SERC

BULLETIN

SCIENCE & ENGINEERING RESEARCH COUNCIL

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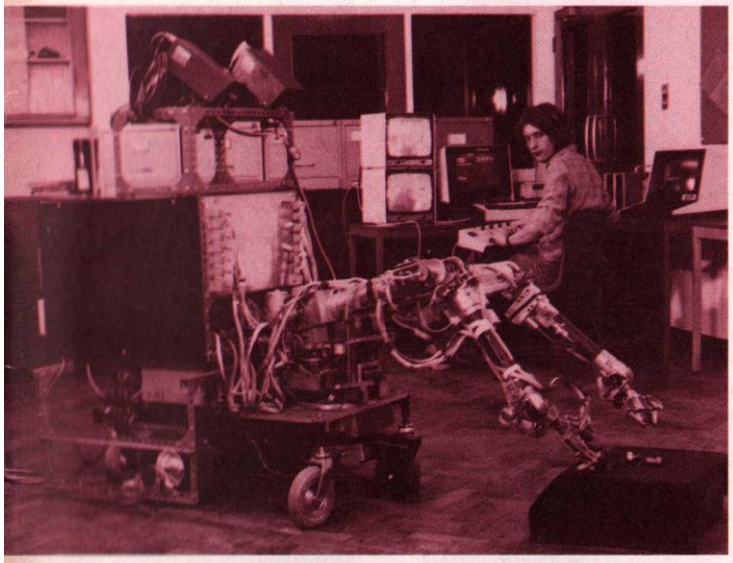

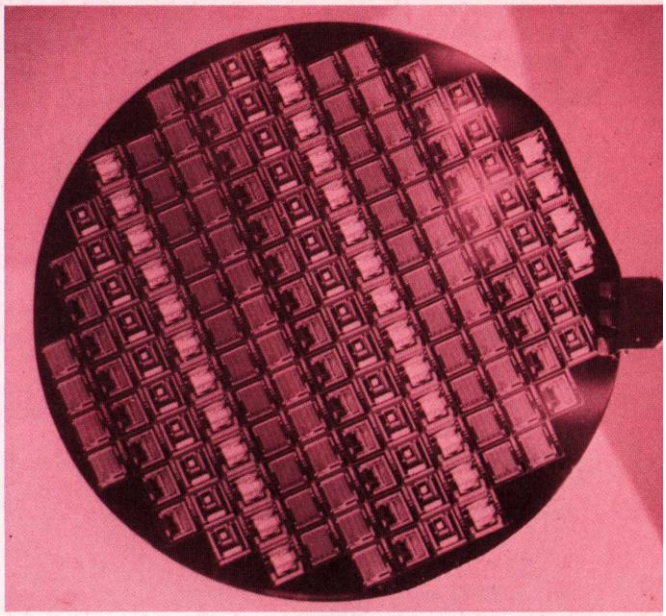

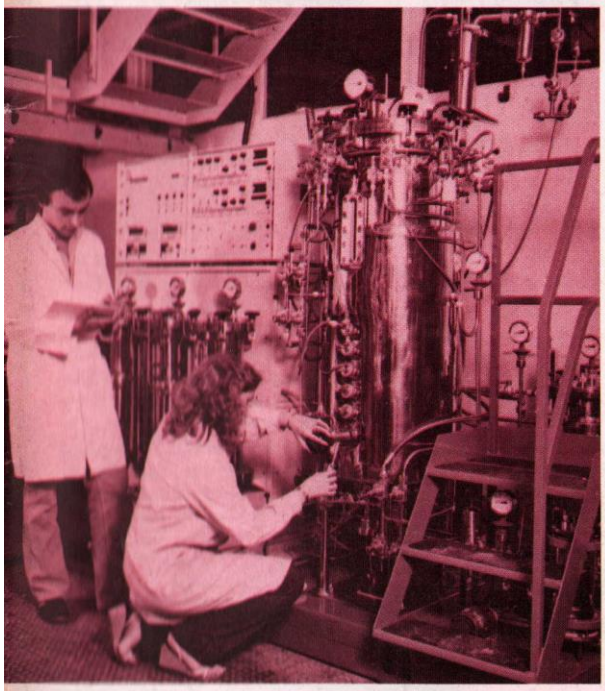

In this issue

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Change of name

As noted briefly in the last *Bulletin* (Spring 1981) Her Majesty, on the advice of Her Privy Council, agreed in April that the Science Research Council should now be known as THE SCIENCE AND ENGINEERING RESEARCH COUNCIL (SERC). The change of name does not alter or widen the objects of the Council as set out in its Charter. The new name recognises the increasing importance SRC has placed on ensuring that engineering research departments in universities and polytechnics have the necessary resources to produce the innovative technology and highly qualified manpower urgently required by UK industry. The Engineering Board's expenditure in universities and polytechnics rose, for example, from £9 millions in 1973-74 to £27 millions in 1979-80. Its proportion of the total SRC budget rose in the same period by 50% at a time when the budget, in real terms, was falling. The major element of that growth has been applied to stimulate and support research programmes chosen to be of the greatest potential benefit to the national economy in such areas as marine technology, polymer engineering, manufacturing systems, energy, microelectronics and materials. Great emphasis has been placed on achieving a high level of academic-industrial collaboration with the aim of effecting rapid technology transfer.
Through such collaborative schemes most large companies are well aware of the help SRC has given in funding academic partners and providing assistance for postgraduate work. It is hoped that the change of name will also encourage smaller companies to view the Council as a medium through which research and training collaboration with academics can be undertaken.

Research supported by the Engineering Board ranges from biotechnology and microelectronics to robotics and manufacturing. Shown (clockwise) are:

1. *The Mark V robot in the Artificial Intelligence Robotics Laboratory at Queen Mary College, London, with the speech-controlled workstation in the background. The robot is controlled by an LST-11/23 main computer with disc store and TV imaging, plus three microcomputers for sensory processing, speech processing and low-level control. The system is used on a cooperative project funded by the Council and ICL to develop speech control for robots, for applications particularly where remote manipulation is required, such as in nuclear power stations, and reprocessing plant, seabed exloration and handling explosives.*

2. *Each of the 148 chips on this 3" silicon wafer is 5 mm square and contains up to 6,000 transistors. Using masks made at the Electron Beam Lithography Facility at Rutherford Appleton Laboratory, it is possible to have five designs on one wafer. The devices were designed by five MSc project students in the Electrical Engineering Department, Edinburgh University, using GAELIC and ICF link to Prime at RAL, and fabricated in the University's SERC-supported Microfabrication Facility.*

3. *Engine assembly at BL Cars, where a Teaching Company programme with Warwick University has led to major cost savings in stocks of materials and components. As a result of collaboration with the University's engineering department, Teaching Company Associates and BL staff at the Common Lane plant in Birmingham have developed a micro-computer-based monitoring system which has been used to bring stock levels down from 12 weeks to three.*

4. *A new computer-controlled 100 l fermenter supplied by L H Engineering has recently been installed in the Department of Chemical and Biochemical Engineering University College London. Research in biotechnology suppported by SERC in the department by Professor M D Lilly and Dr P Dunnill includes work on fermentation, immobilised enzymes and protein technology. Seen with the fermenter are Timothy Oxley and Susan Ross, both SERC-supported Advanced Course students on the MSc course in Biochemical Engineering at UCL.*

The Science and Engineering Research Council is one of five Councils funded through the Department of Education and Science. Its primary purpose is to sustain standards of education and research in the universities through the provision of grants and studentships and by the facilities which its own establishments provide for university research.

The SERC Bulletin summarises topics concerned with the policy, programmes and reports of the SERC.
All publications described are available from the appropriate department of the Council, free, except where otherwise stated. The SERC's Annual Report (available from HMSO bookshops) gives a full statement of current Council policies together with appendices on grants, awards, membership of committees and financial expenditure.

Enquiries and comments are welcome and should be addressed to the editor, Miss J Russell, at the Science and Engineering Research Council, Polaris House, North Star Avenue, Swindon SN2 1ET.
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1981 Forward look

In presenting its Forward Look to the ABRC, Council was obliged to work to a main assumption based on a level budget of £197.5M at 1981 PES prices over the next three years. This represents a reduction of about £2.5M a year on the 1980 Forward Look and means that further reductions have had to be made in nuclear physics and space science so that the provisions for these activities are now below the minimum level for a balanced programme. Likewise it is no longer possible to avoid cuts on the Science and Engineering Boards or to set aside funds for growth in new areas at the rate previously planned. If extra funds were made available then these would be used to restore some of the cuts which the Council had to make and to bring forward certain new programmes which cannot be properly funded under the main assumption including:

NERC/SERC programme in earth orientated space science;
Joint programme with the nationalised industries in energy research;
A pioneering activity in molecular electronics;
MRC/SERC collaboration in biological science using the Synchrotron Radiation Source.

A feature which is evident throughout Council's activities is the extent to which they depend on collaboration either with overseas partners or with industry here in the UK. Since its inception in July 1978, the Cooperative Grants Scheme has established itself as a particularly successful means of fostering collaborative work between industry and the academic community and high quality proposals have come forward in large numbers despite the economic stringency in the private sector. Developments have now reached the stage where Council believed that the Scheme could be integrated with the work of subject committees who will take over the responsibilities of the Cooperative Grants Committee from the beginning of the 1982/83 session.

1980/81 expenditure

Indications of a potentially large overspend on Council's domestic sub-head led to a number of cutbacks late in 1980, notably in SERC recruitment and on new external commitments at Council establishments. These measures, together with savings which the Council was permitted to transfer from the international heading, were sufficient to reduce the ultimate overspend to very small proportions.

Astronomy and space developments

As well as the Protocol on Dutch/UK collaboration in astronomical research (see page 16), in March Council lent its support to a Memorandum of Understanding at governmental level between India and the UK, the purpose of which was to promote collaboration in space science and technology between the two countries. Council has also approved a proposal from the ASR Board for UK participation in AMPTE, the Active Magnetospheric Particle Tracer Explorers project, proposed jointly by West Germany and the United States for launch in 1984. The mission is intended to investigate energy and mass transfer between the solar wind and the magnetosphere. UK participation will take the form of the provision of a free-flying sub-satellite and will involve groups at ICST, MSSL, Sussex, Sheffield and the Rutherford Appleton Laboratory in collaboration with British Aerospace. Council hopes to construct a Space Science Instrument Development Facility at RAL to support University space groups and its space programme generally.

Dual support system

Since February, Council has been very much aware of the severe difficulties that are likely to arise consequent on the Government's decision to reduce financial support for the universities over the next three years. Council has agreed that it should act in concert with the UGC in its policy of selective reductions. New mechanisms of research support might be needed during the transitional period before a stable dual support system emerges once more and assurances will be sought from universities that they will be able to provide adequate support to prospective grant holders throughout the period of a proposed award. Holders of the Council's studentships and fellowships will be reminded that they may transfer their awards to other universities should that prove necessary during the course of their support from SERC.

Industrial use of central facilities

Council endorsed proposals of the Science Board providing guaranteed access to central facilities for industry within a maximum of 10% of the time available. It was held that priority use of this kind would be of considerable benefit to the academic community, as well as being in the national interest. The utilisation of the central facility was likely to be broadened both scientifically and technically and it was hoped that closer collaboration between the academic community and industry would result.

Central computing

In December 1979, Council agreed to the establishment of a Working Party to undertake a wide-ranging review of the computing services provided by SERC and, in particular, to formulate a strategy for replacing the ageing mainframe computers at Chilton and Daresbury. The Working Party reported to the Council in May, recommending that within SERC there should be more central planning, coordination and control, to be achieved primarily through a restructuring of the committees dealing with computing, and that externally, collaboration with the Computer Board should be continued and strengthened.

A new Central Computing Committee has since begun operation which will bring together the batch-processing interests of the former Facility Committee for Computing and the resources of the Interactive Computing Facility. Council's internal management arrangements have been similarly strengthened with the appointment of a Computing Coordinator – presently Dr G Manning – who is supported by a panel comprised of the computer managers at the various establishments.

The Working Party recommended a phased programme of capital installations at the two major Laboratories, with the first priority being the replacement of the 370/165 at Daresbury. (see page 21). The requirements at Chilton were for an urgent improvement in the service to terminal users, necessitating the replacement or up-grading of the 3032 and, later, an additional machine to provide further front-end capacity and partially to replace the 195s. Further back-end capacity would be needed to provide for the 10% pa growth in use envisaged by the Working Party. It was felt that the scale of provision should be closely geared to the scientific needs of the Council's programme and that a system of apportioning central computing costs to Boards should be introduced as soon as possible.

Council endorsed the Working Party's recommendations which are being put into effect as rapidly as the availability of funds allows.

Part-time and post-experience education training

In June, approval was given, under the Integrated Graduate Development Scheme, for a second intake of students on a Warwick University/British Leyland/Lucas programme and for a new course serving the process-plant industry centred on Paisley College of Technology, but also involving a large consortium of manufacturing companies and academic institutions. In July, the first two continuing

(continued overleaf)

New Council members

The Secretary of State for Education and Science has appointed the following new members of Council:

Mr Diarmuid Downs, CBE, has been appointed Chairman of the Engineering Board. He is Chairman and Managing Director of Ricardo Consulting Engineers Ltd, leading international consultants in the internal combustion field. Mr Downs joined the company as a postgraduate student during the war. His studies of abnormal combustion phenomena in the petrol engine have resulted in a clearer understanding of the commercially important problems of 'knock' and 'pre-ignition'. He followed these studies with work on other petrol engine phenomena.

He was elected Director of Ricardo in 1957, appointed Managing Director in 1967 and Chairman and Managing Director in 1976. He has served as President of the Institution of Mechanical Engineers, and as a member of a number of bodies including the Advisory Council for Applied Research and Development (ACARD). He has been a member of the SERC's Engineering Board since 1979 and in that year was appointed Commander of the Order of the British Empire and elected to the Fellowship of Engineering.

Mr Philip Hughes is Chairman of Logica Holdings Ltd, of which he was a founder member in 1969, when he became Managing Director. He was appointed Chairman in 1972.

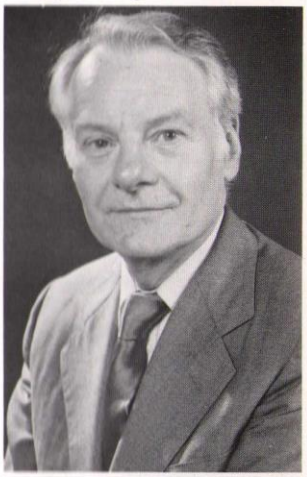
After graduating in Mechanical Sciences and Economics from Cambridge, he worked for Shell International Petroleum Co Ltd for four years before joining CEIR Ltd (now Scicon Ltd) in 1961. There he was appointed General Manager and Head of Professional Services in 1968.

At Logica he has provided technical supervision and consultancy on computer studies for such organisations as the Ministry of Defence, the Inland Revenue, Barclays Bank and British Telecom (on the international development of Prestel) and consultancy for the European Economic Community on policy for the computer industry with the EEC.

Mr Hughes is a member of the Board of Governors of the Technical Change Centre (see *Bulletin* Spring 1981), Visiting Professor, Department of Computer Science, University College London, and the author of a large number of papers.

Professor Alistair G J MacFarlane joined the Metropolitan-Vickers Electrical Company in Manchester in 1953 and five years later he was appointed lecturer in Electrical Engineering in Queen Mary College, London and Reader in 1965, moving the following year to UMIST's newly-established Control Systems Centre where he became Professor of Control Engineering in 1969.

Professor MacFarlane was elected to a Chair of Engineering in the University of Cambridge in 1974 and became Head of the Control and Management Systems Division of the Engineering Department at Cambridge. He is Vice-Master of Selwyn College, Cambridge. His research interests are in the fields of feedback theory, dynamical theory and automatic control. For papers on these topics he has been awarded numerous major prizes. He has served on SERC's Engineering Board since 1978 and on several other SERC committees. He was elected to the Fellowship of Engineering in 1981.



Professor Leslie Wilcock has been Professor of Physics at the University College of North Wales, Bangor, since 1965, following appointments as Lecturer in Physics at Manchester University, and Reader in Instrument Technology, later Applied Physics, at Imperial College. His interests are in optics and photoelectronics, and he was one of the pioneers of the development of photoelectronic imaging radiation detectors for scientific use, particularly in astronomy.

He has served on SERC's Astronomy II Committee; is currently Chairman of the Science Committee for Optical Telescopes which advises on the scientific aspects of SERC-supported optical telescopes and their instrumentation; and is also one of the two British members of the Advisory Committee on Instrumentation of the Anglo-Australian Telescope.

In 1977 he received the Arnold Beckman award from the Instrument Society of America for work on optical methods of on-line particle size analysis.

Council commentary

(continued)

education courses in Computer Applications and Manufacturing were approved. The two courses link the acknowledged academic expertise at centres of excellence in universities, polytechnics and industry throughout the UK with the distance learning and production capabilities of the Open University. The approval of the Department of Education and Science will be required before this cooperative venture with the Open University can proceed.

Retirements

The following members of Council retired on 30 September 1981:

Professor Sir James Baddiley, FRS; Professor R L F Boyd, CBE, FRS; Professor J Brown; Mr D H Roberts, FRS.

July also marked Professor Sir Geoffrey Allen's last meeting as Chairman and members paid warm tribute to his leadership and conduct of Council's affairs during his term of office.

SERC's new Chairman looks ahead

Professor John Kingman, FRS, became Chairman of the Council on 1 October. He discusses here some of the problems which the Council will have to tackle during his term of office.

You have taken over as Chairman of SERC at a time when financial support of universities has been reduced. What effect will this have on the policies and objectives of the Council?

Each university is having to cut its activities and the advice it has received from the UGC, if followed, would typically achieve only a small fraction of the required saving. There is a serious risk that universities may take action which will endanger research to which SERC attaches importance and in which indeed it may have a significant investment. The best of such research must be preserved and SERC will do what it can, within severely limited resources, to facilitate this. But universities cannot expect SERC to compensate wherever UGC funds become inadequate.

What they can expect is that the Council will continue to find funds to support really good new ideas and to help the very best young scientists and engineers to carry their work to fruition. This means keeping flexibility to respond to new developments and not tying up all our funds in existing activities.

What do you expect will be the effect on studentships and the long term effect on postgraduate education?

Research studentships and fellowships play a key role in university research and I hope that the total size of this operation can remain roughly constant. There may well be shifts of emphasis, as for instance between CASE and quota studentships. An example of the way in which SERC can respond to the needs of the academic community is the Special Replacement Scheme which offers some relief from the blockages caused by reduced recurrent grant and anomalous age structure.

Professor John Kingman, FRS, has been Professor of Mathematics in the University of Oxford since 1969 and a Fellow of St Anne's College, Oxford since 1978. He was elected a Fellow of the Royal Society in 1971. He has been a member of the Council since 1979 and was Chairman of its Science Board.

If some universities close down departments, what happens to research grants already announced for workers in such departments?

At an early stage, we would want to talk to universities faced with this sort of problem. If closure proved inevitable, the Council could in some cases help the research to be transferred to another university. It must be stressed that the universities are faced with a very difficult period of transition to a system in which many subjects are concentrated in fewer universities. The final result may be a healthier one, but only if the remarkable capacity of British universities to combine teaching and research is not impaired; SERC has an important part to play in this process.

SERC has itself been under great financial pressure. How can it keep up its level of activity and support?

In big science by thinking even more in international terms. The facilities in our laboratories and observatories are of world class and scientists abroad will wish to use them and contribute to their cost. We already have similar arrangements in the opposite direction and they are scientifically stimulating as well as financially effective. In engineering and applied science, involvement with industry is crucial, and I intend to build on the success of my predecessors in bringing the academic and industrial worlds closer together.

It should also be remembered that not all the projects we support are expensive; some of the best are relatively cheap. By spending quite small sums imaginatively, surprisingly large scientific returns can be achieved.

Do you see SERC as a passive body, waiting for ideas from the community, or as an active initiator of new developments?

New ideas come not from committees, but from individual scientists who may be in universities or polytechnics, or may be in our own research establishments.

The Council must be ready to encourage these, but it must also monitor the overall situation, and ask why some areas may not be fertile and what might be done, for instance to bring good people into an important field. This does not mean supporting second-rate work in the hope that first-rate work will follow; in the old phrase 'scientific quality, timeliness and promise' must continue to be the dominant criteria.

New management structure at RAL

SERC's largest establishment has changed its name and has a new management team. From 1 October 1981, the Rutherford and Appleton Laboratories became known as the Rutherford Appleton Laboratory, signifying the completion of their merger, and Dr Geoffrey Manning took over as Director with Professor John Houghton FRS as Deputy Director.

Dr Godfrey Stafford FRS retired as Director General of RAL on 30 September in order to devote more time to St Cross College, Oxford, of which he is Master. Dr Stafford joined the Rutherford Laboratory when it was set up in 1957, becoming Director General of both Rutherford and Appleton Laboratories on 1 September 1979 to oversee their merger.

The new management structure comprises Associate Directors for each of the four areas of SERC's work and one for technical services (eg computer operations). Dr Manning holds the latter responsibility himself and, pending the appointment of a new Associate Director, the portfolio for science; Professor Houghton retains responsibility for astrononmy and space; Associate Director of engineering is Dr David B Thomas; and Associate Director for nuclear physics is Dr John J Thresher. Laboratory Secretary is Dr James M Valentine.

Specially promoted programmes ...two profiles

The Engineering Board's system of selective support, through its Specially Promoted Programmes (SPPs), was introduced in the Spring 1981 issue of the *Bulletin* and a list given of the coordinator and SERC contact for each programme. In future issues we intend to focus on the progress of each SPP in turn. Here are the first two in the series – Grinding Technology and the new Medical Engineering SPP.

Grinding technology

Following a survey of metal removal processes in 1974, SERC (then SRC) decided that a coordinated programme of research in grinding technology could greatly help to improve production methods in the metal working industry. The programme has proved very successful; many of the research results are already being used by industry, in some cases dramatically cutting manufacturing costs.

Traditionally, grinding was regarded as a finishing process. The objectives of the programme were to develop high speed removal rates, thus facilitating the use of grinding for high stock removal while maintaining acceptable standards of geometry and surface finish, and to establish guidelines for improved productivity.

The focus of the programme has been the creation of a number of academic centres of expertise specialising in various aspects of grinding technology ranging from research on grinding wheels, abrasive belts and discs, the control and instrumentation of driving machines, centreless grinding and the techniques to achieve high standards of surface finish. Particular attention has been devoted to investigations of grinding coolants and fluids and the environmental aspects of the grinding process. Since the programme began, considerable importance has been placed on involving machine manufacturers and users in individual projects. This ensures that the research and its take-up retain the highest degree of industrial relevance. The coordinator has played a key role in maintaining close collaboration with interested companies.

Among the many research results now being used in industry, the technique of creep feed grinding, developed by Bristol University has had a major impact. The technique had shown considerable promise when used on difficult materials such as Nimonic alloys but was limited for high stock removal grinding because of thermal damage to the workpiece. The research group under Professor Andrew has alleviated such effects.

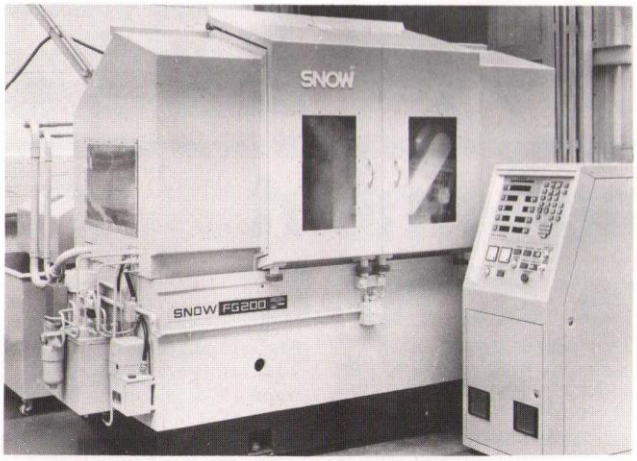
Associated research on coolant application, wheel speed and a new method of wheel sharpening called continuous dressing has resulted in a 20-fold increase in the rate of removal with an acceptable standard of surface finish. Rolls-Royce have incorporated this technology in their production of turbine blades for the RB211 aero engine saving over £1M per year in manufacturing costs. Several other major machine tool manufacturers are now actively collaborating with Bristol and the design concepts developed have been incorporated in the first major new creep feed grinding machine by a UK machine tool maker – Snow and Co Ltd of the B Elliott Group.

Notable advances have been made on grinding fluids and coolants which are subject to degradation due to bacteria growth. Research at Birmingham University under Professor Rowe has demonstrated that such degradation can be prevented by a simple pasteurisation process. As a result fluid life can be greatly extended with considerable savings on fluid costs and long-term grinding performance.

Work on the adaptive control of grinding machines by Professor Bhattacharyya, originally at Birmingham University and now at Warwick University, shows considerable promise. The aim of the research has been to produce a control device for 'off the shelf' grinding machines which will ensure their highest performance under a variety of working conditions without the need for skilled operators.

The coordinated phase of the programme is due to end in 1982. During the final phase emphasis will be placed on ensuring that the results of the research are transferred beyond those firms which participated in the programme. A grinding exhibition has been arranged for the Production Engineering and Processes '82 Conference in March 1982 and it is planned to produce a handbook describing the technological achievements of the programme. Some of the university groups have also run in-company seminars.

Anyone interested in further details about the programme should contact Mr M Hotchkiss, SERC Central Office, Swindon (extension 2155).



The first major new creep feed grinding machine built by a UK machine tool maker, Snow & Co Ltd of the B Elliott Group, incorporating design concepts developed by Bristol University.

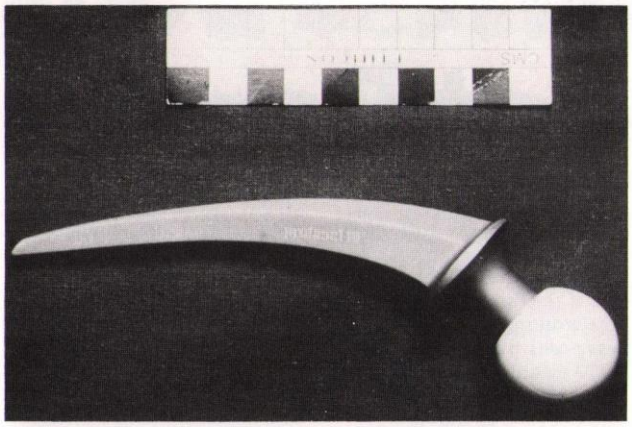
The research team at Bristol University with the laboratory creep feed grinding machine. Left to right: SERC industrial student John Liverton (sponsored by TI Matrix Ltd and now Technical Director of Jones and Shipman Ltd), Dr Trevor Howes and Professor Colin Andrew.

Medical engineering

The Specially Promoted Programme in Biomaterials, which has proved most successful since it was set up in 1977, has now been extended by the Engineering Board to cover medical engineering as a whole. The broad aim of this expanded programme is to promote research on materials, devices and aids to assist in the diagnosis and treatment of disease or damage in human beings, through closer collaboration between the clinical and technological disciplines.

Dr Arthur Mason, Coordinator of the Biomaterials SPP, will continue as Coordinator for the new Medical Engineering SPP.

The exact scope of the new programme is still under discussion but it will include such topics as diagnostic electronics, control engineering, robotics, imaging and parts of medical physics as well as biomaterials.



Ceramic hip prosthesis made of high density alumina which has high wear resistance and good compatibility with the tissues of the body. A number of centres are working on improvements in the material and design of prostheses of this as part of the Medical Engineering SPP.

Dr Arthur Mason

Close links

Other organisations have considerable interest in medical engineering and emphasis will be placed on strengthening the close links already developed under the Biomaterials SPP with the Medical Research Council, the Department of Health and Social Security (and parallel organisations in Scotland and Northern Ireland) and the National Research and Development Corporation.

During the past three years the Biomaterials Sub-Committee pursued three main aims:

- To develop a fundamental understanding of the interaction of natural tissue and implanted material;
- To develop new materials with properties directly relevant to performance in medical applications;
- To design and develop internal and external devices using existing or novel materials.

Within these aims, three priority research areas were identified – dental products, internal prostheses and external aids. Dr Mason's appointment as coordinator in 1978 was a crucial factor in the stimulation and coordination of research projects and several research teams in various centres are now well established; to date more than £1.4M has been awarded in grants under the Biomaterials SSP.

Problem areas

The Biomaterials Sub-Committee recently reviewed its long-term priorities, and identified five problem areas in which it would wish to encourage more research:

- Study of the physical and chemical structure of biomaterials and the relationship to biocompatibility.
- Studies of adhesion phenomena between living tissue and synthetic materials for dental and internal prostheses applications.
- Development of improved materials, such as polymers, ceramics and metals, for use in dentistry, internal prostheses and external aids.
- Correlation between the structure and physical properties of composite dental filling materials.
- Studies and development of novel membrane systems for use as skin replacement and dialysis.

These topics cover a wide range of materials and scientific disciplines and overlap strongly with medical and dental sciences and clinical practice. Effective work requires close collaboration between different disciplines and much of the work of the broader SPP, through its Coordinator, will be to encourage such interdisciplinary work and collaborative ventures in these areas.

Industrial involvement

The objective has from the start been to balance such long-term studies with a number of short-term projects of more immediate commercial significance. The majority of these have some measure of industrial involvement ranging from provision of materials and equipment to direct participation. Several projects are now approaching a stage when exploitable results can be anticipated and the National Research and Development Corporation is investigating their commercialisation. For example, Queen Mary College has shown that composites based on hydroxyapatite and polyethylene are particularly promising as implant materials for bone replacement. Processing development is currently in progress and will be followed by clinical evaluation. Leeds University has demonstrated that orientated polymers, because of their low wear, compressive creep and permeability, can be used for a range of biomedical applications especially for orthotic and prosthetic devices. Stanmore Hospital has improved the effects of heat treatment and surface finish on two alloys, Co-Cr-Mo and Ti 318, used in total joint replacements resulting in significant improvement in their fatigue life.

The Biomaterials Sub-Committee has also been keen to improve the provision of postgraduate education in biomaterials and has agreed to sponsor a two-week short course at Leeds and Liverpool Universities (see page 25). This aims to improve the awareness of the research community to potential developments in these fields.

Contact points

The new Medical Engineering Sub-Committee invites grant applications in the research areas outlined and the Coordinator will be pleased to advise and help in the preparation of such applications. Interested applicants should contact either the Coordinator, Dr Arthur Mason, at Daresbury (0925-65000) or the Secretary of the Medical Engineering Sub-Committee, Mr Stuart Ward, at SERC Central Office, Swindon (ext 2110).

Combustion engines coordinator chosen

Mr Lindsay G Dawson has been appointed coordinator for the Specially Promoted Programme in Combustion Engines, it was announced in August.

Mr Dawson, who is a consulting engineer, can be contacted at 19 Piper Drive, Long Whatton, Leics. Tel: Loughborough (0509) 842591

The CRAY-1 computer service at Daresbury

About two years ago a new type of computer, a vector processor, was installed at Daresbury Laboratory. The computer can perform scientific calculations much faster than existing conventional machines and was provided as a 'state of the art' facility to enable new areas of research to be opened up. This article looks at the machine and the kinds of use to which it is being put.

The origins of the case for a vector processor computer can be traced back to the early and mid 1970s when two reports pointed to the need for an order of magnitude increase in computing power over the most powerful machines then available (IBM 360/195, CDC 7600), in order to be able to tackle important calculations in the physical sciences. By 1978 machines capable of meeting the need were coming on the market and towards the end of that year a working party of scientists was convened to evaluate the scientific case for such a computer, with a view to the SERC obtaining one if the case was good. The working party's verdict was positive and in March 1979 Council agreed that a computer should be obtained and installed at Daresbury.

The computer selected for the job was a Cray-1. The most striking first impression of the Cray is its compact physical size. The central processor and memory are contained in a vertical cylinder some six feet high and five feet diameter. Around the foot of the cylinder is a padded seat beneath which are housed the machine's electrical power supplies. The small size of the Cray is not accidental; it follows from the need to keep the wires inside the machine as short as possible so that delays in propagating signals do not slow the computer down.

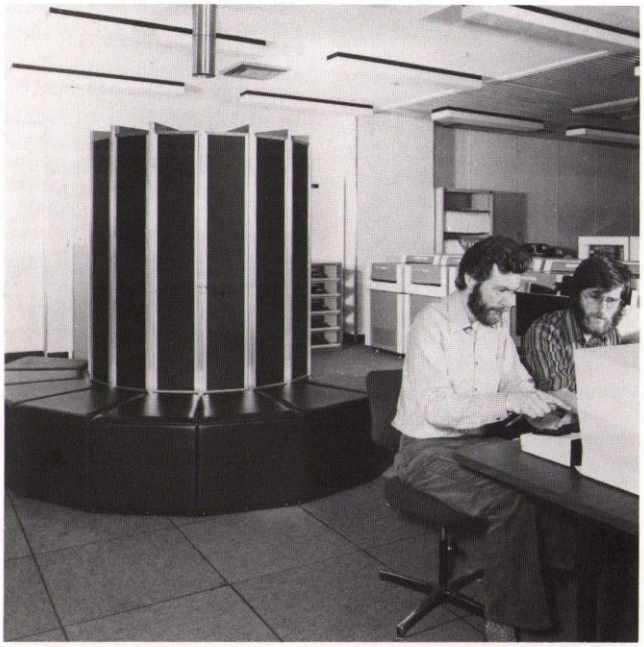
The Cray achieves its very high performance partly because of its small size and its use of fast memory and logic components. These features are probably sufficient to make it perform at about twice the speed of a 360/195. However the machine also contains hardware designed to handle certain types of arrays of numbers (vectors) and it has several functional units which can be concurrently operating on different sets of data. These features can contribute a further factor of five or ten in speed. Overall, several tens of millions of operations per second can be carried out, depending on the vector content of programs and the extent to which different operations can be overlapped.

Fortunately most users do not need to be aware of the computer's inner complexities to realise its high performance. The Cray accepts standard Fortran programs and the Fortran compiler automatically looks for vectors and opportunities for concurrent operation so as to make best use of the computer's hardware. If the resulting performance is not sufficient, a user can often make relatively minor changes to his Fortran which will enable the compiler to make a better optimisation. Further performance improvements can sometimes be made, if necessary, by using assembler language for tricky sections of code, but this is regarded as a last resort and is not needed in most cases.

What is the Cray being used for? There are now about fifty groups of scientists using the computer. They come from disciplines as diverse as astrophysics and protein crystallography and they are based in universities and laboratories across the country. New scientific results are being produced. Early calculations included the quantum mechanical structure of large many-electron systems such as Cr_2 $(O_2CH)_4$ and similar quantum chemical calculations are leading to a better understanding of chemical reactions. Atomic processes are being calculated to unprecedented accuracy and these are particularly important in understanding processes which are difficult or impossible to investigate experimentally. For example, many of the atomic transitions which give rise to stellar spectra are in this category, and calculations performed on the Cray-1 are helping the understanding of stellar composition and structure by allowing more information to be extracted from the optical spectra of stars. In molecular dynamics calculations, the properties of liquids are being studied by simulating the motions of the molecules. The extra power of the Cray means that a larger number of molecules – hence much more representative – can be treated. In protein crystallography the extra power is enabling the structures of important protein molecules to be refined.

Some of this work is done under the auspices of the Collaborative Computational Projects which are coordinated from Daresbury. In these Projects different groups come together to develop large program packages to solve computational problems in theoretical physics, chemistry and biology. About ten per cent of Cray time is taken by the Natural Environment Research Council for large scale modelling work.

As regards the Cray machine itself, the computer delivered two years ago was the prototype Cray-1 which had already done service for Los Alamos, the European Centre for Medium Range Weather Forecasting and Aldermaston. This machine was at Daresbury until March this year when it was replaced by a more reliable production machine. The Cray is connected to Daresbury's mainframe computer (previously an IBM 370/165 but now replaced by an NAS AS7000, see page 21) and thereby to the SERC computer network which can provide access to the machine from most universities in the UK.



Cray-1 at Daresbury: its compact size contributes to its high-speed performance. Several tens of millions of operations can be carried out per second.

VULCAN: a versatile new laser system

A major upgrade and redesign of the high power laser system at the Rutherford Appleton Laboratory was completed early this year giving university user access to probably the world's most versatile laser facility.

The laser now has two independent amplifier chains and can consequently deliver laser pulses from 100 picosecond to 10 nanosecond duration with powers up to the terawatt level to two separate target areas, thus permitting two experimental teams to work in parallel. In one experimental area a single laser beam is focused on various targets. The beam is either used directly or passed through harmonic generator crystals to convert it to its second, third or fourth harmonic. This allows laser-target interaction studies to be pursued at four different laser wavelengths from the infrared to the ultra-violet.

In the other target area, six beams are available for experiments involving the compression of spherical targets by laser driven ablation pressure. The six primary infrared beams arriving in the area are converted in non-linear crystals to the second harmonic at a wavelength of 530 nanometres (green light) before being focused with six large aperture lenses on to gas-filled shell targets of about 100 micrometres diameter.

Previous single beam experiments have indicated that considerably enhanced drive-pressures can be achieved by green-beam irradiation of targets compared to the infrared. Experiments at the Laser Facility can now take advantage of this. Several other laboratories implode spherical targets using numbers of infrared beams but for the present this multi green-beam compression facility is a world first and will enable British plasma physicists to maintain a prominent position in the field of laser-driven compression.

X-ray probing is a major diagnostic technique that is being developed by users of the Laser Facility for measuring the parameters of dense laser-produced plasmas. The new laser system has been designed to make a significant advance in this technique since the installation of a pulse stacker after the laser oscillator now allows a short (100 picosecond) pulse to be fed down one amplifier chain to generate a plasma x-ray source while at the same time a long pulse (1 nanosecond) is built up by the stacker and fed down the other amplifier chain to implode the target. Thus for the first time flash-radiography of imploding targets will be possible allowing important information about shell stability during implosion to be studied.

Such is the flexibility of the new laser configuration that as well as providing a long pulse to drive implosions and a high power, short pulse for x-radiography, a synchronous short pulse is available for conversion to higher harmonics for optical probing studies. Consequently it is now possible to measure on a routine basis the density profiles and magnetic field structures occurring in the plasma ablated from plane targets and observations of the symmetry of the plasma expansion from spherical, six-beam irradiated targets.

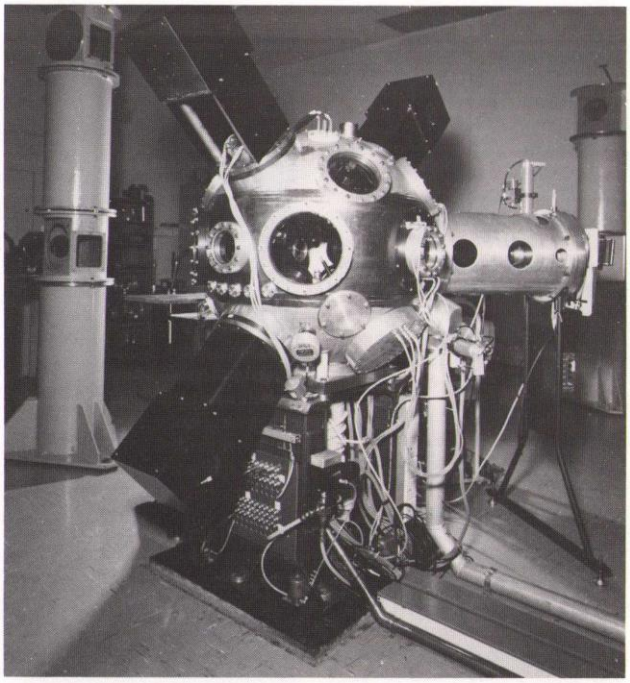
The versatility of the new laser system has been demonstrated by the rapidity with which major new scientific results have been obtained. Since imploded target core densities increase dramatically for higher drive pressures, accurate measurements of laser driven ablation pressure are of vital importance to the progress of laser compression schemes. Ablation pressures depend on the rate at which material is vaporised and ablated from the target surface by the laser radiation. Measurements of these rates on plane layered targets by time-resolved x-ray emission techniques, using the single beam multi-wavelength target irradiation facility, have shown conclusively that considerably increased pressures can be generated on targets irradiated at short wavelengths compared to the infrared.

These results have been confirmed and extended in a series of carefully performed experiments carried out on layered spherical targets using the six green-beam experimental facility. In this much more ideal experimental situation, where problems of laser focal-spot edge effects are removed, simultaneous ion ablation measurements and time-resolved x-ray observations have demonstrated that the increased drive pressures achieved with green light more than offset the losses involved ($\sim$ 50%) in the harmonic conversion process.

In a further series of compression experiments, time-resolved x-ray backlighting observations of imploding shells have enabled measurements of the trajectory and inward acceleration of the target wall to be carried out. These results have shown conclusively that the use of green radiation to drive implosions leads to very efficient conversion of laser energy to kinetic energy of inward shell motion. Additional x-radiography experiments have shown that micro-disc type targets can be accelerated stably to world-record velocities greater than 200 km/sec when irradiated with green light.

An extensive series of further experiments has already been scheduled to take advantage of the flexibility, reliability and versatility of the new laser system and to ensure that users of the Laser Facility maintain their position in the forefront of international laser interaction and compression research.

PR



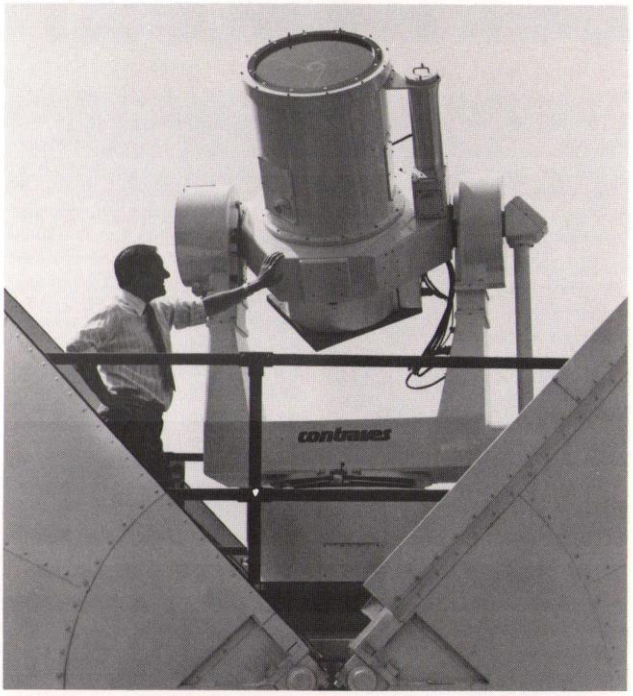
Target chamber for conducting six green laser beam driven compression experiments.

Satellite laser ranger

The Royal Greenwich Observatory has recently taken delivery of the telescope system for the UK's new facility for precise laser-ranging to satellites carrying retroflectors. It comprises a refractor of 10 cm aperture to transmit the laser pulses, and a reflector of 50 cm aperture to collect the returning photons. The two subsystems share a common mount which will be capable of tracking under computer control at 2° per second with an accuracy of 25 microradians. A building previously used for observing the Sun has been adapted for the new facility; an eye-lid dome and access platform have been fitted, air-conditioning and a clean air tent for the laser have been installed in the room below the telescope, and a support frame for a radar mount and radome has been built on the roof of the control room.

The Applied Physics and Electronic Engineering Departments of the University of Hull are responsible for the laser, receiver and timing subsystems and expect to deliver them to Herstmonceux in March 1982. The laser will be a mode-locked neodymium-YAG system operating at the second harmonic at a wavelength of 530 nm; the pulse length will be 150 ps, the energy per pulse will be about 30 mJ and the repetition rate will be 10 Hz. The receiver and timing subsystem will measure the interval from emission of a pulse to the detection of a returning photon with a precision of about 100 ps.

The system will be capable of ranging to targets like the LAGEOS satellite, which is at a height of 6000 km, so determining their distances with a precision of better than 2 cm. This represents an improvement by at least an order of magnitude over SLR systems in common use elsewhere in the world and is matched by only a few systems now coming into use.



Above The Satellite Laser-Ranging Facility was installed in July in its new eye-lid dome at Herstmonceux, supervised by Mr P F Cottrell, in charge of the Engineering Workshop.

Below NASA's LAGEOS (Laser Geodynamic Satellite, for studies of the earth's gravitational field) has a 60 cm diameter. The new laser-ranging facility is designed to determine distances of such satellites to a precision of better than 2 cm.

During the next few months the RGO will commission the telescope and x-band radar system and will test the computer programs for the control of the system and for the prediction of the positions of satellites. The radar will detect any aircraft that is likely to pass through the laser beam so that emission can be inhibited to prevent any risk of damage to the eyes of persons looking out of an aircraft towards the Observatory.

The facility will be operated by the Time Department since the main interest of the RGO is its use for the determination of the variations in the rotation of the Earth. The data will also be of value in connection with many aspects of Earth sciences (such as the gravitational field, internal structure, geodesy, oceanography, atmospheric physics, celestial mechanics) and so the Solar System Committee of the Council's ASR Board has set up a Users' Advisory Committee, under the chairmanship of Mr D G King-Hele FRS of the Royal Aircraft Establishment, with members from universities, polytechnics and research councils. The committee will advise on the operational programme and will encourage cooperation in the analysis of the data, which will be exchanged with other countries.

The results of the analysis are expected to be at least an order of magnitude more precise than those now available. It is hoped it will therefore be possible to explore new fields of interest, such as the direct determination of the motions of tectonic plates, as well as to study in finer detail phenomena such as polar motion that have been studied by 'classical' techniques. It is also hoped that such an improvement in precision will draw attention to unsuspected phenomena or be used in ways not so far envisaged.

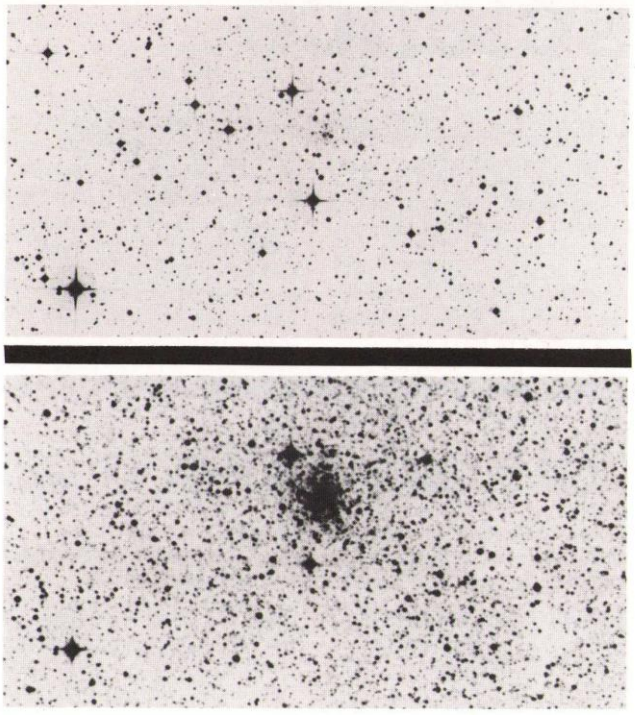
Further information about the project may be obtained from Dr A T Sinclair at the Royal Greenwich Observatory.

Infrared sky atlas

Exploring the Universe in new ways has always been one of the most exciting aspects of astronomy. In July, the Royal Observatory, Edinburgh (ROE), issued the second instalment of photographs for a new near-infrared atlas of the sky. Comparable photographs have never before been obtained beyond the normal range of visible light, so this Atlas promises to yield a rich harvest of new discoveries and to provide a fresh understanding of the structure of our Galaxy.

In these days of sensitive photoelectric devices, photography may seem an unlikely technique to use, but a recent discovery has enabled astronomers to use infrared-sensitive emulsions successfully at the extremely low light levels involved in photographing stars and galaxies. The trick is to bathe the photographic plates (Kodak type IV-N) in a dilute solution of silver nitrate prior to exposure in the telescope. This hypersensitisation technique enables astronomers to obtain photographs (in exposure times of an hour or longer) at wavelengths of around 800 nm which are quite comparable in depth and quality with the best pictures obtainable in visible light.

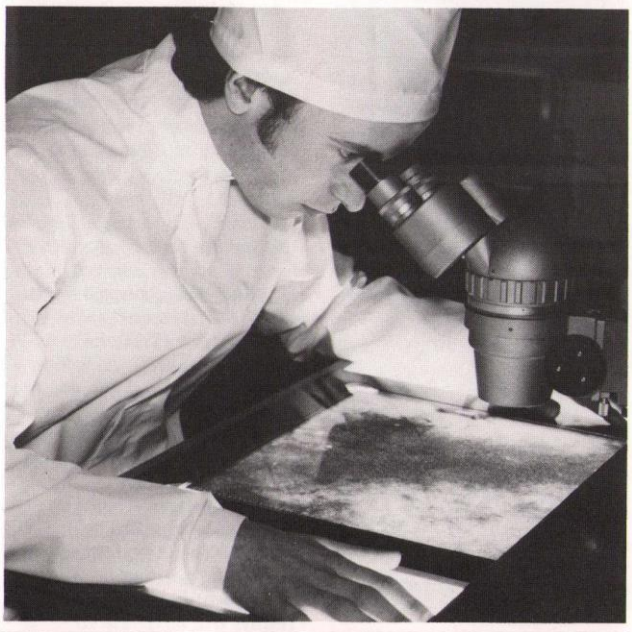
This technique is now being exploited at the UK Schmidt Telescope (UKST) in Australia. The major project is to carry out a systematic sky survey; the first phase, now nearing completion, covers all of the Southern Milky Way and the two Magellanic Clouds. The Milky Way was chosen initially because it includes several regions where star formation is going on, and because many interesting objects are obscured by foreground dust clouds: infrared radiation penetrates these dust clouds much more easily than does visible light.



Negative photographs of a star cluster near the centre of our Galaxy, heavily obscured by foreground interstellar dust.

Above In a blue-light photograph from the SRC(J) Atlas the star cluster (in the middle of this photograph) is barely detectable.

Below The same cluster is very clearly shown in the equivalent photograph from the UKST Near-Infrared Sky Atlas.



Right

ROE photographer Duncan Waldron inspecting one of the photographs for the UKST Near-Infrared Sky Atlas. All the work has to be done in very clean, dust-free conditions because small specks and flaws can be very easily mistaken for images of stars or galaxies.

Two other reasons for undertaking this survey were the commissioning in 1979 of the UK Infrared Telescope (UKIRT) in Hawaii and the planning of IRAS, the Infrared Astronomy Satellite to be operated jointly by NASA, the Netherlands and the UK, due to be launched in August 1982. The UKST Near-Infrared Sky Atlas will help to bridge the gap between observations at visible wavelengths and the new infrared data provided by UKIRT and IRAS.

The first phase of this UKST survey consists of 163 pairs of near-infrared and red photographs. The red-light photographs are included to make it easier to select the most interesting very cool objects, which show up much more strongly in the infrared. Most of the necessary photographs have already been taken with the telescope in Australia. Sets of film copies are now being produced in the Photolabs at the ROE for publication as an Atlas. About sixty copies of this Atlas have been ordered by institutions throughout the world of which some twenty are being provided by the SERC for UK universities and observatories.

The success of this survey has been so great that plans are now being made to extend the work to cover the whole southern sky. It turns out that the most distant clusters of galaxies, some quasars, and several rare types of star are more easily detected in the infrared than on the 'deepest' (most sensitive) visual-light photographs.

RDC

Blending science and social science

Many problems of technical change within industry and public service today demand that the technical and scientific understanding of those who work in them is matched by an appreciation of the social, economic and psychological forces which shape that change. Because of the need to influence the development of technology in directions that are both economically sound and socially acceptable, the Joint SERC-Social Science Research Council Committee was set up in 1968 to provide support for research and postgraduate training in the areas of science, engineering and social science covered by the two councils.

Postgraduate training

Initially the Committee focused its attention on providing more trained postgraduates, through advanced courses and research studentships, with an understanding of both the technical and socio-economic aspects of change and their inter-relationship. The Committee now supports well-established courses combining the social and physical sciences in a variety of ways and including, where possible, a research project in industry. The courses are attracting high quality students who are obtaining rewarding jobs in a wide range of organisations where their effectiveness is increased by their interpersonal skills as well as technical expertise.

The Committee has recently taken over responsibility for the Total Technology programmes which are specifically designed to provide the interdisciplinary skills required of professional engineers in modern industry. These programmes provide three year research training and include an in-company project which is often of direct and immediate benefit to the participating company. The universities which organise these courses are still developing the knowledge and procedures needed to maintain the relevance of their content and structure in a rapidly changing social and industrial climate. The Committee ensures that such knowledge is shared between the universities through seminars, workshops and personal contacts.

This wheelchair can be easily adjusted by a severely handicapped child to enable him to find the position that gives the greatest support and comfort; this in turn will improve his concentration and hence his learning power. The chair, which is both robust and cheap to produce, was designed by Gary Sweetman of the Handicapped Persons Research Unit, Newcastle Polytechnic. The unit is supported by a grant from the Joint SSRC-SERC Committee.

Since 1977 the Committee has placed increasing emphasis on encouraging and supporting research on topics which require new approaches of an interdisciplinary nature. For example, the Committee is keen to support projects which investigate the factors which influence the level and success of innovation in industry. Two projects recently completed by Aston and Bradford Universities analysed the organisational barriers to innovation in a medium-sized chemical manufacturing company and the commissioning of engineering projects in a variety of small companies. From such studies it is hoped that general principles can be developed on how more innovative activity can be achieved in different organisational settings. The Committee has also funded research on the support of technological change on the shopfloor. A recent grant to Southampton University will enable the New Technology Research Group to investigate the effects of the modernisation of the telephone exchange in British Telecom, the adoption of a computer-based freight information system in British Rail and the introduction of electronic news gathering equipment in television. The results will be of use to industrial managers and trade unions faced with planning, negotiating and implementing such major changes. Another area of research supported by the Committee is that of environmental design. The Handicapped Persons Research Unit in Newcastle has designed a work centre which has been shown to improve the comfort, concentration and hence the learning of handicapped children in the classroom.

The Committee is conscious that it is often more difficult to define the aims of interdisciplinary programmes than is the case with research in a single discipline. Where appropriate the Committee will award starter grants to aid the formulation of such programmes. The grants enable researchers who have established an initial outline of their aims and scientific methods to undertake some preliminary work which will help them refine and prepare a detailed research proposal for full grant support.

In April this year the Council appointed Mr Harold Palmer as coordinator for the Committee's activities, to advise on the needs of industry and encourage and help universities and polytechnics develop their interdisciplinary postgraduate education and research. The Committee aims not only to maintain the effectiveness of its existing postgraduate training course but to establish new courses of comparable quality and generate more research grant applications with appropriate interdisciplinary content.

Anyone interested in discussing in more detail the Committee's current activities or how they might participate in future programmes should contact either Mr Harold Palmer, c/o the Department of Social and Economic Studies, Imperial College, 53 Prince's Gate, Exhibition Road, London SW7 2PQ (tel: 01-589-5111 ext 2848) or Mrs Audrey Heselwood, SERC Central Office, Swindon, extension 2429.

New directorate on biotechnology

SERC has established a new Directorate to foster and co-ordinate a programme in biotechnology. The Council has been supporting research in the field for many years through its Science and Engineering Boards but believe it is now timely to launch a major co-ordinated activity. Recent developments in recombinant DNA research have provided the tools for revolutionary advances in the industrial application of biotechnology. Total new industries are being created and many traditional industrial processes may be superceded by new biological industries. The increased costs of energy and of oil-based feedstocks have highlighted the growing importance of exploiting such potential applications.

Over the last year an advisory panel of academic and industrial experts under the chairmanship of Dr A T James (Unilever) has been responsible for defining and fostering interest in an SERC programme. Among the research areas so far identified are fermentation, enzyme and immobilised cell technology, separation and concentration technology, product processing, waste product and by-product utilisation, and recombinant DNA technology.

The broad aims of the programme will be to bring together biologists, process engineers and experts in related fields to undertake more research in topics identified and to speed up industrial exploitation of such research. A co-ordinated activity through a Directorate is regarded as vital because of the multidisciplinary nature of the subject and the need to obtain the extensive involvement of various sectors of industry and close collaboration with other Research Councils and government departments.

Promoting molecular electronics

The importance of the device applications that could follow further investigation of the electronic properties of molecular materials was recognised by SERC in autumn 1980, when the Chairman called together academic and industrial scientists from a range of disciplines and set up the Molecular Electronics Discussion Group. The aim of the group was to discuss potential research objectives within the field of molecular electronics and how these objectives might be pursued within both industry and university research centres.

The group, under the chairmanship of Mr D Roberts of GEC, considered that a first requirement was to identify, within academe and industry, those groups whose current research came within the field of molecular electronics and whose work could have ultimate applications in the electronics industry. Accordingly a questionnaire was circulated to over 400 university departments in May this year, the results of the survey are being analysed by the discussion group at its meeting in late 1981.

The discussion group also recommended that a small number of working parties should be set up concerned with well defined areas of the field in order to make recommendations for the promotion of collaborative research on selected topics and suggested that the first working party should be concerned with the exploitation of Langmuir-Blodgett thin film deposition technology.

Langmuir-Blodgett Working Party

The first meeting of the Langmuir-Blodgett Working Party took place in June 1981 under the chairmanship of Professor Gareth Roberts of the Department of Applied Physics and Electronics at the University of Durham. One of the primary aims of the working party is to consider how Langmuir-Blodgett film research might best be exploited to the advantage of UK industry.

Langmuir-Blodgett films are an interesting example of ordered organic systems; they may be assembled one monolayer at a time to form a planar, two dimensional sheet of accurately controlled thickness. The preparation process generally involves depositing a small quantity of a solution of a suitable organic material on to a liquid surface and waiting for the solvent to evaporate; the floating molecules may then be compressed until a quasi-solid, one molecule thick, is formed. The container which holds the liquid subphase (usually highly purified water) upon which the monolayer floats is termed a Langmuir trough. The thickness of the film then depends on the number of monolayers deposited and the molecular size of the material used.

Langmuir-Blodgett films are now the subject of broad and intense study in both the physical and biological sciences. This has led to a need for an improvement in the design of the deposition system and the synthesis of novel materials with the required structure to form oriented monolayers on a substrate. Progress has only been achieved by collaboration between solid state physicists and innovative synthetic chemists. Possible technological applications of LB films are numerous but as an example the good insulating qualities of many materials have led to their incorporation in field effect devices. Thus, whereas the success of integrated circuits based on silicon is due largely to its native oxide, LB films have been successfully deposited as insulating layers on to other semiconductors. An attractive feature of the Langmuir trough technique is its large area capability which could be exploited in display and photovoltaic devices. The presence of an organic layer within a transistor structure also offers exciting possibilities in the transducer field and by assembling biological molecules such as antibodies and enzymes within insulating LB films, it is possible to propose field effect devices for monitoring immunological response (IMFETs) etc. The LB technique also provides a means of building up organized supermolecular functional units which would be difficult or impossible to achieve by other means. This capability is likely to be capitalized upon in future investigations of high temperature superconductors, organic semiconductors, conducting polymers and magnetic storage devices.

The Langmuir-Blodgett Working Party is currently formulating recommendations for the promotion of research. Actions are likely to include special symposia where experienced workers can report progress and exchange ideas, industrial visits, and regional meetings to attract new academics and industrialists into the field. A large international conference on Langmuir-Blodgett films is to be held at the University of Durham in September 1982.

Dr D Yarrow at SERC Central Office, Swindon (extension 2212) is responsible for the coordination of the activities of both the Working Party and the Molecular Electronics Discussion Group and can provide further information.

The role of the Cambridge Crystallographic Data Centre

The Chemistry Department in Cambridge has housed since 1965 an unusual project – the compilation, by a small group of crystallographers, of a computerised database on crystal and molecular structures. Over the years the operations of the Cambridge Crystallographic Data Centre have grown considerably and are now supported partly by a rolling grant from the SERC Chemistry Committee and partly by international subventions. Its product, the Cambridge Structural Database, is a major British contribution to international efforts aimed at preserving and disseminating critically evaluated scientific data.

The Structural Database contains bibliographic, chemical and numeric crystallographic data for all organics, organometallics and metal complexes studied since 1935. Critically evaluated results for some 30,000 analyses are now available, with about 4,000 new entries added each year, or one for each half-hour of a working day. The database can be searched for bibliographic and chemical text, and for complete chemical structures or substructures. The numeric data may then be retrieved and used to prepare diagrams and illustrations, and for a wide variety of geometric calculations. The Centre is now working on a new development which will allow the computer storage and retrieval of chemical diagrams in addition to the crystallographic illustrations already available.

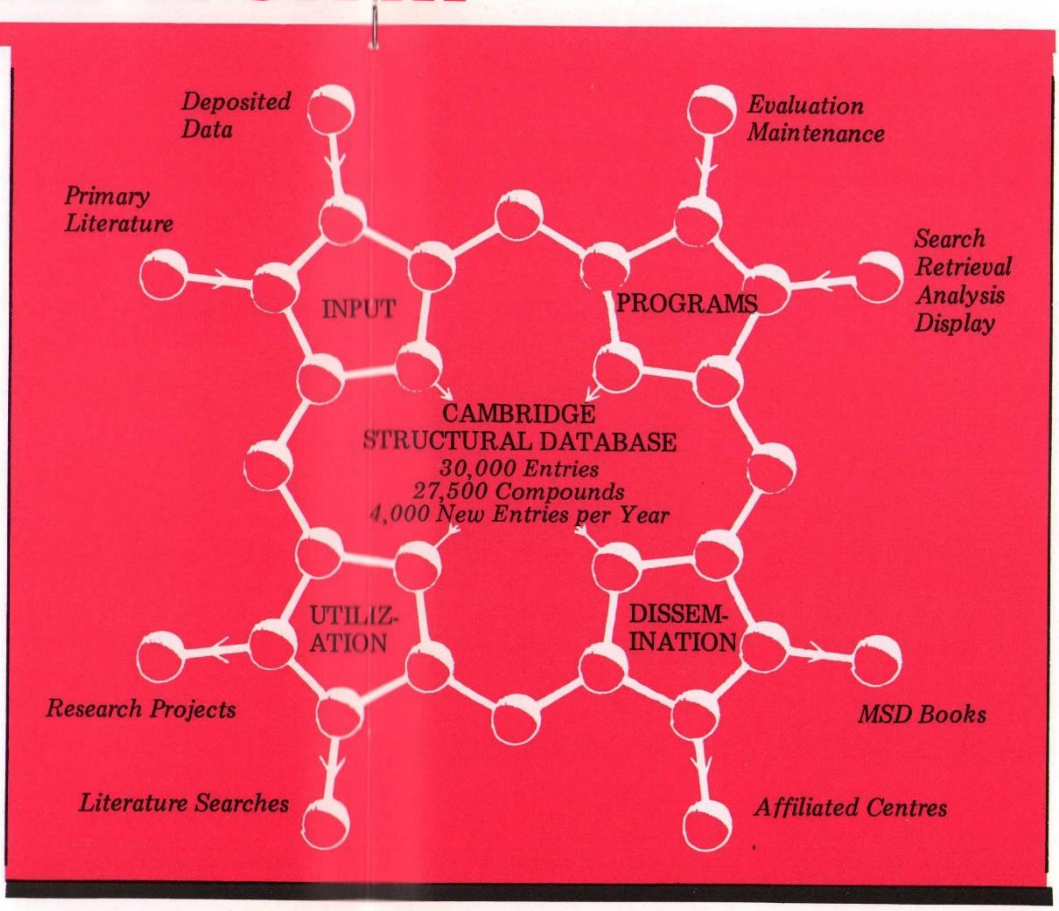
The need for the Database

A crystallographic study is a highly sophisticated analytical tool, resulting in identification of element types and bonding patterns, and three-dimensional coordinates for each atom. A wealth of accurate geometric data is also derived in the form of bond lengths, valence angles and conformational descriptors. Such results may have impact in many fields: a structure determined to provide analytical data for a chemist may be of conformational interest to a molecular biologist or pharmacologist.

Today a vast amount of crystallographic information is available for a wide variety of compounds. Theoretical and technical advances applied to structure solution methods, automated data collection and computers have led to almost

Dr W B T Cruse (left) preparing a crystal for x-ray examination – an illustration of the research activities linked to the Data Centre. With him is Dr Kennard.

Molecular Structures: a new look...



Right: Cambridge Structural Database: a schematic outline of the activities of the unit.

exponential growth in output. The number of organo-carbon structures published in 1980 equalled total production for the decade 1960-69.

A fundamental requirement for data which is to be re-used, perhaps by non-specialists, is accuracy. More than 20% of input papers contain at least one numeric error and the Centre has developed error-detection techniques. Critical evaluation and error-correction, often in conjunction with authors, has reduced residual errors to 2% in the database. In recent years the Centre has also begun to act as a depository for unpublished data from a number of journals. Thus the database is both more accurate and more comprehensive than the original literature, and is used in preference to the latter for in-depth investigation in many fields.

Availability

The Structural Database is available internationally via national affiliated data centres, responsible for use within their own geographic boundaries. Each affiliated centre holds current computer files and is supplied with the Cambridge program system for search, retrieval, analysis and display. Some centres have developed their own interactive or batch programs and offer a variety of services to users. The 17 affiliated centres now cover 20 countries worldwide. In the UK the database is available at Cambridge, at the London and Manchester Regional Computer Centres, and via Crystal Structure Search and Retrieval, on the DEC-10 at Edinburgh University.

The Cambridge Centre also produces the reference book series *Molecular Structures and Dimensions*. The first two bibliographic volumes were produced by computer typesetting methods as early as 1970. Bibliographies are now published annually and typeset via the FR80 microfilm recorder at Rutherford Appleton Laboratory: volume 12 appeared in July 1981.

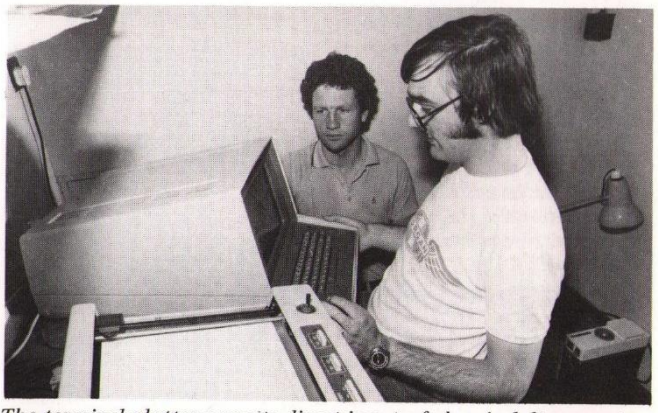
Utilisation

Initially the database was used by crystallographers for literature searches and to compare their own results with those from related studies. This use will obviously continue and grow but the real potential of the database lies in the systematic utilisation of numeric structural data for the very wide variety of compounds that have been studied by x-ray methods. These range from common 'known' structures to a rare 'one-off' compound where x-ray analysis was the final recourse of characterisation. The past two years have seen an encouraging number of papers where numeric data from solid state studies has been correlated with chemical and theoretical results. Thus the database has contributed to reaction-pathway analysis; structure-reactivity and transition-state studies; structure-activity correlations; studies of hybridisation and substituent effects; and to the classification of intermolecular interactions and hydrogen bonding.

Results from these studies show that small, but nevertheless important, variations in molecular structure may not be revealed by an individual x-ray analysis. Such effects can only be seen when a large body of data for related structures are analysed systematically. The Structural Database and associated computer programs provide the tools for this re-appraisal of existing results. These tools are now available, not just to crystallographers, but to all scientists concerned with molecular structures.

Olga Kennard
D G Watson and
F H Allen
Cambridge Crystallographic Data Centre
University Chemical Laboratory
Cambridge

Dr Olga Kennard (right), in charge of the Centre, discusses with Dr Robin Taylor a project connected with the scientific utilisation of the database, comparing a statistical survey with physical models.



The terminal plotter permits direct input of chemical diagrams in the database. Operating the terminal is Dr B A Cartright, with Dr J E Davies (background).

Affiliated data centres operating in 1981 covering 20 countries across five continents

Australia	**India**	**New Zealand**
Belgium	**Israel**	**Scandinavia**
Brazil	**Italy**	**South Africa**
Canada	**Japan**	**Switzerland**
France	**Netherlands**	**U S A**
Hungary		**West Germany**

Each volume of Molecular Structures and Dimensions is prepared from flat sheets of camera-ready material produced by Mrs K Crennell using the FR80 microfilm recorder at Rutherford Appleton Laboratory. At Cambridge, the FR80 output for Volume 12 is inspected by (Left to right): Dr S Bellard, Dr D G Watson and Dr F H Allen.

Astronomy goes Dutch

An international agreement on astronomical research has been signed between the SERC and their counterparts in the Netherlands, just 15 months after the possibility of such a partnership was first discussed.

Thirty astronomers and research council staff from the two communities met in the Royal Greenwich Observatory in March 1980 to discuss the new observatory being built on La Palma. The degree of goodwill and enthusiasm generated at that meeting led to a formal agreement being signed in a remarkably short time by the standards of international negotiation. The agreement, a 'Protocol on Collaboration in Astronomical Research on La Palma', was concluded between the SERC and the Netherlands Organisation for the Advancement of Pure Research (ZWO) on 18 June.

The SERC-ZWO partnership will result in the Netherlands providing 20% of the manpower and costs of the construction and operation of four telescopes in return for the same proportion of the observing time otherwise available to the UK. The 80:20 balance approximately reflects the relative sizes of the two communities and it is hoped that a common peer-review system will be set up for allocating telescope time to the best scientific proposals from both countries. Experience of other international collaborations has shown how two communities, working in real partnership, can gain in stimulus and new ideas. This will be particularly important in developing new instrumentation in order to keep the Observatory a world leader through its useful working life.

The La Palma site itself, known as the Roque de los Muchachos Observatory, has been shown to be one of the best observing sites in the northern hemisphere.

The need of several European nations to have access to such good conditions led, in 1979, to an international agreement between Spain, the UK, Sweden and Denmark to create the observatory. Spain is providing the site and infra-structure and other nations are constructing telescopes. The Netherlands will now join the UK in providing the four major telescopes, to be completed by 1986 (see opposite).

Informal collaboration between British and Dutch astronomers at the UK Infrared Telescope on Hawaii has also started. When taken together with the large southern hemisphere telescopes to which the two communities separately have access (at the European Southern Observatory site in Chile and at the Anglo-Australian Telescope in New South Wales) and with the strong radio-astronomy base in both countries, it is clear that British and Dutch astronomers will be well placed for ground-based observations. They will be able to exploit fully data coming from satellites such as the Space Telescope (the NASA-ESA project due for launch in 1984) and IRAS (the NASA-SERC-Netherlands infrared satellite due for launch in August 1982).

The Anglo-Dutch partnership was signed in a formal ceremony in Amsterdam by Professor W F de Gaay Fortman, Rector of the Free University of Amsterdam and Chairman of the ZWO Board and Council, and Dr H H Atkinson, Director of Astronomy, Space and Radio and Nuclear Physics, SERC. Seated are (left to right): Professor L de Ruiter, University of Groningen and Vice-Chairman of ZWO Board; Professor de Gaay Fortman; Dr Atkinson; and Professor F Graham Smith, Director of the Royal Greenwich Observatory, SERC. Standing (left to right) are: Professor van der Laan, Leiden University and Chairman of Netherlands Foundation for Radio Astronomy; Professor R van Lieshout, Director of ZWO; Dr H Weijma, central office of ZWO; Dr K H Chang, Netherlands Ministry of Education and Science; Professor A Blaauw, Leiden University and Chairman of ASTRON (the Foundation for Astronomical Research); Dr P T Davies, ASR Division, SERC; Professor A T de Hoop, Technical University of Delft and member of ZWO Board.

Herschel commemorated

The new 4.2 metre telescope, which will be the largest of the three main optical telescopes in the Roque de los Muchachos Observatory on La Palma, was officially named the William Herschel Telescope in April. Speaking at the National Maritime Museum as part of National Astronomy Week, Professor F Graham Smith said that the telescope would have very high quality optics and precise mechanical drives to take full advantage of the excellent observing conditions on La Palma.

Sir William Herschel (1738-1822), discoverer of the planet Uranus (1781), made outstanding advances to observational astronomy by his invention and use of large telescopes. He used the Alt-azimuth mounting which has been adopted for the 4.2 metre telescope. One of his best telescopes, with a 2-ft diameter mirror, was purchased by the King of Spain and installed in Madrid in 1804 – an appropriate link with the new William Herschel Telescope, because the Roque de los Muchachos is a Spanish Observatory set up for the benefit of astronomers from several European countries.

La Palma progress

The 2.5 metre Isaac Newton Telescope

The original INT, formerly at Herstmonceux, has been refurbished by Grubb Parsons in Newcastle and was shipped to La Palma in July. Its dome, complete with shutter and dome-drives, electrical installations and sliprings, was handed over after proving in July when the first phase of installation of the telescope began, including the erection of the major components, using the 35 ton crane mounted in the new dome. The instrumentation programme is well under way and commissioning is expected to begin in the autumn of 1982.

The 1 metre Telescope

This is a new optical telescope for photometry and other complementary programmes in support of the 2.5 m and 4.2 m telescopes and has been temporarily erected in the old INT building at Herstmonceux to undergo development tests on the drive systems. Its dome is at present being built in Vancouver and the support building on La Palma is under construction. The acquisition guider box has been delivered by SIRA and the spectrograph by St Andrews University. Commissioning is expected to coincide with that of the INT.

The 4.2 metre William Herschel Telescope

The manufacture of the main telescope structure and its drive and control system is expected to be under way by the end of the year. Grubb Parsons have started the figuring of the 4.2 m primary mirror, a task which they expect will continue for about two years. Specifications for the secondary mirrors have been drawn up and design work has begun for the telescope dome and building. Commissioning of the completed telescope is expected to begin in late 1986.

The 15 metre radio telescope

This will provide an important facility for observations at wavelengths around 1 mm, the region of the electro-magnetic spectrum in which molecular clouds in space between the stars radiate and give valuable information on star formation. The facility is now being designed at Rutherford Appleton Laboratory. An unusual feature for a radio telescope will be the protective enclosure, the design of which is progressing satisfactorily. Development of the surface panels for the highly accurate dish of the antenna is entering the final stages and the major design work is expected to be carried out during 1982.

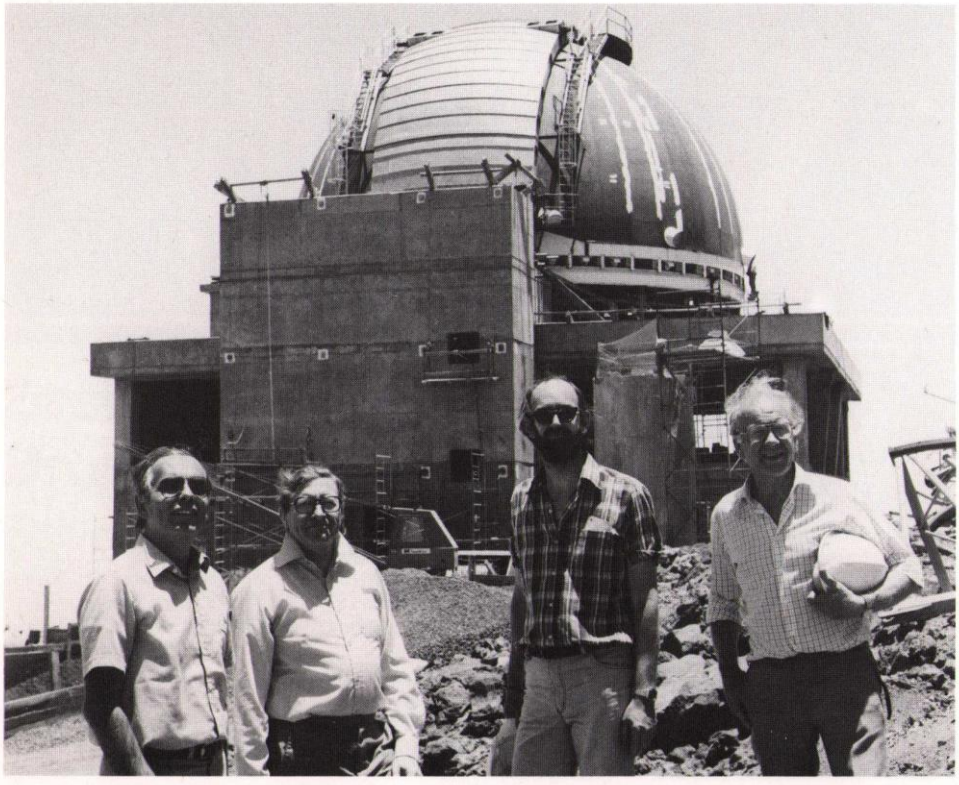
All these four telescopes and their buildings come within the Anglo-Dutch collaboration. Further international collaboration, with Denmark, is assisting with another facility.

The Carlsberg Automatic Transit Circle

This 20 cm aperture telescope, jointly operated by the RGO, Copenhagen University Observatory and the Instituto y Observatorio de Marina, San Fernando, is used for the positions of stars, Sun and planets as they transit the N-S meridian. Work on the building on La Palma is due to begin before the end of 1981 and it is hoped to have the telescope in commission a year later.

Site seeing

Professor Sir Geoffrey Allen, FRS, Chairman of SERC, visited the site of the new observatory complex on La Palma with colleagues in June 1981. Seen below the almost complete dome that will house the 2.5 m Isaac Newton Telescope are (left to right): Professor F Sanchez Martinez of the Instituto de Astrofisica de Canarias, Universidad de la Laguna, Tenerife; Sir Geoffrey; Dr Paul Williams (Head of SERC's Astronomy, Space and Radio Division) and Professor F Graham Smith (Director, Royal Greenwich Observatory, which is in charge of site operations).



Giotto on Merseyside

A display by SERC of British research in astronomy has recently completed three months in Liverpool, at the Merseyside County Museum. An estimated 30,000 visitors saw the exhibition which showed a range of projects grant-aided by the Council and featured the 1985 Giotto mission to intercept Halley's Comet and the new Northern Hemisphere Observatory in the Canary Islands.

The display, set up at the request of the museum to coincide with the inaugural meeting of the Association for Astronomy Education is being used at other venues, the first of which was the Science Museum Open Day Wroughton, Wiltshire) in September.

Developments in polymer engineering

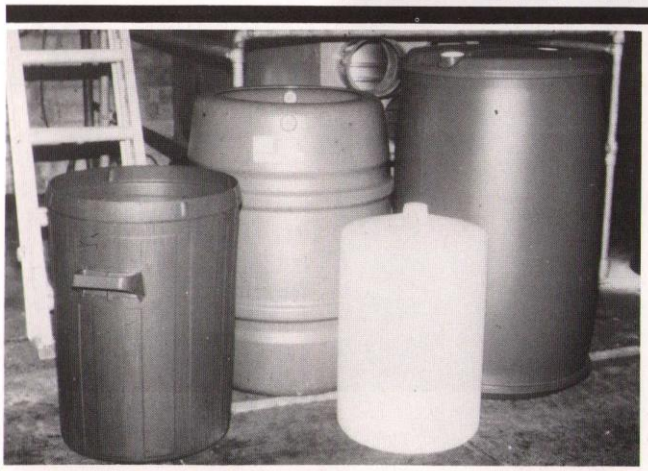
The Polymer Engineering Directorate (PED) was set up by the SERC in 1976 to mobilise the engineering-oriented skills of universities and polytechnics to help improve the performance of the UK polymer fabrication industry. It has now established a coherent programme of some 120 research projects, the majority of them in collaboration with industry, with a current commitment of over £4M. In addition to sustaining these existing projects, the Directorate is also actively encouraging applications from previously untapped sources, particularly those in design and instrumentation.

New director appointed

Mr Peter Rice, C Eng, F I Mech E, FPRI, who has been Acting Director of the Polymer Engineering Directorate since October 1980 when Dr Anthony Challis left to become Chief Scientist in the Department of Energy, has now been appointed Director of the Unit. Mr Rice joined PED in 1976 as Assistant Director from the plastics company Harcostar Ltd where he was Technical Director.

REVIEW MEETING 1981

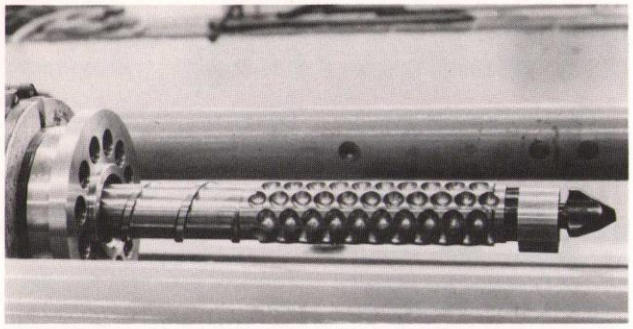
The second major review of projects funded by PED took place at Loughborough in April 1981, attended by some 250 delegates, one-third of them from industry. The meeting consisted of presentations of a number of individual projects backed up by informal sessions and a well stocked exhibition. Seen here are exhibitors and visitors at the Cranfield Institute of Technology stand.



BLOW MOULDING CLUB

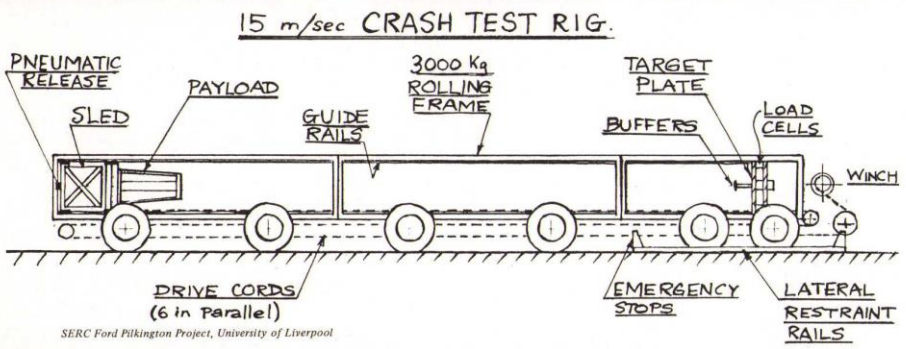
In addition to funding individual research projects, PED encourages the formation of cohesive groups, or 'clubs', of academics and industrialists to provide an interactive approach to particular problems. The Blow Moulding Club is one such collaborative venture involving Bradford, Loughborough and Newcastle Universities, QMC and a number of industrial companies in studies of wide-ranging aspects of the blow moulding process.

Already valuable data on cooling criteria have been produced and full scale trials have been undertaken in production conditions.



NOVEL MIXING HEAD FOR INJECTION MOULDING

Part of a programme at Brunel University involves an assessment of the performance of a novel bolt-on mixing head developed by RAPRA for use with an injection moulding machine. Use of the mixing head improves the dispersion of pigment and is particularly valuable for processing materials which require extensive mixing. The quality of the mix is determined by on-line optical characterisation methods and by studying mechanical performance of the mouldings made.



SERC Ford Pilkington Project, University of Liverpool

ENERGY ABSORBING COMPOSITES

Liverpool University is carrying out a major programme, in collaboration with Ford Motor Co Ltd and Pilkington Bros Ltd, to develop energy absorbing composites for the automotive industry. The primary objective is to produce a lightweight material to replace steel in car bodies with particular reference to unitary and monocoque structures. A servo-hydraulic machine is used to test axial compression of fibres at cross head speeds of up to 5 mph. New safety regulations will eventually demand passenger survival in a 30 mph head-on collision and a crash test facility is currently being assembled for this work.

FAILURE OF THERMOPLASTIC PIPE

Dr Marshall of Manchester Polytechnic has been working for several years on a programme aimed at improving the performance of PVC pipe. This is supported by four pipe manufacturers and two materials suppliers. The picture shows a pipe which was shattered following impact from a JCB; this simulates the sort of point-loading failure which previously frequently occurred in practice. Improvements in the quality of PVC and, more importantly, in its processing as a result of this collaborative programme have now eliminated this type of failure.

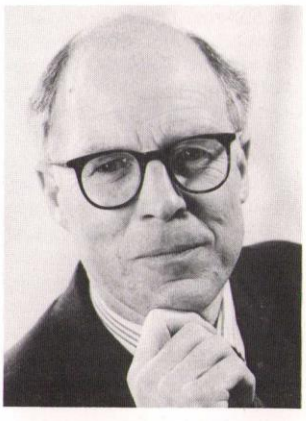
ROLL COATING OPERATIONS

At Bradford University, a second phase of a programme on roll coating operations has been approved aimed at measuring the roll separating force with purely viscous and viscoelastic liquids, film thickness measurements with viscoelastic liquids and the transfer of liquid between the roll and a substrate. The programme is supported both by equipment manufacturers and by users of roll coating machines.

Eastern Regional Broker appointed

Mr Stephen Bragg has joined the SERC's team of Regional Brokers. He will be based in Cambridge and cover a wide region of Eastern England including Cambridgeshire, part of Leicestershire, Northamptonshire, Bedfordshire and the whole of East Anglia. The brief of the regional brokers is to involve more firms in the Council's many schemes to support research and postgraduate training in universities and polytechnics in collaboration with industry and commerce.

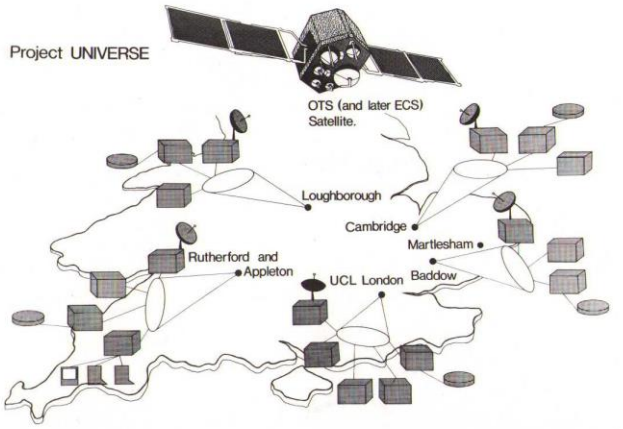
Mr Bragg has for the past ten years been Vice-Chancellor and Principal of Brunel University, following more than 20 years with Rolls-Royce Ltd (latterly as Director of the Aero Engine Division). He has taken up the appointment as Regional Broker as a result of his long-standing interest in improving liaison between industry and the academic world. He has served on numerous bodies including the SERC's Engineering Board, the Court of the Administrative Staff College at Henley and the University Grants Committee. He was elected to the Fellowship of Engineering in 1981. Mr Bragg may be contacted at 6 Chaucer Road, Cambridge, telephone Cambridge (0223) 352569.



Project UNIVERSE links computers through a satellite

A major national demonstration facility in communication between computers via satellite has been established by a consortium involving Government, academe and industry. Those involved in project UNIVERSE are British Telecom, Cambridge University, the Department of Industry, GEC-Marconi Electronics Ltd, Logica Ltd, Loughborough University of Technology, SERC and University College London. The cost of the project over three years will be approximately £3 million, shared between DoI, SERC, British Telecom, GEC-Marconi and Logica.

The combination in project UNIVERSE of ground-based Cambridge Rings (local networks) with satellite links will form a powerful new technique for high bandwidth transmission of data between computers which is of increasing importance to industry, business and scientific research. Project UNIVERSE will enable UK scientists to gain valuable experience in operating such a computer system and will provide a national demonstration facility to show to potential overseas customers with the promise of export orders and UK sales for the participating industrial companies. The scheme was first conceived at SERC's Rutherford Appleton Laboratory (RAL) and initially proposed as a joint research project with the universities (UNIVERSE stands for UNIVersities Expanded Ring and Satellite Experiment). The project was quickly extended when GEC-Marconi Electronics, Logica and British Telecom agreed to join.



Six earth stations in the UK will each be equipped with a 3m diameter dish aerial, 14 GHz radio transmitter and 11 GHz receiver. Together these will provide a two-way link from each site to the Orbital Test Satellite (OTS). This satellite, operated by the European Space Agency, is positioned in a geostationary orbit 36,000 km above the Equator over Gabon. The six stations will be sited at the universities of Cambridge and Loughborough; University College London;

Marconi Research Laboratories at Chelmsford, Essex; British Telecom Research Laboratory at Martlesham Heath, Suffolk, and RAL at Chilton, Oxfordshire.

Further information can be obtained from Dr David Thomas (extension 6660) or Mr John Burren (extension 6331) at RAL (Chilton), telephone Abingdon (0235) 21900.

Energy research meetings

The Energy Research Support Unit (ERSU) at RAL (Chilton) has organised meetings in various fields, on behalf of SERC's Energy Committee, to bring together universities on the one hand and industries and organisations in the field of energy on the other, in order to identify research needs and priorities. Two of these meetings were held in April this year, one on energy storage and the other on the mechanical property requirements of materials for fusion reactors.

Energy storage

The present state of phase change materials came in for considerable discussion at this international gathering. Some 170 delegates assembled at Brighton to review the technologies, problems and applications of the storage of energy in all its forms. The conference, organised jointly by the British Hydrodynamics Research Association, the Energy Technology Support Unit and ERSU, was opened by Dr A Challis, Chief Scientist at the Department of Energy. He stressed the importance of energy storage in connection with the conservation of energy.

Papers were presented on a wide range of storage techniques including chemical, sensible and latent heat, electrochemical, kinetic, potential and mechanical energy. Applications of these technologies were described ranging from domestic to large utility systems.

An important workshop session covered priorities in energy storage research and development, in which the properties of materials, reversible chemical systems, large capacity heat stores and large scale electrical storage were singled out for study. In the discussion, the importance of coordination in matching the needs of the consumer, industry, prime energy generation and university research work was emphasized.

As a result of the meeting, ERSU is developing a storage research programme for the Committee's consideration.

Mechanical properties of fusion materials

Speakers from UKAEA outlined the problems to be encountered in fusion reactor systems. The design aspects were presented and the potential materials problems were surveyed, particularly relating to the first wall and blanket. University speakers described their work to see how it related to fusion reactor problems.

Contributions included studies on creep mechanisms and gas bubble formation, creep crack growth and fatigue under multi-axial stresses.

(continued on opposite page)

LEP gathers momentum

The proposed new European facility for high-energy physics research, a large electron-positron collider called LEP, was given a firm push forward at the end of June when nine of CERN's 12 member states recorded votes in favour of the project. The remaining three countries are expect to have reached positive decisions by this Autumn, so that the LEP project should now be all set for a formal start on 1 January 1982. It is planned to be completed to a stage where initial experiments can start in about five years.

The United Kingdom's delegate to CERN was Sir Geoffrey Allen FRS, who was among those members of CERN Council who were able to report in June that their Governments were in favour of the project. UK approval included reservations against risks of unexpected increase in the cost of the project or the time taken to build it, or a serious fall in the SERC budget over a period. If any of these were to happen, the UK would have to review its position.

The LEP machine will be housed in a circular tunnel of about 27 kilometres circumference. It will circulate beams of electrons and their anti-particles, positrons, at energies of 50 GeV in opposite directions. The beams will be collided with each other at fixed points around the ring and the resulting collisions will form the basis of the experiments to be conducted on the machine.

When an electron and its anti-particle collide, they annihilate each other, creating an instantaneous 'blob' of pure energy; this energy is then manifested in the creation of a range of particles that will be detected by the experimental apparatus. It is hoped that LEP will permit physicists to detect, for the first time, the 'W' particles that are responsible for the so-called 'weak' nuclear force, one of the four forces known to govern the behaviour of matter. LEP will enable Europe to be at the forefront of physics and the machine will be a world leader in the field to the end of the century.

British physicists are already discussing the experiments that will be possible with LEP and conferences have already taken place at national and international levels on this subject. SERC is also interested in the industrial spin-off that will occur. As well as being an obvious opportunity for exports (the capital cost of LEP is about £250M), much of the technology involved will be new, presenting the chance to firms to be in at the beginning of product developments with future potential markets in other fields.

Site just outside Geneva of the 27 km tunnel for housing CERN's proposed Large Electron-Positron Collider.

Aided by the Departments of Trade and Industry, SERC has been giving wide publicity to these possibilities by articles in the technical press, mail shots and seminars. Five seminars, covering various sectors of industry, have been held so far, including a meeting of senior industrialists with Council members after the Council meeting in June of this year. The interest aroused has been very considerable and it is hoped that this will carry through into firm orders in the years ahead.

Energy meetings

(continued)

A number of areas were identified in which universities could make useful contributions. These included the design of small test specimens (necessary because of limited suitable radiation facilities) and the relationship of their results to large structures, the influence of multi-axial stress on fracture, the effect of hydrogen and helium generated in the material in promoting embrittlement and generally the need to understand irradiation embrittlement and creep.

The Committee's Fusion Materials programme will now be expanded to include problems raised concerning mechanical properties.

New computer for Daresbury Laboratory

Daresbury Laboratory's ageing IBM 370/165 computer was replaced in July by a modern IBM-compatible machine, an AS7000, purchased from National Advanced Systems. The 370/165 has been in service as the Laboratory's general purpose computer for the past eight years. In its early days it was used mainly for processing data from high energy physics experiments at NINA. More recently it has been used for preparatory work for experiments at the Synchrotron Radiation Source and the Nuclear Structure Facility and for processing some of the grant-supported work funded by the Science and ASR Boards. For the last two years the computer has also acted as a front-end for the very powerful Cray 1 computer (see page 8).

The arrival of the new computer is very timely for the start of experiments at the SRS and NSF. The AS7000 is about 30% more powerful than the 370/165 and has more memory and peripheral storage. Initially it will run the same operating system as the 370/165 and, apart from the increase in power, it will appear largely unchanged to the users. It should however be considerably more reliable. During the next year or so a modern operating system will be introduced and this will open up the possibility of introducing new facilities which could not be supported on the old computer.

Computer software development

SERC supported research programmes frequently lead to new computer software, which sometimes has potential applications greater than the researcher may appreciate. The National Research Development Corporation (NRDC) has as one of its principal functions the achievement of commercial utilisation of inventions arising in research organisations, including universities and polytechnics. The Corporation can offer considerable help and advice to academics with such software.

A condition of SERC grant support requires all researchers to bring to NRDC's attention results which it is considered might have commercial significance through the issue of patents, copyrights or other exploitation methods, and there are particular reasons why NRDC should be consulted where computer software is involved.

Computer programs created in the course of research are in most cases designed only to meet the needs of that research and possibly to provide for exchange and communication among closely collaborating colleagues at the originating site and elsewhere; they represent at most a prototype for a commercial product. To produce such a product usually requires substantial further investment, perhaps many times the original costs, in engineering the product to market standards and possibly completely rewriting it; in documentation, user support and market preparation.

Commercial firms have generally proved unwilling to make such investment, and even where a company was willing to invest, it would normally require exclusive rights to the item in order to obtain a return which justified its investment. This commercial need for confidentiality presented conflicts with the research worker's desire to publish, and careful handling was called for. To tackle these problems NRDC established in 1977 a subsidiary company, Compeda Ltd, which specialises in marketing research-originated software. Compeda's first development activity was devoted to the GAELIC design software developed at Edinburgh University.

Grant investigators therefore whose research leads to the production of new software are urged to notify NRDC at the address below, who will help with overcoming the considerable problems in bringing university/polytechnic originated software into successful commercial use.

Contact: Mr P G Tanner NRDC, PO Box 236, Kingsgate House, 66/74 Victoria Street, London, SW1E 6SL; tel 01-828 3400.

The future of UK infrared astronomy

Astronomical results obtained so far in the infrared, especially with the UK Infrared Telescope (UKIRT), were presented at a two-day symposium at the Royal Observatory, Edinburgh in July 1981. Eighty astronomers attended the meeting which also considered the opportunities offered by the Infrared Astronomical Satellite due to be launched in August 1982 and the efforts being made by British astronomers working in the infrared to prepare for it.

UKIRT, on Mauna Kea, Hawaii, has been in operation since October 1979 and the meeting gave the user community the opportunity to comment on the current state of the telescope and common-user instrumentation. They also discussed what improvements might be possible to ensure that the astronomical work from this important facility remains of the highest quality.

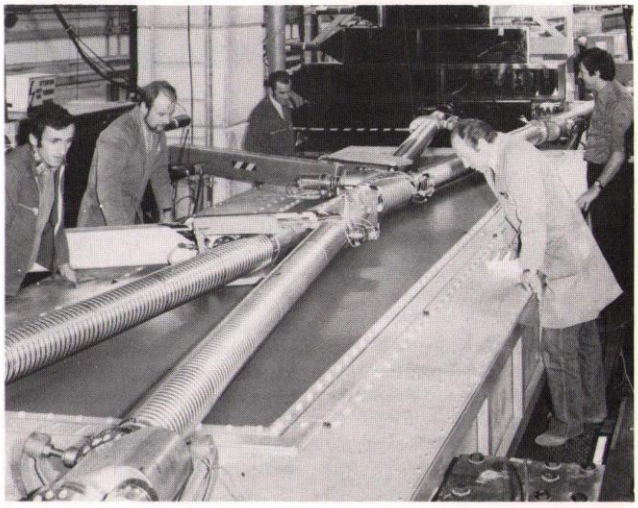
Antiprotons - the new tool in high energy physics

The particles of matter that make up our universe have antimatter equivalents with the same masses but opposite electrical charge. The proton, nucleus of the hydrogen atom, has such an 'anti-particle': the antiproton. In early April 1981, antiprotons created in the CERN Laboratory were stored, accelerated and finally made to collide with normal matter in the form of protons travelling in the opposite direction. This 'world first' occured in the Intersecting Storage Rings (ISR) facility at CERN.

Though antimatter is absent from the world as we know it, its constituents can be created with relative ease by fast moving particles from accelerators. However, since matter and antimatter annihilate each other on contact, the problem until now has been to store the antiparticles for a period of time long enough for them to be used in experiments. A technical development at CERN known as 'stochastic cooling' has resulted in a technique for building up the intensity of a beam of antiprotons circulating in a storage ring to levels where they can, after acceleration to a suitable energy, be used to bombard a target or, as in the present case, to collide head-on with a beam of counter-circulating protons.

This work has been undertaken as a preparation for a programme of experiments to commence in late 1981 in the Super Proton Synchrotron (SPS), CERN's largest machine. Beams of protons at an energy of 270 GeV will be collided with antiprotons at the same energy going in the other direction. British involvement in the first generation of proton-antiproton experiments comes from Birmingham and Cambridge Universities, Queen Mary College, London, and RAL. The physicists are confident that this programme will open a new window on unexplored fields on the frontier of the infinitely small.

A streamer chamber, one of the devices that will be used to detect the results of proton-antiproton collisions, here being installed for testing at one of the intersections of the ISR at CERN. During the test, the success of the 'stochastic cooling' of antiprotons was amply demonstrated, for the antiproton beam reached an intensity of 0.61 milliamps which means that about 12 thousand million antiprotons were circulating.



The analytical scientist

The Analytical Science Working Group, set up two years ago, has now published its report on the uses made by industry of analytical scientists, on the forms of training that are appropriate and on the direction that research in this area is likely to follow in the next few years. This review was undertaken following a report from the Analytical Science Panel which had suggested a range of actions that would be required for the research activity to be maintained and enhanced to meet the challenges that may arise in the future, for example in developing new instrumentation or sensors and in environmental protection.

The working group, chaired by Professor Jim Turner of Nottingham University, who is also the Chairman of the Chemistry Committee, noted and warmly welcomed the recent changes in attitudes in the academic community and the commitments to major new developments such as new courses and chairs.

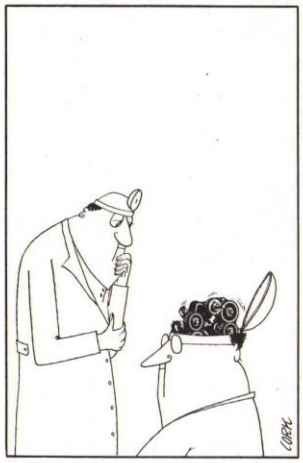
The major criticism made by industry of applicants for posts in analytical science is not that the graduates recruited do not know sufficient detailed analytical chemistry but that they do not have a sound understanding and experience of the science of measurement and the interpretation of data. Some of the full-time courses in analytical science at the MSc level provide a useful and valuable training but the need for such courses is limited. The merits of part-time training at the MSc level are very high; the applicability of the courses, their relevance to industry and the quality and commitment of the students suggest that this form of training is appropriate particularly in the applied sciences and this type of course is to be encouraged.

At the PhD level the training provided by universities and polytechnics is in general well regarded by industry and the number and subject area of graduates at this level satisfies industrial requirements. The aims and objectives of the CASE studentship scheme are well suited to many aspects of analytical science and greater use of this scheme is also to be encouraged.

The specially promoted programme in Instrumentation and Measurement gives selective support, via research grants, to technological aspects of analytical science, ie sensor development, automation and control. The working group did not feel there was a case for a parallel programme within the basic science of analysis since the science-based problems are different from those of technology and because of the overlap and possible conflict with the existing programme. Nevertheless, it is hoped that it will become well known that analytical science is an area that the SERC wishes to encourage.

Research in analytical science is often multidisciplinary and this can create additional complexities in ensuring that such applications receive proper assessment by peer review. In order to assist this procedure it is hoped to arrange appropriate cross-membership between relevant committees and to increase the awareness of the committees of the views of leading analytical scientists.

The report of the working group has been endorsed by the Chemistry Committee and the Science Board and has recently been circulated; additional copies may be obtained from Miss L C Gosden, SERC Central Office, Swindon, extension 2166.



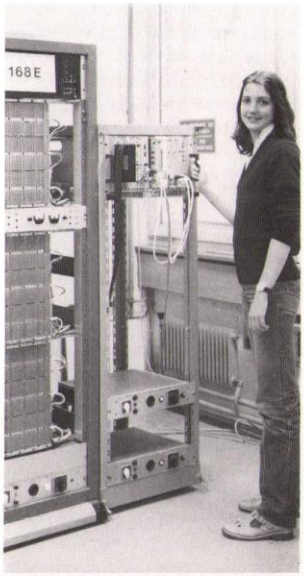
UK sandwich students at CERN

As an international laboratory, CERN at Geneva is host to numerous visitors from its member states each year. It is not always appreciated, however, that these visitors are by no means all practising physicists who come to use the experimental facilities provided. The visitors range right through the age and educational spectrum, down to parties of schoolchildren – a keen test of the hospitality for which the laboratory is rightly famous.

One scheme run by CERN of particular interest to some higher education institutions in Britain is the Technical Student Programme. This is aimed at full-time students aged 18 or over, especially in engineering and applied science, whose home institutions require them to spend a period of from six to 12 months on industrial training. In British terms, this is the 'sandwich' undergraduate, and UK institutions have been making good use of this provision.

The scheme allows for the appointment of about 40 students per year; over the five years 1976-80 the total number appointed has been 206, of whom 97 (47%) have come from the UK. The institutions that have used the scheme during this period have been the Polytechnics of Hatfield, Kingston, Leicester, Newcastle, North Staffordshire, Portsmouth, Thames and Wales; Dundee and Paisley Colleges of Technology and Bath, Bradford, Brunel, Queen's Belfast and Surrey Universities.

Karen Gregson is a third-year student on the Applied Physics course at Bradford University. She spent six months this year working on a recently developed piece of computer hardware at CERN, the 168E, a microprocessor emulator of a large mainframe computer. Before going to CERN, she had been at Daresbury Laboratory for six months working on the design and construction of a prototype multi-wire proportional chamber.
Photo: CERN



Distributed array processor

The Distributed Array Processor (DAP) is a 64 x 64 array device whose computational capability is distributed within the store of a conventional computer; it has been developed by ICL with financial support from the DoI's Advanced Computer Techniques Project. It is particularly suitable for a range of problems where the same, or similar, calculations need to be performed on large arrays of data, eg image processing, finite element computation, linear algebra and partial differential equations. When linked to a 2900 series host computer, the DAP can have a performance 10 times better than conventional series machines.

Following the Computer Board's decision to purchase a DAP and link it to a new 2980 machine at Queen Mary College, the Council agreed in December 1978 to provide complementary funding for a DAP Support Unit which would assist the development of applications software and provide a national advisory service to DAP users. A DAP Management Committee was established to oversee the development of the Support Unit and to allocate the DAP resource to individuals or project groups.

The Support Unit has developed a range of advisory activities. It has organised a library of subroutines, publishes a regular DAP newsletter with a circulation of over 700 and has arranged a number of presentations and DAP Fortran courses for potential users. Currently there are 120 authorised users of which 89 are actively using the facility for up to 350 jobs per week. Users include the computational physics group of the Institute of Physics, RAE Farnborough, British Aerospace and the British National Oil Corporation.

The unit has been particularly keen to organise meetings of users with similar interests to exchange information and expertise; areas covered so far include linear algebra, differential equations, non-numeric applications, transforms, image processing and statistics. The Unit has identified several areas in which it would wish to stimulate interest: crystallography, quantum chemistry, finite element analysis sparse matrix manipulation and network and linear programming.

Anyone interested in these areas or who wishes to find out more about the capabilities of the DAP and how they might use it should contact Dr Heather Liddell, Queen Mary College, 01-980 4811, ext 616.

Fellowships

Royal Society European programme

The European Exchanges Committee of the Royal Society on which three SERC representatives serve meets twice yearly to consider applications for postdoctoral fellowships tenable in Europe. About a dozen awards are transferred annually to SERC for support from its NATO funds.

The Royal Society European Programme, now in its fifteenth year, provides for a number of fellowships at postdoctoral level tenable in a laboratory on the continent of Europe. Fellowships are normally awarded for a full academic year, although applications for less than a full academic year but not less than six months will also be considered. Two-year fellowships may be awarded to a few outstanding candidates where the project merits this.

Preference is given to newly or recently postdoctoral applicants but candidates holding permanent appointments in the UK are also eligible to apply; in such cases the award will take into account any continuing salary which the candidate will receive.

The closing dates for applications each year are 12 January and 10 May.

Those interested should write for further details and an application form to:
The Executive Secretary, The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG.

Closing dates forms and contacts

1. Senior Fellowships – 30 November (SERC Form SF2)
2. Postdoctoral Fellowships (UK and countries outside Europe) – 31 December (SERC Forms RF2, 3 and 4)
3. Postdoctoral Fellowships (Europe except UK) – 12 January and 10 May (Royal Society Form)

Contact for schemes 1, 2 and 3: Central Office, Swindon ext 2206

4. Advanced Fellowships – 30 September (SERC Forms AF2, 3 and 4)
5. Royal Society/SERC Industrial Fellowships – 31 March and 31 October (SERC Form IF 1, 2 and 3 and 4)
6. Special Replacement Scheme – 31 August and 31 December (SERC Form SRS 1)

Contact for Schemes 4, 5 and 6: Central Office, Swindon ext 2403

7. Industrial Visiting Fellowships – No form or closing date. Contact Central Office, Swindon ext 2352.

Senior Fellowships

Applicants for Senior Fellowships, which enable outstanding tenured academic staff to devote themselves full-time to research free from administrative duties and teaching for periods of up to five years, have again set a high standard. From among the 24 applicants, Senior Fellowships have been awarded to:

Mr D Annis (Liverpool University) for 5 years: A study of the interaction of synthetic polymer materials and living tissues with which they are brought into contact; creation of new biomaterials and their use to construct new or improved internal prosthetic devices.

Professor Sir James Baddiley (Newcastle-upon-Tyne University) for 2½ years: The biosynthesis of bacterial cell wall polymers (at the Unversity of Cambridge).

Professor H C Macgregor (Leicester University) for 3 years: Nuclear function in oogenesis, with special regard to lampbrush chromosomes.

Dr D N Stacey (Oxford University) for 5 years: High resolution laser spectroscopy.

The quality of postgraduate research training

In late January of this year the Postgraduate Training Committee of the Council held a special meeting to discuss the aims and objectives of the Council in supporting postgraduate education.

The Committee invited members of the Council to join them and, in addition, asked senior members of the scientific and engineering community in industry and in the universities to come to the meeting.

Possibly the most important matter to emerge was the opinion expressed by those who came to the meeting about the need of the Council to concern itself more directly with the quality of research training within our universities and polytechnics.

Everyone present made clear their awareness of the responsibility of heads of departments in relation to research students under their control. Nevertheless it was felt necessary to remind heads of departments of the interest the Council has in the education and training being offered to postgraduate students supported by the Council.

This meeting took the view that they wished to recommend to the Council:

- that a PhD should be regarded as a time-limited project;
- that heads of departments should take into account the quality of supervision being offered when allocating award-bearing students to members of staff;
- that all senior members of staff in universities should be aware of the importance the Council placed on writing up, under supervision, as part of research training;
- that suitable course work should always be included in the programme of a research student, and interaction and collaboration with other students and staff outside the immediate topic of research should be encouraged;
- that only those students who satisfy a rigorous probationary assessment at the end of their first year should be allowed to continue with research training.

Specific proposals relating to these recommendations were considered by the Council at their July meeting.
The resulting changes in procedures will be promulgated in the usual way.

Meanwhile I write, not to criticise, but to publicise the concern of the Postgraduate Training Committee with these matters. We know there are many institutions and many individuals who take their responsibilities in this connection totally and absolutely seriously. Unfortunately there are those outside the university system who appear to doubt whether we all take our responsibilities seriously. I hope that all members of the scientific community will help us in proving that our critics are wrong and that our aim is to produce postgraduates whose calibre is beyond doubt, and who are trained in such a way that their contribution to the scientific work of the country will continue to be of the highest value.

Dr W H Cockcroft is Vice-Chancellor of the New University of Ulster and Chairman of SERC's Postgraduate Training Committee.

W H Cockcroft
Chairman
Postgraduate Training Committee

Short courses round-up

Biomaterials

The Medical Engineering Sub-Committee of the Materials Committee is sponsoring a new two week course organised by Leeds and Liverpool Universities. The course is primarily intended for recent medical and science graduates currently working in the field of medical engineering. As well as recent graduates, the course may interest others in academe and industry moving into medical engineering from other fields. It will comprise two one-week residential modules and covers a wide range of fundamental science and technology underlying the use of materials for medical engineering applications. Topics included will be the structure and properties of materials (including biological materials), the principles of biocompatibility, and the use of materials in clinical applications such as orthopaedics and dentistry.

The first week of the course will be held at Leeds University from 4 to 8 January 1982 and the second week at Liverpool University from 29 March to 2 April 1982. Priority will be given to SERC-supported students whose full attendance costs will be borne by the Council. Those ineligible for SERC support may also attend the course, provided there are places available, upon payment of a course fee of £700 plus residential charges.

For further details, contact Mr S D Ward at SERC Central Office, Swindon (extension 2110).

Short courses: Control engineering

Few undergraduate courses in the UK are devoted solely to control engineering and training at postgraduate level is widely dispersed. For these reasons the SERC (then SRC) decided in 1974 to sponsor the first of a series of three one-week schools specifically designed to acquaint research students with the broad scope of control theory and research. A typical programme consists of lectures, case studies, practical work, an industrial visit and demonstrations of computer and other control equipment. The three modules are held at Warwick (Stochastic Processes in Control Systems), UMIST (Modern Approaches to Control System Design) and Cambridge (Systems Modelling and Optimisation).

The first two series were most successful and it has been decided to run a third series including some new modules. The modules which have been added are Instrumentation and Measurement for Control Systems at City University; and Computer Control at Sheffield University which includes a large element of practical work. The third new module on Digital Signal Processing will be held at Sussex University in September 1982.

The next UMIST course is to be held from Monday 29 March to Saturday 3 April 1982. The course is open to SERC research students, who attend free of charge. Places are also available to personnel from industry, who wish to update themselves on the latest advances in control engineering; they will be charged an attendance fee. Details of the course may be obtained from the Director, Dr D Bell at the Control Systems Centre, UMIST.

Facilities for digital systems engineering

The SERC has recently announced grants totalling £1m to set up digital systems laboratories at six UK institutions. This investment represents the first phase of an initiative aimed at meeting the national need for more research expertise and highly skilled manpower in the design and application of digital systems. This need was identified in the SERC Report *Proposed Initiatives in Computing and Computer Applications* (The Roberts Report).

The six laboratories will be sited at Kent, Brunel, Heriot-Watt, Bradford and Salford universities and the Polytechnic of Central London. These sites were selected from over fifty applications. Each institution will concentrate on selected areas of digital systems research and training:

Kent University: this laboratory will provide an infrastructure for the study of design methodologies and the development of new user-tools. It will aim to produce locally specified digital structures and techniques for their implementation in silicon.

Brunel University: the laboratory will support some 30 researchers and up to 100 students using a multi-user 32-bit computer with enhanced graphics capability. They will research associative processing, pattern recognition, cognitive process modelling and CAD of digital systems.

Heriot-Watt University: research effort will be concentrated on applying digital techniques to real-time computing control, image processing, signal analysis and communications.

Bradford University: the Microprocessor Applications Centre will be enhanced to provide a range of courses on the latest digital systems to a large number of students at all levels. The Council's funds will allow more postgraduate and industrial students to participate in these courses.

Polytechnic of Central London: facilities will be provided to investigate real-time evaluation and on-line logic analysis of microprocessor-based projects and to examine systems from simple state tracing to complex data domain and time domain analysis.

Salford University: this laboratory will research the application of digital techniques in instrumentation, control systems and microprocessor studies.

Further phases of the programme are currently being planned. Details on the activities of the above laboratories and how other university or polytechnic groups might collaborate in the programme may be obtained from Mr A Kurzfeld, SERC Central Office, Swindon, extension 2161.

£8m for marine technology research

Grants totalling more than £8 millions for two-year research programmes have been awarded by the SERC's Marine Technology Directorate to seven university centres with provision in all cases for the research effort to continue beyond June 1983.

The awards are as follows: £357,000 to Cranfield Institute of Technology; £946,000 to Glasgow University; £1,498,000 to Heriot-Watt University; £2,437,000 to Imperial College of Science and Technology (for a combined programme with University College London); £565,000 to Newcastle-upon-Tyne University; £530,000 to Strathclyde University; and £1,930,000 to Manchester University on behalf of the North West Universities Consortium comprising Manchester University, University of Manchester Institute of Science and Technology, Liverpool and Salford Universities and University College of North Wales at Bangor.

The Cranfield programme is centred on materials and welding; Glasgow is primarily concerned with hydrodynamics, materials and offshore structures; Heriot-Watt's programme involves nine academic departments and covers surface and underwater systems, environmental sciences and petroleum engineering; Strathclyde's specialisms are in underwater maintenance and inspection; the broad-based programme at Newcastle includes marine transport, underwater engineering and seabed studies; London University's programme concentrates on methods of construction, design, maintenance and repair of offshore structures; while the North West Universities Consortium programme spans wave loading, the performance of structures, pipelines and materials offshore, coastal problems, marine fouling and the influence of economic, political and legal factors on the future uses of the oceans.

Dilution refrigerator at RAL

The Physics Committee provides support for a dilution refrigerator, maintained at the Rutherford and Appleton Laboratories for the use of university visitors. The facility (described in the *Bulletin*, June 1980) can reach temperatures as low as 17mK and incorporates a high homogeneity 5 Tesla superconducting solenoid. Further enhancements to the dilution refrigerator have now been approved by the Physics Committee and a 6mK Oxford Instruments dilution unit and a 12 Tesla magnet are to be added to the facility. It is expected that the modifications will be completed early in 1982. In the meantime the refrigerator is still available with its original specification.

The SERC will be pleased to consider research proposals requiring use of the refrigerator. Requests for formal regular use should be submitted as part of a SERC research grant application (on form RG2) to Central Office at Swindon.

The application should include a statement of the time required, as well as the normal scientific case for support. If necessary an informal run on the refrigerator can be arranged to test the feasibility of a proposed experimental programme, prior to the submission of a grant application.

Those interested should contact Dr S F J Read at the Rutherford Appleton Laboratory, Chilton, Didcot, Oxon OX11 0QX, telephone Abingdon (0235) 21900 extension 453.

Major new grants

ASTRONOMY, SPACE AND RADIO BOARD

Geophysical and astronomical research in space
A consolidated grant of up to £621k over one year to Professor R L F Boyd and Dr J L Culhane (University College London)

Radio astronomy
A consolidated grant of up to £465k over one year to Professor Sir Bernard Lovell (Manchester University)

X-Ray astronomy, astrophysics and solar physics
A consolidated grant of up to £455k over one year to Professor K A Pounds (Leicester University)

Astronomy in the radio & millimetre wave fields
A consolidated grant of up to £377k over one year to Professor Sir Martin Ryle (Cambridge University)

ENGINEERING BOARD

Microwave research
A special grant of up to £540k over four years to Professors A L Cullen, E A Ash and D E N Davies (University College London)

Distributed Array Processor Support Unit activities
A special grant of up to £404k over three years to Professor K W Sykes (Queen Mary College, London)

Optical fibre communications
A special grant of up to £431k over four years to Professor W A Gambling, Dr D N Payne and Dr M J Adams (Southampton University)

Design methodology and second generation design tools for very large-scale integration (VLSI)
A special grant of up to £301k over four years plus use of central facilities (notional cost £42k) to Professor D J Kinniment, Professor J Whitfield and Dr G Russell (Newcastle upon Tyne University)

VLSI circuits for digital signal processing
A special grant of up to £234k over four years plus use of central facilities (notional cost £128k) and terminal equipment (£34k) to Professor J Mavor, Dr P B Denyer and Dr M A Jack (Edinburgh University)

SCIENCE BOARD

Laser and non-linear optics
A special grant of up to £388k over four years to Dr M H R Hutchinson, Dr W Sibbett and Dr J R Taylor (Imperial College, London)

Theory of condensed matter
A special grant of up to £297k over four years plus central computing facilities (notional cost £51k) to Professor Sir Sam Edwards, Professor V Heine and Dr J C Inkson (Cambridge University)

NUCLEAR PHYSICS BOARD

Particle Physics Centres
Rolling programme grants providing staff support for three years and travel and recurrent costs for one year to particle physics experimental groups at Birmingham (up to £528k), Cambridge (up to £299k), Glasgow (up to £599k), Imperial College (up to £916k), Liverpool (up to £438k), Manchester (up to £399k), Oxford (up to £747k) and University College London (up to £338k)

MARINE TECHNOLOGY DIRECTORATE

Consolidated grants over two years to seven Marine Technology Centres (see page 26).

COOPERATIVE RESEARCH GRANTS COMMITTEE

Radio-isotope imaging techniques in gas turbine engine measurements
A grant of up to £122k over 45 months (plus intramural expenditure of up to £168k at the Rutherford Appleton Laboratory to Professor J Walker (Birmingham University) in collaboration with Rolls-Royce Ltd.

Some new publications from SERC

The Council's report
Copies of the *Report of the Science and Engineering Research Council for the year 1980-81* are available from mid-November from H M Stationery Office bookshops, price £4.00 (ISBN 0 901660 45 0; ISSN 0261-7005).

Establishment reports

Daresbury 1980 describes both experimental and theoretical work at Daresbury Laboratory during the year, on synchrotron radiation, nuclear structure, theory and computational science. Copies are available from the Laboratory, telephone Warrington (0925) 65000.

Rutherford Laboratory and Appleton Laboratory were formally merged in September 1979. This report, *Rutherford and Appleton Laboratories 1980*, describes the work of the combined laboratories during the calendar year 1980. Copies are available from RAL, Chilton, Didcot, Oxon OX11 0QX (tel: Abingdon (0235) 21900).

Copies of the *Royal Greenwich Observatory Report 1979/80* are available from the Observatory at Herstmonceux Castle, Hailsham, East Sussex BN27 1RP (tel: Herstmonceux (032 181) 3171) price £3.00 net.

Polymer reports

A report on *The use of polymers in agricultural machinery*, commissioned by SERC's Polymer Engineering Directorate, has been compiled by the National College of Agricultural Engineering at Cranfield Institute of Technology. Copies are available from PED, Garrick House, 3-5 Charing Cross Road, London WC2H 0HW (tel: 01-930 9162).

Copies of the *Polymer Engineering Directorate report for the year ended 31 December 1980* are available from the same address.

Research grants

A new edition of the booklet, *SERC Research grants 1981* sets out the terms and conditions on which all types of SERC research grants are offered. Copies are available from SERC Central Office, Swindon (extension 2405).

Chemistry newsletter

The Chemistry Committee Newsletter and Statistical Review No 9 is now available from the Committee's secretariat at SERC Central Office, Swindon (extension 2126).

Energy Committee

Copies of the *Energy Committee Annual Report 1979/80* are available from Dr B D Jones, Energy Research Support Unit, RAL, Chilton, Didcot, Oxon OX11 0QX (tel. Abingdon (0235) 21900).

If you would like your name added to our mailing list to receive copies of SERC Bulletin regularly, please write to:

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Swindon SN2 1ET,

or telephone 0793 26222 ext 2120.

Edinburgh's new visitor centre

Above

After the opening ceremony, Patrick Moore examines a model of the NASA Space Shuttle at the Visitor Centre with some of the young people who helped create the exhibition.

Below

A 16/24-inch Schmidt telescope, no longer in active service, has been carefully restored to form a centre piece for the Observatory's Visitor Centre. The tower in which it stands has been converted into an impressive display gallery with a wide spiral staircase around its periphery from which the telescope can be examined in detail.

Below right

The upper gallery of the Visitor Centre at the Royal Observatory, Edinburgh, has a wide range of displays and exhibits including two unique collections of early telescopes. Some aspects of the work of the Observatory at home, overseas and in space are also featured.

The Royal Observatory, Edinburgh, welcomed some 80 guests for the formal opening of its new Visitor Centre on Blackford Hill in April. Guest-of-honour at the celebration was Patrick Moore who, having performed the opening ceremony, spent the rest of the day chatting to the dozens of members of the public who visited the Observatory despite snow that was unseasonal even by Scottish standards.

The new Visitor Centre fulfils a double role by providing a shop window for the work of Scotland's national observatory and its outstations in Australia and Hawaii, and by offering a venue for schools, colleges and other educational groups to come and learn about astronomy. The latter aspect has been welcomed by the community with particular enthusiasm.

Created from what was essentially a disused part of the Observatory, the Centre was built over a period of 3½ years using funds donated by the Bank of Scotland and other sponsors and staff provided by the Manpower Services Commission Job Creation Programme. In overall control was the ROE project officer, Dr Jim Campbell; the scheme had the enthusiastic backing of two Astronomers Royal for Scotland, first Professor Vincent Reddish OBE and now Professor Malcolm Longair who succeeded him in 1980.

On entering the Centre, the visitor finds himself at the foot of the Observatory's west tower whose interior is now dominated by a 16/24-inch Schmidt telescope and its pier. A spiral staircase leads past displays on the UK Schmidt Telescope and the COSMOS Measuring Machine to the roof – which affords spectacular views over the City of Edinburgh – and the upper gallery. Here there are two fine collections of historic instruments alongside displays on the UK Infrared Telescope, the Space Shuttle and other aspects of modern astronomy and space science.

The Centre is open daily to the public, and plans are already under way for the extension of community activities. Perhaps the most exciting of these is the concept of a 'Popular Observatory' for use by members of the public, a notion which reflects the purpose of the original eighteenth century observatory in Edinburgh.

F G W