560 000,00	630 000
<i>Excess income transferred to Accumulated Funds</i>	R (162 251,46)	474 344,67	312 093,21	555 739

PRETORIA

19 September 1977

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

**CSIR BUDGET
1977/78**

Statement No. 3

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	34 980 168	24 801 883	-	59 710 051	24 985 090	7 516 577	27 208 384
Grants and subsidies	344 566	428 663	3 615 985	4 389 214	3 529 510	113 831	745 873
Subtotal	35 252 734	25 230 546	3 615 985	64 099 265	28 514 600	7 630 408	27 954 257
Less Internal Revenue		7 630 408		7 630 408		7 630 408	
Total	35 252 734	17 600 138	3 615 985	56 468 857	28 514 600	-	27 954 257

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	408 280	7 473 110	192 395	200	100 000	2 006 400	10 180 385	5 398 960	4 781 425
Grants to universities etc.	1 000	51 165	6 000	-	-	-	58 165	25 040	33 125
Total	409 280	7 524 275	198 395	200	100 000	2 006 400	10 238 550	5 424 000	4 814 550
GRAND TOTALS A & B							66 707 407	33 938 600	32 768 807

CSIR PERIODICAL PUBLICATIONS

Annual Report of the CSIR

Gratis.

Scientiae

Quarterly. Feature articles and news items on scientific topics. Gratis.

TI – technical information for industry

Monthly. Short articles on aspects of CSIR research with industrial application. Gratis.

CSIR publications

Quarterly list of articles and reports published under the auspices of the CSIR, with keyword and author indexes. Gratis. Also contains information on recent translations by the CSIR Foreign Language Service.

CSIR – organization and activities

Irregular. A directory of the various divisions and services of the CSIR. Gratis.

CSIR – research for South Africa

Popular general brochure on the CSIR. Irregular. Gratis.

Calendar of scientific and technical meetings in South Africa

Six-monthly list of conferences, symposia, etc. due to be held in the ensuing 18 months. Gratis.

Scientific research organizations in South Africa*

Annual. A guide to government organizations, statutory bodies and industrial concerns which maintain research laboratories. R4,00 per issue.

Scientific and technical societies in South Africa*

Annual. A guide to societies, giving particulars of their aims and objects, membership, publications, etc. R2,50 per issue.

Scientific and technical periodicals published in South Africa*

Annual. A list of current periodicals, giving particulars of fields covered, subscription rates, etc. R1,50 per issue.

Psychologia Africana

Journal of the National Institute for Personnel Research, CSIR. R5,00 per volume or R2,00 per single number. Subscriptions payable per volume and not per annum.

NIPR News

Quarterly. Newsletter of the National Institute for Personnel Research, CSIR. Gratis.

NBRI information sheets

Every two months. Brief articles on technical and practical problems related to building. Gratis.

Houtim

Quarterly. Technical news for the timber industry, compiled by the National Timber Research Institute, CSIR. Gratis.

VIA

March and September. Summarized reports (mostly of an interim nature) by the National Institute for Transport and Road Research, CSIR. Gratis.

SAWTRI bulletin

Quarterly. Technical news for the textile industry compiled by the South African Wool and Textile Research Institute. Gratis.

NIWR Information Sheet

Irregular. Information on specific water and waste water problems. Gratis.

Water Report

National Institute for Water Research newsletter. Six-monthly. Gratis.

* R6,00 per set, if all three directories are ordered.

ENQUIRIES:

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