

INFORMATION  
TECHNOLOGY  
EDINBURGH  
UNIVERSITY

## Expertise Serving Industry & The Community

“Knowledge has certainly never  
in history been so central to the  
conduct of an entire society”

Clark Kerr

“To live effectively is to live with  
adequate information”

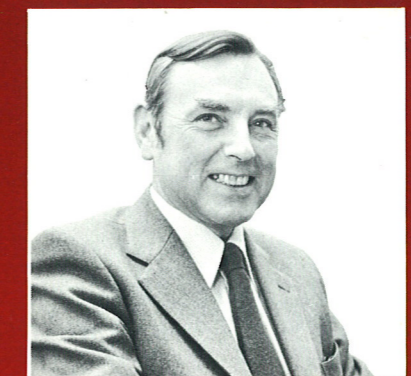
Norbert Wiener

“Nothing is more difficult, and  
therefore more precious, than to  
be able to decide”

Napoleon Buonaparte

Primitive man evolved from a basis of a few simple facts and observations but to-day **Homo sapiens** is faced, through his own boundless curiosity, with the need for an infinity of information whereby to order his affairs and, simultaneously, for means to control the so-called “information explosion” which bids fair to smother him. Nowhere is this more evident than in the centres of knowledge themselves – the Universities. Edinburgh has been an acknowledged centre of learning for some centuries but it was amongst the first to recognise that new methods would be needed to handle knowledge. Now it is an acknowledged, international leader in that conglomerate of increasingly integrated disciplines which has developed over the last two decades to enable knowledge to be obtained, assessed and utilised – Information Technology.

No one can afford to contemplate the next decade, let alone the twenty-first century, without some knowledge of this technology of the future. This brochure, therefore, describes briefly how Edinburgh University is creating devices and techniques which enable the right information to be obtained most effectively and economically together with some examples of applications in a diversity of fields. I commend this short account not only to information technologists but to all those thinking men and women who believe in the importance of knowledge, in the objective assessment of its worth, and its importance in deciding how best man may live in society.



John H. Burnett  
Principal

# INFORMATION TECHNOLOGY EDINBURGH UNIVERSITY

INFORMATION TECHNOLOGY is the use of computers, microelectronics and telecommunications to help us obtain, store, process and send information in the form of pictures, words or numbers, more reliably, quickly and efficiently. The range of science-based studies in a large modern university and their interplay, provides a particularly fertile base both for the technical development and application of advanced information technology.

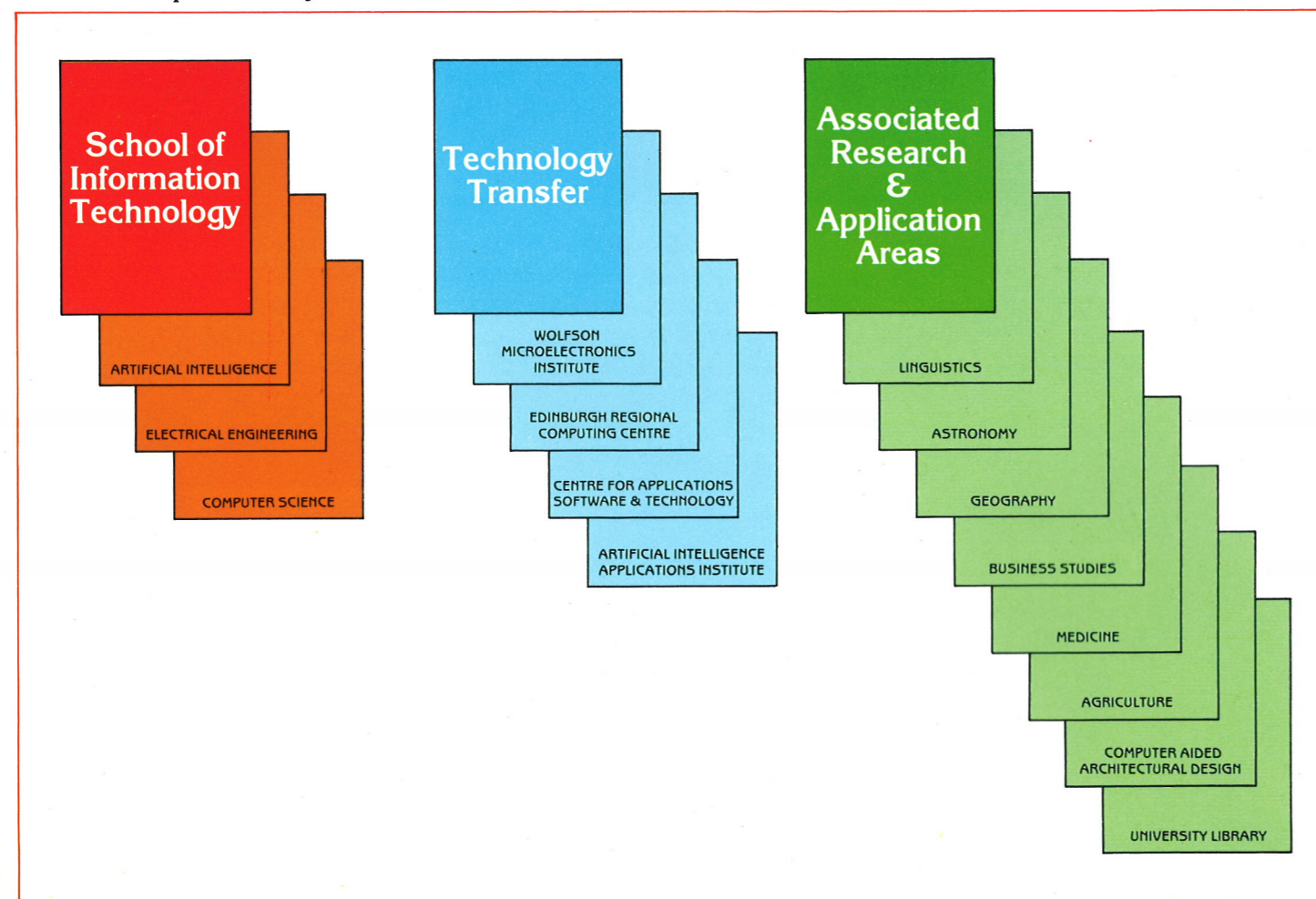
EDINBURGH UNIVERSITY contributes to major advances both in research and practical applications across a whole range of fields: medical diagnosis and treatment; agricultural productivity; classroom teaching, industrial and commercial productivity.

The innovative and extensive distributed computing network, provided by the Edinburgh Regional Computing Centre (ERCC) and the major concentration of skilled personnel and resources, most obviously in Artificial Intelligence, Computer Science, and Electrical Engineering, are without parallel in Scotland.

COURSES OF INSTRUCTION in information systems are available to all Edinburgh students and, in addition, specialist courses in aspects of advanced information technology are offered on a full and part-time basis at post-graduate and post-experience levels.

RESEARCH AND CONSULTANCY POTENTIAL is channelled into commercial and industrial applications through the University's inter-disciplinary Information Technology Committee, with active support in technology transfer by the Wolfson Microelectronics Institute (WMI), the ERCC, the Centre for Applications Software and Technology (CAST) and the Artificial Intelligence Applications Institute (AIAI). The independent company, Integrated Micro-Applications Ltd. (INMAP), established jointly by Edinburgh and Heriot-Watt Universities, markets university-based information technology skills to industry and commerce.

## The I.T. Community at Edinburgh University



# School of Information Technology

The School of Information Technology, formed to promote academic co-operation in this new and rapidly growing field, is a federation of the Departments of Artificial Intelligence, Electrical Engineering and Computer Science. Associate Members of the School who have a contribution to make in teaching and research in the field of Information Technology, include the Dept. of Astronomy, the School of Epistemics and the Department of Physics.

The School has oversight of matters such as the joint MSc program of the three principal members and the development of a VLSI Systems Research Centre. It also co-ordinates the provision of shared computing facilities, promotes joint teaching at undergraduate level and co-operation in research areas such as Databases, Robotics, Real Time Control and Communications.



## ARTIFICIAL INTELLIGENCE

A.I. was recognised as a separate discipline by Edinburgh University in 1966. During its existence it has steadily built up a programme of undergraduate and post-graduate teaching and has engaged in a vigorous research programme. As the only Department of Artificial Intelligence in any UK university, and as an organisation which has made a major contribution to the development of the subject, it is poised to play a unique role in the advance of Information Technology which is seen to be a national necessity.

As A.I. is a new subject, there is a very close relationship between teaching at all levels, and research. Artificial Intelligence is about making machines behave in a manner which exhibits some of the characteristics of intelligence, and about how to integrate such capabilities into larger coherent systems. The vehicle for such studies has been the digital computer, chosen for its flexibility.

The Department collaborates closely with others within the University in two distinct groupings, one area being the School of Information Technology and the other, those concerned with Cognitive Science, namely Linguistics, Philosophy and Psychology, in the School of Epistemics.

A.I. is also involved in collaborative work with other institutions which are significant in the sense that they involve the transfer of people, ideas and software. In particular these involve MIT (robotics), Stanford (natural language and robotics) and Grenoble (robotics).

### Artificial Intelligence Applications Institute

Relationships with industry are encouraged. As well as a number of development contracts, A.I. has recently had teaching and research posts funded by a major software house.

The AIAI has been created to enhance the Department's service to industry. This Institute is operating as a revenue earning laboratory, performing a technology transfer function on the model of organisations such as the Stanford Research Institute and Bolt Beranek and Newman.

### A.I. Languages and Systems

The development of high level languages has been crucial to all aspects of computing because of the consequent easing of the task of communicating with the machines. Artificial Intelligence has given birth to a distinctive series of languages which satisfy different design constraints to those developed by Computer Scientists whose primary concern has been to develop languages in which to write reliable and efficient programming systems to perform standard computing tasks. Languages developed in the A.I. field have been intended to allow people readily to try out ideas about how a particular cognitive process can be mechanised. Consequently they have provided symbolic computation as well as numeric, and have allowed program code and data to be equally manipulable. They are also highly interactive, and often integrated with a sophisticated text editor, so that the iteration time for trying out new ideas can be rapid.

Edinburgh has made a substantial contribution to the development of A. I. programming languages

and will continue to do so. POP-2 was designed and developed in Edinburgh by Popplestone and Burstall. Kowalski first formulated the crucial idea of predicate logic as a programming language during his time in Edinburgh. This led to the development of PROLOG, which was designed and implemented in Marseilles as a result of his interaction with a research group there. This was followed by a re-implementation at Edinburgh which demonstrated PROLOG's potential as a practical tool. To date, over 300 laboratories around the world are using implementations of A.I. languages supplied by the Department at Edinburgh, where active development of these systems continues.

### Mathematical Reasoning

If Artificial Intelligence is about mechanising reasoning, it has a close relationship with logic which is about formalising mathematical reasoning, and with the work of those philosophers who are concerned with formalising everyday reasoning. The development of Mathematical Logic during the 20th century has provided a part of the theoretical basis for A.I. Logic provides a rigorous specification of what may in principle be deduced – it says little about what may be usefully deduced. While it may superficially appear straightforward to render ordinary language into logic, closer examination makes it appear anything but easy.

Nevertheless logic has played a central role in the development of A.I. in Edinburgh and elsewhere. A.I. practitioners still regard the automation of mathematical reasoning to be a crucial area in A.I., but have moved from earlier attempts to find uniform procedures for an efficient search of the space of possible deductions to

the creation of systems which embody expert knowledge about specific domains.

### Robotics

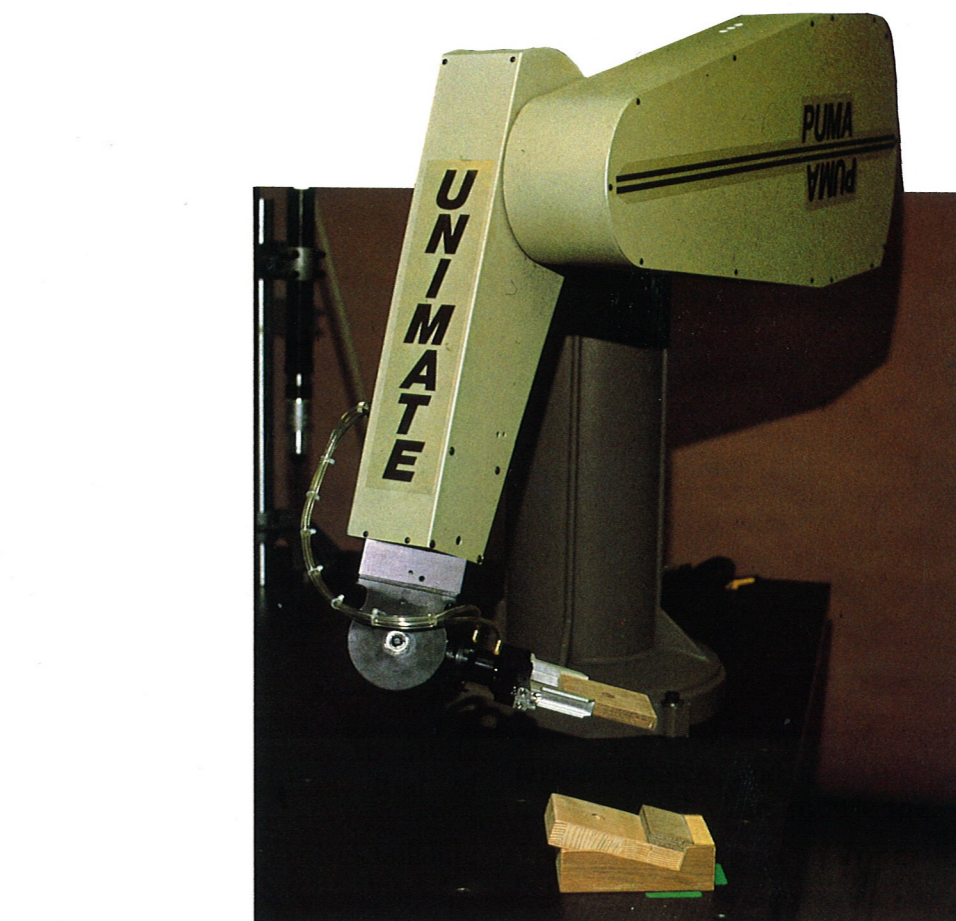
The Department has always had a lively interest in robotics, an area which involves a wide range of engineering capabilities. An intelligent robot must have an internal representation of its world which is sufficiently accurate to allow it to predict the results of planned actions. This means, in particular, that it must possess a good representation of the shape of bodies.

Clearly, conventional simulation and shape modelling techniques permit a hypothetical world to be represented in a computer. But, despite their undoubted usefulness in robotics, they have two weaknesses. They do not deal effectively with uncertainty, and, while they allow one to predict what the consequences of a particular sequence of actions may be, they do not greatly assist in formulating an action sequence which will produce a given desirable result.

The aim at Edinburgh is to produce robot command systems which while making good use of conventional modelling and simulation techniques, overcome their limitations by making use of the inferential techniques developed in A.I.. Towards achieving this aim, the robotics group have developed the RAPT robot command language.

### Vision and Remote Sensing

The interpretation of data derived from sensors depends on expectations about the structure of the world. In manufacture the prior expectations may be highly specific, one will know what objects are likely to be present and how they are likely to be



A Unimate Puma in operation at Edinburgh

related to each other. A vision project in the A.I. Department is taking advantage of this in integrating vision with the RAPT development in robotics – the prior expectations are expressed by defining body geometry in RAPT, and by defining the expected inter-body relationships in the same medium.

A robot operating in a natural environment will have much less specific expectations. The A.I. Department collaborate with the Heriot-Watt University to study one such application, that of the sonar based control of a submersible. This involves building a world representation by integrating stable echo patterns.

### Natural Language

Several different lines of research are being followed in the general area of natural language processing, some of them in collaboration with the School of Epistemics. The Natural Language group are investigating formal models of human sentence understanding,

with emphasis on the relationship of syntactic parsing to semantic interpretation and context. They are particularly interested in parsing mechanisms based on the combination of a categorical grammar with compositional semantics. Research is being carried out into a detailed psychological model of word recognition in continuous speech and the group has a strong interest in computational models of language production including the issues of discourse planning, lexical choice and the use of complex real world knowledge.

There are also a number of projects with the practical aim of building software tools for the development of natural language interfaces to computer systems. These include the implementation of a general-purpose parsing and testing system for generalised phrase structure grammars, and a joint project with East Anglia to develop dictionary access and manipulation programs which carry out sophisticated morphological analysis.

## Planning Systems

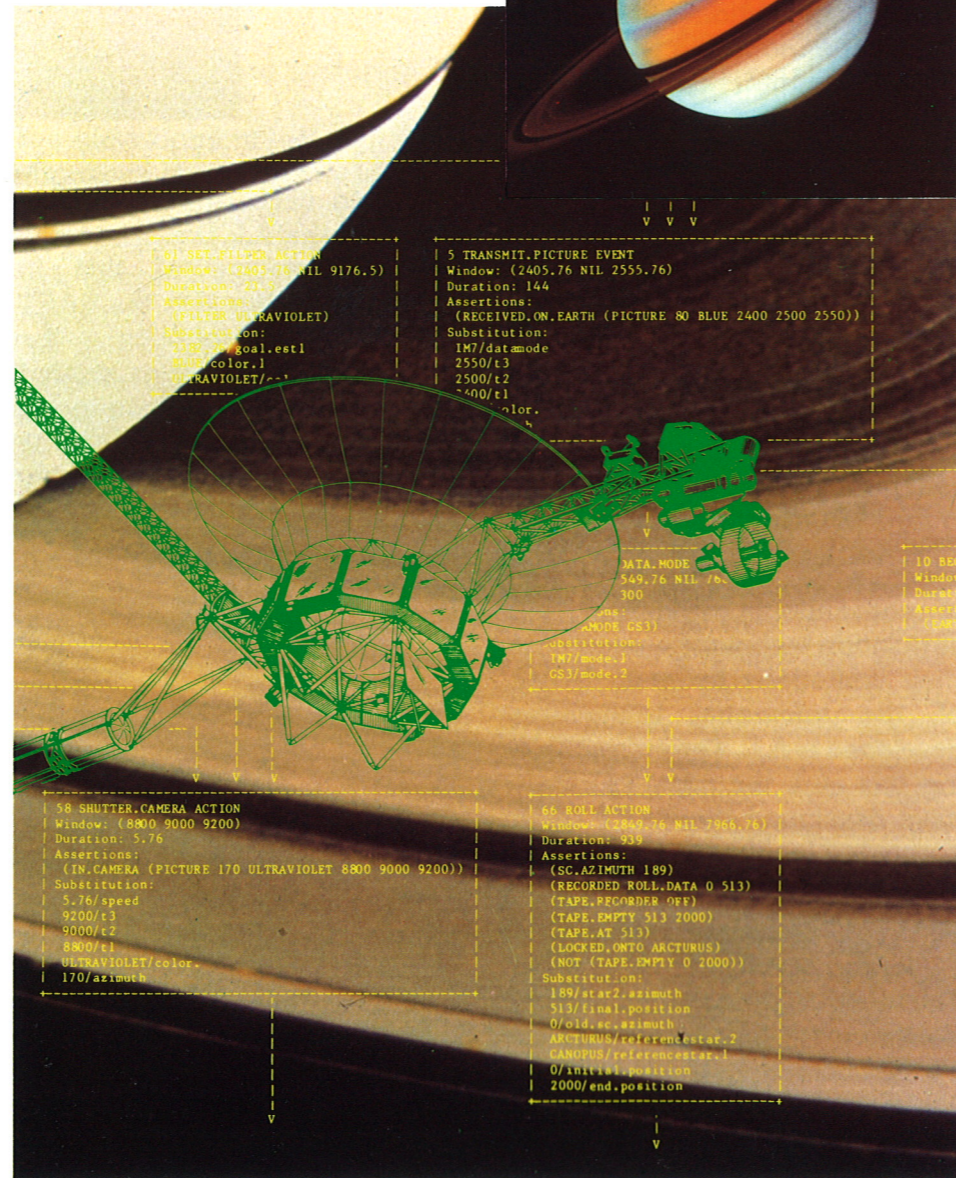
General purpose planning systems for automatically producing plans of action for execution by robots have been a long standing theme of A.I. research. The A.I. Department at Edinburgh has a very active programme of planning research and is one of the leading international centres in this area. The Edinburgh planners have been applied to the generation of project plans for large industrial activities (such as electricity turbine overhaul procedures). A prototype planner in use at NASA's Jet Propulsion Laboratory which can schedule the activities of a Voyager-type planetary probe is based on Edinburgh work.

New work on planning has recently restarted and is mainly concerned with the interrelationships between planning, plan execution and monitoring. The commercial exploitation of the techniques is also being considered.

## Knowledge Based and Expert Systems

Much of the A.I. Department's work uses techniques often referred to as Intelligent Knowledge Based Systems (IKBS) – this includes robotics, natural language, planning and other activities. However, researchers in the Department of A.I. are also directly concerned with the creation of expert systems in ecological modelling, user aids for operating systems, sonar data interpretation, etc.

Particular emphasis is placed upon the development of "Intelligent Front Ends" and related issues in the provision of automatic advice and the design of man-machine dialogues. These interests reflect a commitment to making the expertise embedded in computer programs more accessible and more accountable to the user. As expert systems become more powerful and complex, the need for ancillary software to regulate their use and explain their behaviour becomes more pressing, as does the demand for tutorial and support facilities in general.



Edinburgh work has been used as a basis for NASA spacecraft mission sequencing



Planning for Electricity Turbine Overhaul



## Computers in Education

The Department has pioneered in this country an approach to the use of computers in schools in which children can engage in an active and creative interaction with the computer without needing to acquire abstract concepts and manipulative skills for which they are not yet ready. The vehicle for this work has been the LOGO language, which has a simple syntax making few demands on the typing skills of children. While LOGO is in fact equivalent to a substantial subset of LISP, a child can get moving with a very small subset of the language, and one which makes the actions of the computer immediately concrete in the form of the movements of a "turtle" which can be steered as a small mobile robot or as a symbol on a VDU screen.

This approach has a significant value for Special Education. For example in one study an autistic boy found he was able to communicate with a "turtle" which apparently acted as a metaphor for communicating with people, resulting in his being able to use language spontaneously for the first time. In another study involving mildly mentally and physically handicapped youngsters a touch screen device invoked procedures for manipulating pictorial materials designed to teach word attack skills to non-readers. More recent projects include a diagnostic spelling program for dyslexic children, and a suite of programs which deaf children can use to manipulate text to improve their ability to use language expressively.



Teaching LOGO to school children via a microcomputer



The Edinburgh LOGO Turtle

## Teaching in the Department of Artificial Intelligence

The Department is involved in an active teaching programme at undergraduate and postgraduate level. At undergraduate level, there are A.I. first, second and third year courses. There is a joint honours degree with the Department of Linguistics. A large number of students are registered with the Department for postgraduate degrees. An MSc/PhD in Cognitive Studies is provided along with the Departments of Linguistics, Philosophy and Psychology under the aegis of the School of Epistemics. The Department teaches two modules on this: Symbolic Computation (using Prolog) and Computational Linguistics. This course is an SERC-supported conversion course. In October 1983 an MSc conversion course in IT started. This is a joint course with the Departments of Computer Science and Electrical Engineering.

## ELECTRICAL ENGINEERING

A major part of Edinburgh's Department of Electrical Engineering's activities, lie in the area of Microelectronics. Since the late 1960's, the Department has become a widely recognised centre with an international reputation. Its excellence in this discipline, has been recognised through Lothian Regional Council funding the Lothian Chair of Microelectronics.

### Research in Electrical Engineering

#### Integrated Systems

The design challenge posed by the complexity of today's 100,000+ transistor integrated circuit chips is becoming critical: firstly, in respect of the lack of available design tools; and, secondly, regarding the shortage of qualified VLSI design engineers. The Integrated Systems Group (ISG) in the Electrical Engineering Department has been facing up to these problems and for the past decade has been active in teaching and research in the MOS integrated circuit design area.

Undergraduates in Electrical Engineering all complete a project on chip design – called Gateway – and, students registered for a master's degree can also perform an LSI circuit design, supervised by the ISG. The ISG has established links with the British electronics industry and has mounted many intensive courses on MOS LSI specially geared to industry's needs.

ISG researchers have produced many functioning chip designs for a variety of applications in the signal processing area. These include complex correlators to

separate signals from contaminating noise, and filters to select particular spectral components in a wideband signal. The design timescale for such state-of-the-art chips can exceed one year and so a key activity of the ISG has been the development of an efficient layout tool known as a silicon compiler to speed up the design phase. The Edinburgh silicon compiler which is called FIRST is widely used by the ISG researchers and is in demand from other research teams worldwide.

Although all of the chips designed in the ISG so far have been on silicon technology the potential of high speed gallium arsenide circuits is also being actively investigated. Such technological awareness should maintain the ISG as a team with a worldwide reputation which is striving to research new chip architectures and design tools for tomorrow's million-transistor plus circuits.

#### Signal Processing

This application oriented group has been active over the last decade in the design of the large-time bandwidth product analogue surface acoustic wave and charge coupled device, matched and adaptive filter modules for use in military spread spectrum communication systems.

Recent activities have focussed more heavily on the design of digital adaptive filters for cancellation of interference and compensation for distortion in communication systems. These filters have potential use as echo cancellers and equalisers in data modems in addition to other communication and radar applications. Recently they have concentrated on the design of digital adaptive filters based on the lattice structure which offers faster convergence than the

transversal filter based approach and they believe its increased complexity is not a significant drawback with the advances in VLSI. In contrast to these investigations the alternative distributed arithmetic approach implements a low complexity filter where conventional multipliers are replaced by table look-up techniques and as a consequence it simplifies the design of wideband adaptive equalisers. Wideband equalisers are also under study to extend these techniques to the requirements of applications such as the 140 Mbit/sec digital microwave line of sight radio systems to overcome multipath interference. Another technique under study is the realisation of fast converging equalisers based on matrix inversion processing. In particular they are studying algorithms which lend themselves either to an efficient implementation in VLSI in collaboration with the Integrated Systems Group, or to realisation on fast microprocessors such as the Texas Instruments TMS 320 series.

Performance of a new reduced complexity phase loop demodulator capable of demodulating Multiple Phase Shift Keying (MPSK) is being investigated. The loop, is unique in that it can be programmed to lock to any MPSK format (typically from 2-phase to 16-phase) or to any combination of amplitude and phase keying which may be appropriate to the capacity of the channel in use. Both analogue and digital implementations of the loop are under study.

Methods of improving the signal processing aspects of foetal heart monitoring are being investigated in conjunction with a medical research team at the National Welsh School of Medicine, Cardiff where a test program involving some 900 patients including many

high risk patients is underway with correlation, matched filtering and non-parametric ultrasonic doppler returns of patients from 19 weeks of pregnancy to term. The aim of the project is to achieve reliable results as early as the 14th week of pregnancy.

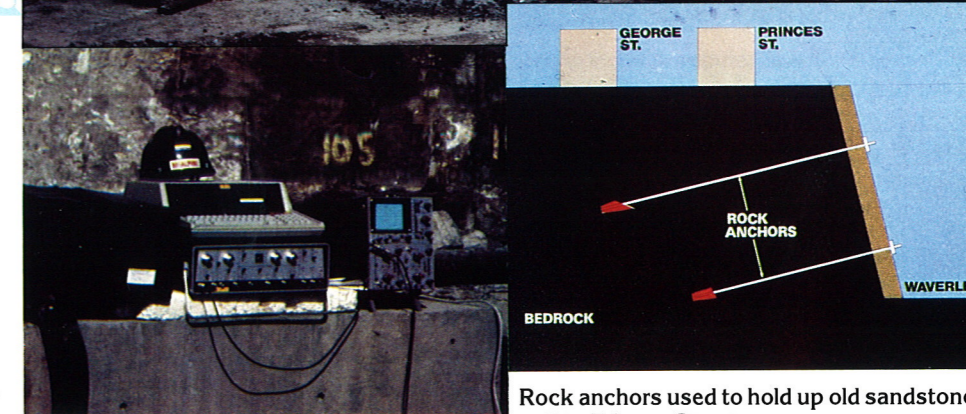
### Instrumentation and Digital Systems

Information technology is based on the advances recently achieved with digital system techniques. These advances have been largely inspired by the need to eliminate the complex, often manual, adjustment procedures that arise when analogue systems are manufactured. However, the real world is predominantly analogue, hence at some point in the design of a system the analogue interface must be addressed. Design techniques which minimise the analogue components and preset adjustments used, are therefore of considerable interest. For example, transducer design should now be approached from the point of view of using a relatively crude transduction technique, coupled with digital signal processing to achieve an overall acceptable performance. The instrumentation and Digital Systems Group brings together a wide range of digital and analogue expertise and is therefore able to investigate problems in this area from a unified point of view.

### \* Non-destructively Testing Civil Engineering Structures



Early stages of Edinburgh Waverley Market Shopping Development showing old wall and Princes Street shops.



On site verification of integrity of anchors by solving wave equation for different boundary conditions.

Rock anchors used to hold up old sandstone wall to Princes Street.

Topics of particular interest are:-

- \* VLSI circuits, transducers and software for machinery health monitoring systems.
- \* Electronic instrumentation, transducers and software for non-destructively testing Civil Engineering structures.
- \* Chemically sensitive electrodes based on microelectronic fabrication technology.
- \* Microcomputer based instrumentation and decision support systems.
- \* Design methods that simultaneously satisfy functionality and testability.

A major unifying theme has been an investigation of the use of noise as an information conveyor. VLSI technology is enabling the low-cost implementation of complex signal processing algorithms (e.g. correlation and spectrum based methods) that can be used to characterise a noise signal. This work has led to novel algorithms, correlators and spectrum analysers which are being used in transit time measurement (e.g. correlation flowmeters) and machinery health monitors (e.g. vibration analysers).

## Edinburgh Microfabrication Facility

Facilities to fabricate integrated circuits were first established within the Department of Electrical Engineering in 1966. Since then, there has been a growing commitment to all aspects of IC technology. There is a specialist BSc degree, an MSc in "Design and Manufacture of Microelectronics Systems" and research projects which cover materials, IC design, fabrication processes and systems development. This broad spectrum of technical capability gives the Department a unique level of vertical integration in high technology and encourages a strong interaction between teaching and research.

The first phase of development at Edinburgh between 1978 and 1982 established LSI processes which are now widely used. The second phase started in 1982 and has enhanced the capability to VLSI levels.

### Processes

All EMF processes are based on MOS technology. The most widely used is an isoplanar n-channel silicon gate process with minimum feature sizes of 6 microns. It is comparable with the industry-standard LSI product and it forms the basis of most other processes which have been developed.

The core nMOS process has been developed in many unique ways, but the principal variants are:

- \* n-well CMOS
- \* 2-level polysilicon nMOS and CMOS
- \* small geometry nMOS and CMOS
- \* metal gate nMOS and pMOS
- \* nitride passivated structures
- \* photo-sensitive structures
- \* array commitment

This common building block approach makes it practicable to formulate a new process to meet a specific objective and to achieve working structures with the first (and possibly the only) fabrication run. It also allows new equipment and process enhancements to be added quickly to the benefit of all users.

### Facilities

All fabrication equipment is housed in adjacent laboratories and in all cases, wafers are only exposed to class 100 clean air. The major facilities are:

Yellow room for contact lithography. Positive resist is used and a track resist spin/bake system feeds two Cobilt contact printers.

Yellow room for VLSI lithography. This houses an Eaton LSI 60 track system, Optimetrix IO:1 wafer stepper and inspection equipment.

12 furnace tubes of which 5 provide oxidation with burnt hydrogen and 3 are for LPCVD (silicon, nitride and oxide).

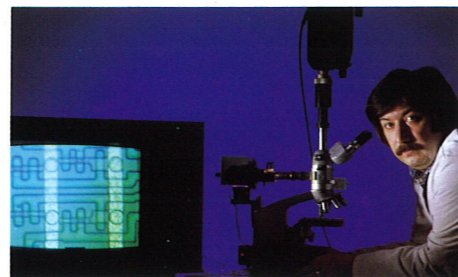
Dry etch facilities with barrel and parallel plate plasma and two RIE systems.

Metal sputtering plant and electron beam evaporation unit.

Linott 111 high current ion implanter.

Wet etch laboratory.

Test laboratory for detailed process analysis and device measurement.



Micrograph of microchip

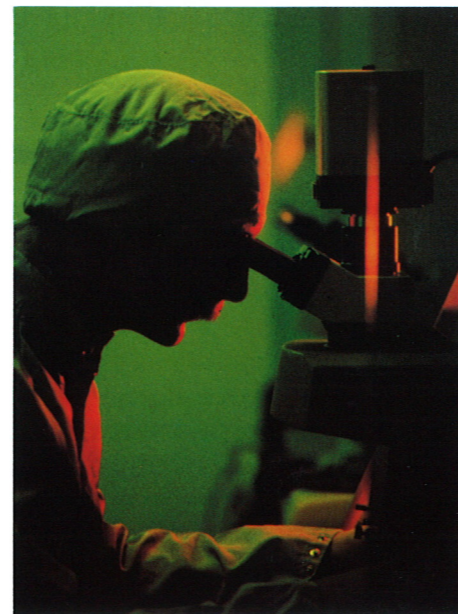
### Testing and Assembly

Wafers are tested throughout the fabrication process. As well as optical inspection, techniques include ellipsometry and mechanical film thickness measurement, four point probe and C-V analysis. The structures may also be examined with optical or scanning electron microscopes. Probe testing of completed wafers is carried out with a variety of automatic data acquisition systems coupled to appropriate probers. After probe testing, the good chips are mounted in packages using eutectic bonding. Wire bonding is usually carried out with a gold ultrasonic bonder.

### Teaching in Electrical Engineering

The department offers two full-time undergraduate degree courses and joint degree courses with the departments of Computer Science, Physics and Mechanical Engineering. It also participates in a joint Information Technology MSc conversion course with Artificial Intelligence and Computer Science.

Engineer inspecting chip during manufacture in the EMF



Created in 1966 as a consequence of the Flowers Report on computing for the Universities and Research Councils, the Department of Computer Science inherited responsibility for teaching and research.

There already existed a Post-graduate Diploma and a first-year course in the subject, together with a major research and development project, the Edinburgh Multi-Access Project, from which sprang the interactive computing system (EMAS) which provides the service now enjoyed by over 4000 users.

Second and third year courses were introduced in 1968 and 1970. By 1972 it became possible to launch a Final Honours year in the subject and an Honours degree in Computer Science alone became available.

### Research in Computer Science

#### VLSI Systems

Very Large Scale Integration (VLSI) is a technology which provides a quantitative leap in the complexity of circuits that can be manufactured with consequent gains in cost-effectiveness. These quantitative changes have also induced qualitative changes which make VLSI currently a very active research area. Many complex systems architectures including highly concurrent systems can be implemented directly in silicon. Work in progress covers investigations into:

- \* systems architectures
- \* design methodologies
- \* computer design aids
- \* simulation and testing aids
- \* formal modelling and verification
- \* complexity

and in other areas.

## COMPUTER SCIENCE



One of the machine rooms in the Computer Science Department

The Department possesses excellent facilities for designing VLSI circuits and implementing the aids that enable design work to progress.

It is also intended to make use of developments taking place in the department such as Advanced Personal Machines and high performance graphics systems to produce even more sophisticated VLSI design tools.

### Programming Methodology

An active project within the Department is researching areas such as:

\* Advanced programming languages, with particular emphasis on functional programming and the use of abstract data types and modularity to structure large programs. An experimental functional language HOPE has been designed and implemented as has another language, IVY, which is oriented to the exploitation of a rich collection of built-in data types.

\* Specification of problems and programs. Specifications of large programs can be complex and need to be presented in a clear and modular way. CLEAR is a specification language developed in collaboration with Stanford Research Institute, Palo Alto.

\* Applications of Algebra and Category Theory. The semantics of CLEAR has been given in an algebraic/categorical manner. This has stimulated work on embodying categorical concepts directly in programs, "categorical programming".

### Data Curator

The work on this project is distinguished by an interest in the relationship between databases and programming languages. Its long-term aim is to eliminate databases, at least as visible objects. To achieve this end, it intends to support persistent data as a natural part of using that data in programs. This will lead to a more coherent and consistent programming environment.

### Application studies in LCF

LCF is a fully implemented interactive proof system, in which properties of computations may be rigorously verified by a mixture of automatic and interactive methods.

The current project is focussed upon case-studies of proof. The main aim is to evaluate the methodology which has been developed, consisting principally of:

- (1) the organisation of problems and problem areas in a hierarchic structure of theories, and
- (2) the use of a powerful meta-language ML, a high-level programming language in its own right, to raise the quality of interaction by programming and combining partial or total proof strategies.

### Semantics of Non-deterministic and Concurrent Computation

This research concerns the foundations of non-deterministic and concurrent computation. The aim is to provide a uniform framework containing mathematical models for the intuitive ideas of an event, of process communication and of synchronisation. The mathematics involved is continuous, as advocated by Scott, and uses tools from algebra and category theory.

### Semantics of Abstract Data Types

The aim of this project is to develop further the application of Scott's theory of computation to the study of the synthetic approach to abstract data types. It is intended to pursue a wide variety of topics ranging from the detailed study of practical examples to theoretical problems and to include systematic comparisons with other approaches.

### Computational Complexity and Algorithms

The Theory of Computability provides a broad classification of problems according to whether or not they can be solved by effective computational procedures. Computational Complexity can be viewed as a refinement of this theory which seeks to quantify the computational resources, such as time and space, required to solve specific problems. In order for the subject to progress, it has been necessary for practitioners to draw upon wider-ranging and deeper Mathematics. At the same time, Computational Complexity has been enriching existing areas of Mathematics by providing a fresh computational of what constitutes a "good characterisation".

The search for efficient algorithms for solving practical problems is one important motivation for the study, and already notable successes have been achieved.

### Stylistic Analysis

Stylometry has been defined as the scientific study of the usage of words in an attempt to resolve literary problems of authorship and chronology. The traditional methods of stylistic analysis have often been based upon subjective evaluation of internal textual evidence, often with unsatisfactory results. With the availability of computers as tools, new ideas have burgeoned and new approaches to these age-old problems have led to an increased need for statistical analysis of observational data.

Before any new technique is applied to disputed texts, it must be tested on texts of known provenance. A wide range of texts are being examined in Edinburgh, as well as an ever-growing collection of unanswered questions ranging from the composition of the Iliad to disputed wills in the U.S.A.!

### Computing Systems, Graphics and Advanced Personal Machines

The Department has been active in basic system software — operating systems and language support — over many years. More recently it has been building up expertise in the area of hardware design and implementation, particularly in relation to micro-processors, local area networks and micro-programmed graphics processors. These strands are being drawn together in a Departmental project, now well advanced, to implement a complete modular computer system.

A major aim of this development has been to provide maximum flexibility of configuration, so that it would be possible within the overall framework to experiment with a variety of architectures and processors. Accordingly, the system is constructed round a high-performance memory bus,

shareable by several processors and permitting easy expansion of memory capability. The bus supports full 32-bit data operands and 32-bit (byte) addresses, with separate data and address lines.

The Advanced Personal Machine is one version of this system, the basic version having a single processor board utilising the Motorola 68000 microprocessor chip, one or more 1/2 megabyte memory boards, and a network controller board providing access to an ethernet-type Local Area Network. A typical system will be configured with a graphical processing capability, which provides bit-map graphics under the control of a micro-programmed controller.

The processing capability of the system will be enhanced by the provision of separate user-level processor boards, with the basic processor board retained as an input/output controller and diagnostic monitor. Because of the generality of the design, the

system is not tied to one particular microprocessor range and plans for user level processors include Intel and National Semiconductor parts as well as the later versions of the M68000.

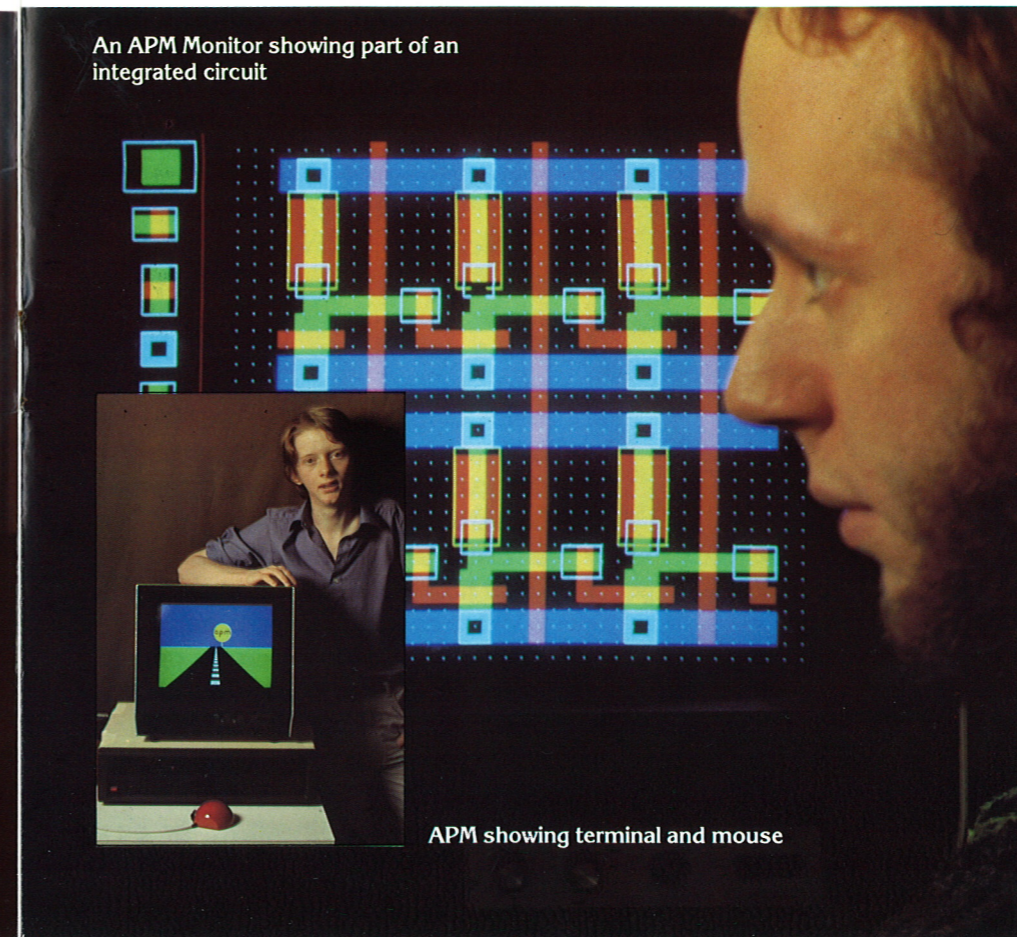
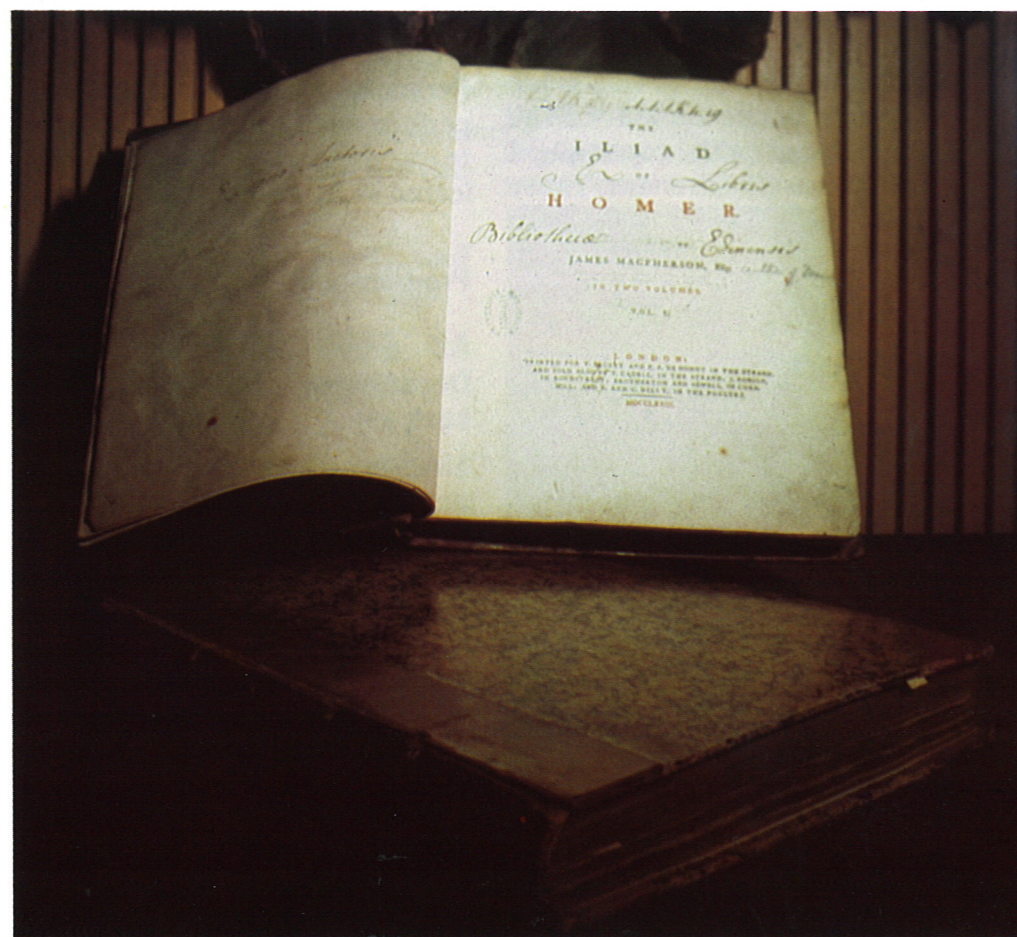
The operating system for the Advanced Personal Machine is aimed at matching the modularity of the hardware. It consists of a small core concerned with process creation and synchronisation, together with an open-ended set of facility modules, selectable at will according to configuration and user requirements. This approach permits a number of different user interfaces to be provided and may even be extended to provide support for complete alternative operating systems. Emphasis is being laid on designing the programming support environment on a multi-lingual basis.

### Teaching in the Department of Computer Science

The Department has a very active teaching programme at both the undergraduate and postgraduate levels. At the undergraduate level there are first year courses for students who wish to learn programming and systems design as part of their main course, and those who wish to concentrate on some of the applications of computers, by doing the Information Systems course as an outside subject. Joint degrees are available with the Departments of:

- Electrical Engineering,
- Management Science,
- Mathematics,
- Physics
- and Statistics.

There are research students working for MPhil/PhD degrees in all of the research areas in which the Department is active. There is also the joint MSc conversion course in Information Technology.

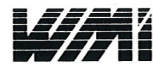


An APM Monitor showing part of an integrated circuit

APM showing terminal and mouse



# Technology Transfer



## WOLFSON MICROELECTRONICS INSTITUTE

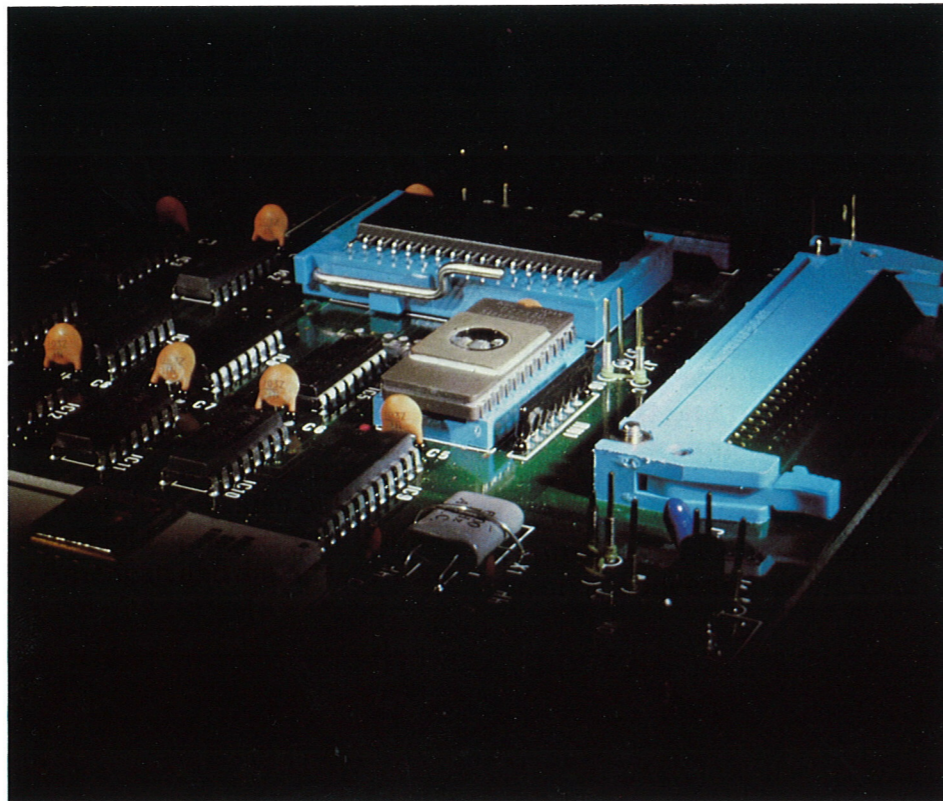
Located on Edinburgh University's King's Buildings Science Campus, the Wolfson Microelectronics Institute (WMI), plays an important role within Scotland as part of the local industrial infrastructure, undertaking a range of high-technology microelectronics activities on a commercial contract basis. These activities include basic research and development of electronic products at both component and systems level involving hardware and software. Training is also undertaken on a basis complementary to that of the academic departments of the University.

WMI was established in 1969 with one of the first grants from the Wolfson Foundation. This money was used to establish the Institute but after the initial period of three years it has operated in a fully commercial way and has gained widespread recognition as a "centre of microelectronics expertise". It has also been actively concerned with the application of the technology in the fields of industry and commerce. To assist with this latter activity it has established a new specialist company, INMAP, to market the skills of the Institute and broaden the customer base among the more traditional industries.

The Institute has worked successfully with a large number of companies and government agencies throughout the United Kingdom.

### Structure

WMI is separate from but is located next to the Department of Electrical Engineering and there is a close working relationship between the two staffs and with



the staff of other relevant departments. Informal relations also exist with government agencies, notably the Scottish Economic Planning Department, the Scottish Development Agency and local authority agencies. WMI plays an important role in assisting these agencies to attract inward investment into Scotland. In this context the activities of WMI have been highly praised by a number of American and Japanese microelectronics companies and have been instrumental in their location in Scotland.

WMI carries out mainly development work but some projects could be regarded also as engineering research. There is a spectrum of activities with the more fundamental and long-term work being carried out in conjunction with the Department of Electrical Engineering.

### Integrated Circuit Design

The activities of the Wolfson Microelectronics Institute are focussed into two main technological areas, integrated circuit design and microprocessor systems applications. Training is also provided on a specific customer basis, the training programme being tailored to suit particular companies needs. There has been a concerted effort over a number of years to specialise in the custom design of large-scale integrated (LSI) circuits. This activity now contributes more than half the turnover and WMI is widely recognised as a centre of excellence for such designs, particularly those making use of charge coupled device (CCD) and analogue MOS technologies. With developments of semiconductor technology the Institute is now

directing its efforts to designing very large scale integrated (VLSI) circuits which provide the possibility of designing complete electronic systems as a single chip.

Normally, the semiconductor industry demands large-volume runs as a prerequisite to diverting its engineering design effort on to a custom-designed circuit. These circumstances have allowed WMI to perform a significant design role for customers with smaller volume runs requiring digital LSI circuits for 'adding-value' to innovative products. Other designs have involved the use of analogue techniques, particularly CCD signal-processing circuits, for which Edinburgh University is one of the leading research centres in the world. The catalogue of LSI circuits produced by WMI includes correlators for industrial flow measurement, the counter display for the Moore & Wright electronic micrometer, programmable and adaptive transversal filters for pattern recognition and line equalisation, a telephone chip for interfacing handsets to a PABX and speech processing circuits.

The experience of these developments has demonstrated that the interaction of the designer with the customer is a most important consideration in efficient and successful LSI design.

The facilities within the Institute for LSI circuit design on silicon chips are both advanced and comprehensive. There is a full computer-aided design (CAD) facility. A central design suite of programs known as GAELIC which has been generated by WMI in conjunction with the Department of Computer Science is now being sold worldwide. These programs contain a unique degree of automation. The GAELIC suite has also now been adopted for

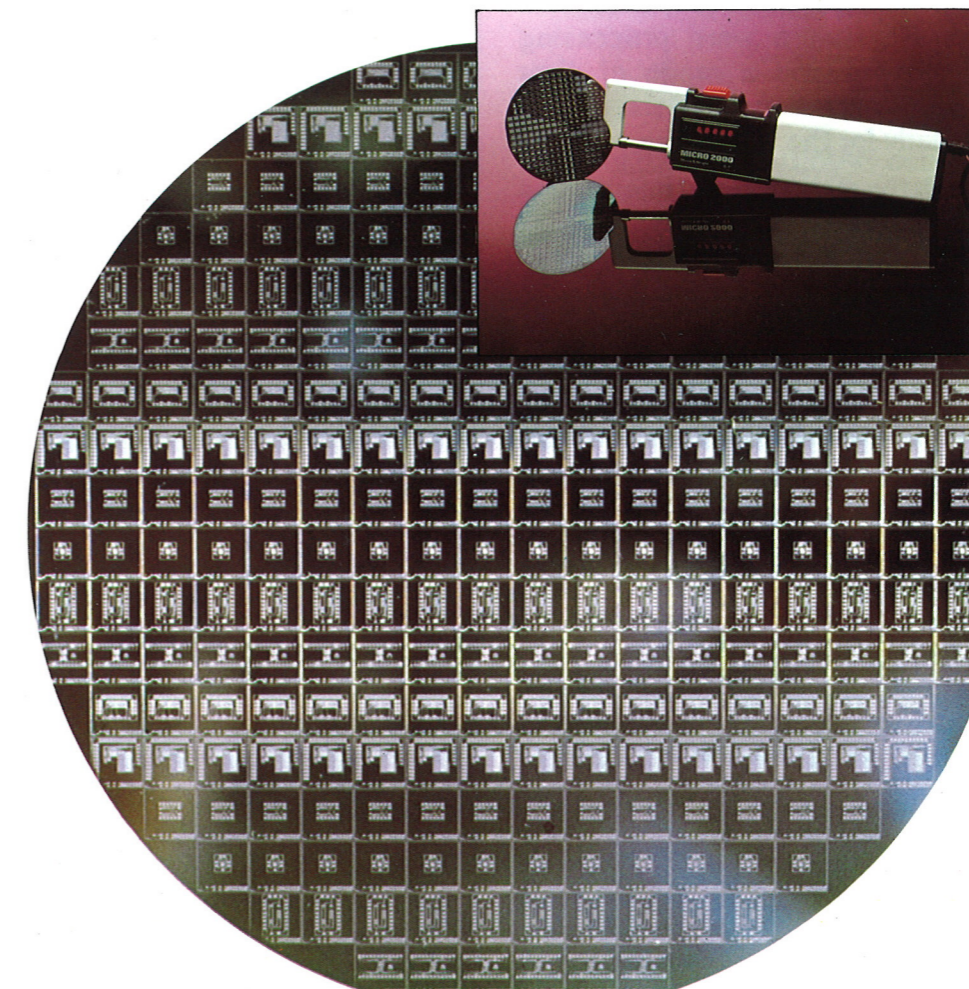
LSI circuit-design work throughout the British universities and by British Telecom. More advanced high level software techniques are currently being developed to allow VLSI systems on silicon to be developed both rapidly and economically.

WMI also has available to it, the full processing capability of the Edinburgh Microfabrication Facility. The co-existence of the EMF and WMI promises to place Edinburgh University at the forefront within British universities for the complete design and manufacture of microelectronic systems and microsystem architectures.

This total facility also forms a unique base for the education and training of graduates in microelectronics for the 1980's and beyond.



The Digital telephone

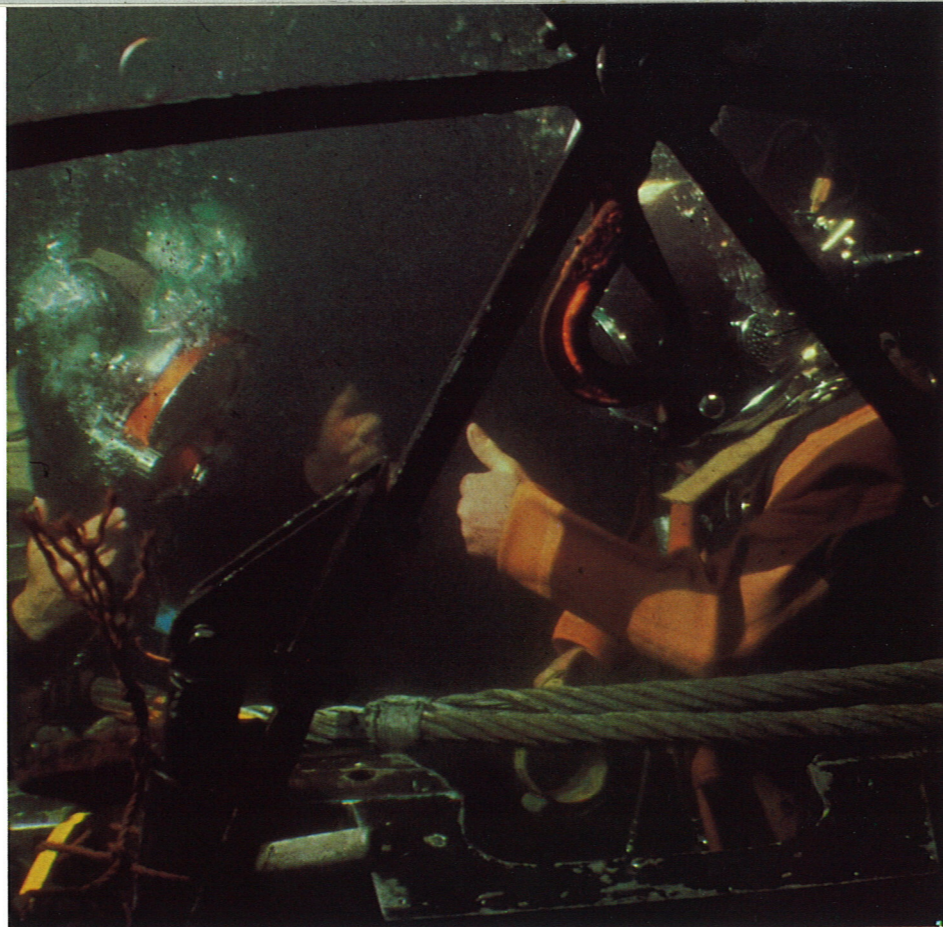


The digital micrometer

## Product Development

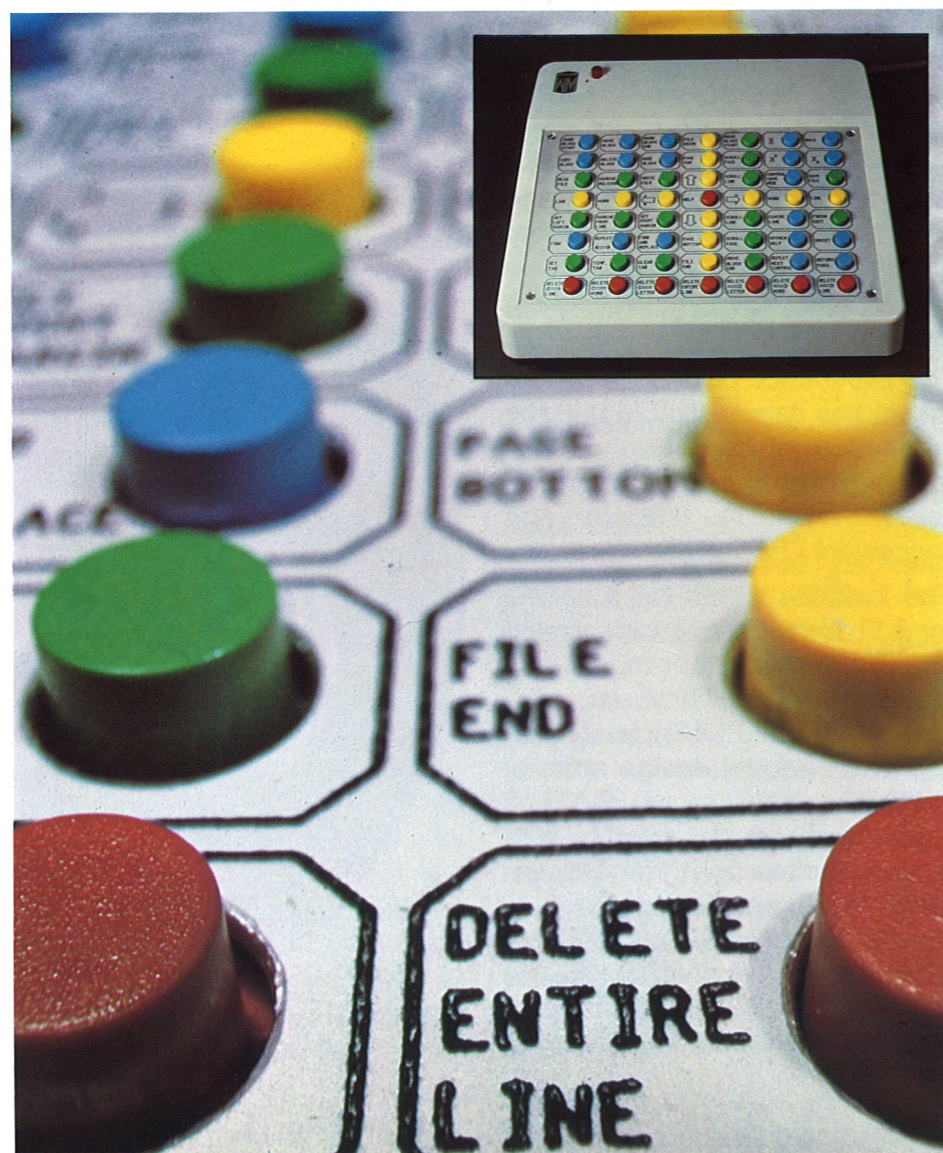
The second technological area of activity for WMI lies in the development of electronic products, instruments, modules and sub-systems. These involve both custom-design circuits and standard components. With the advent of microprocessors this activity has expanded enormously, greatly assisted by funding from Lothian Regional Council for the support of product innovation in local companies. Particular emphasis is now placed on the development of new "intelligent products which exploit the capabilities of advanced electronic components such as micro computers. A range of innovative products have been developed including a heart rate monitor, logic analyser, encrypted communications systems and a location device. WMI has also developed its own products such as Keystar, a word processing keyboard and a range of diver communications systems particularly for the North Sea market.

With the recognition of Information Technology as a market for electronic systems WMI intends to expand its applications activities in this direction. In Edinburgh, the Regional Computing Centre already has many years experience in this field and it is proposed that in conjunction with INMAP Ltd., new opportunities for systems development should be sought by the ERCC and WMI.



Deep sea diver using the Helium speech unscrambler developed by WMI, for underwater communications

Keystar



Heart rate monitor

One of the three major University centres established in the United Kingdom in 1966, the Edinburgh Regional Computing Centre (ERCC) provides a wide ranging computing service to a broad client list which includes, in addition to local Edinburgh University staff and students, other Scottish Universities, institutes funded by all the major UK Research Councils, Treasury funded organisations such as the Department of Agriculture and Fisheries and the Scottish Home and Health Department and also numerous commercial organisations.

The ERCC's services have been the corner stone of many major research projects and joint programmes have been mounted with several major computer manufacturers.

Close links exist between this service organisation and those academic departments which lie at the heart of the drive towards fifth generation systems and the ERCC will play a key role in this venture by providing, in conjunction with the Wolfson Microelectronics Institute, a technology transfer bridge between the teaching and research resource and the business and industrial community.

ERCC has many strengths to offer, for example:

- \* An intimate knowledge of the needs of a large vigorous computing community.
- \* An experienced, stable complement of systems designers and implementers.
- \* Early access to leading edge research results in the field of information technology.

**ERCC**

**EDINBURGH REGIONAL COMPUTING CENTRE**



Central control station for EMAS service

Specialist areas within ERCC are:

- \* Operating system design and implementation.
- \* Compiler design and implementation.
- \* Network system design and implementation.
- \* Application system design and implementation for novel architectures.
- \* Client support in scientific and business systems.
- \* Software engineering.

### Operating Systems

In the field of Operating System design, Edinburgh's major achievement has been the Edinburgh Multi-Access System (EMAS), a project born in the days when large scale interactive computing was still a far off dream. This operating system has, since 1972, provided ERCC users with an extremely powerful and efficient interactive and batch computing service and currently there are over 4000 users of this facility.

Many of the original EMAS design concepts have been incorporated into later commercial offerings. Written in a high level language developed in Edinburgh, EMAS supports compilers such as FORTRAN 77, Pascal, Algol, BCPL, SIMULA and packages such as the NAG Library, SPSS, GENSTAT, BMDP, SCSS and EDEX.

The ERCC's Operating and Distributed Systems groups also have in-depth experience of the application in diverse situations, of a variety of externally produced systems such as UNIX, DEC's VMS and the UCSD p-System. Development work is being undertaken to fully integrate services based on these systems, running on a number of hardware options, into the Edinburgh local and wide area networks.

## Compilers

ERCC has developed and sustained one of the most active groups developing and supporting compilers in any European University. Compilers developed by ERCC are designed to conform with International Standards. Strategies which facilitate transfer to different hardware and operating system bases are used. ERCC has played a major role in the international provision of large programme packages which are written in FORTRAN and many compilers developed initially for local EMAS use, have been adapted to run on commercial systems and are now marketed worldwide. Considerable expertise in the production of portable compiling systems exists within ERCC and one of the current projects in this area is a collaborative development of a portable SIMULA compiling system with the Norwegian Computing Centre.

## Networking

The basic framework for the provision of the ERCC's services is its communications network. Under development since the late 1960s, it is now the carrier of perhaps the heaviest academic and research computing traffic load in Europe.

As with EMAS, ERCC provided its users with network services in advance of these facilities becoming generally available. Packet switching and terminal concentration were a reality in Edinburgh nearly ten years ago. Currently, over 1000 directly connected access points are supported on a multi-node X25 standard service.

ERCC users have access locally, via the network, to facilities based on hardware and software from most of the major computer manufacturers and world wide access to other services through

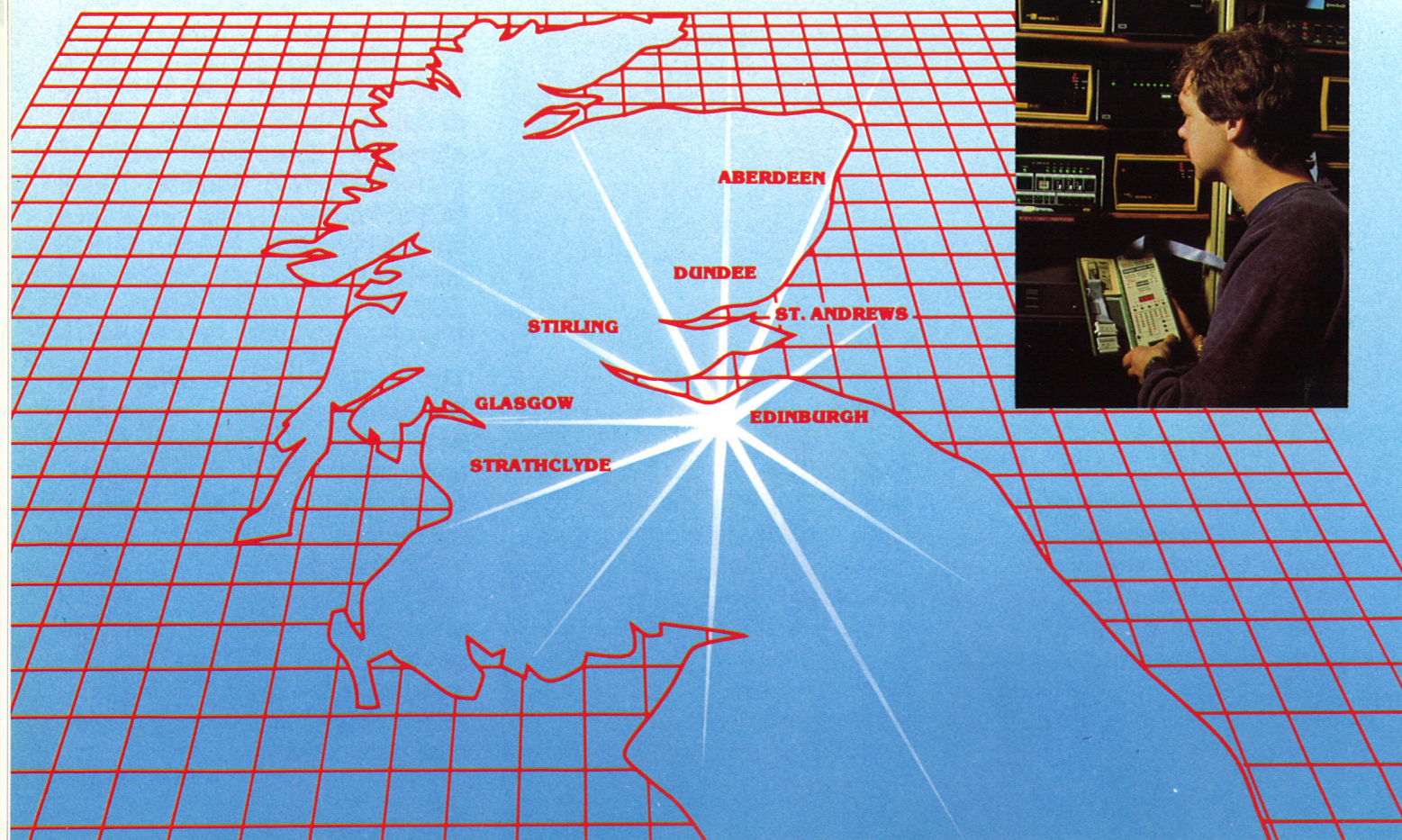
a gateway to the Public Packet Switching Service.

High speed local area networks using both Cambridge Ring and Ethernet technology have been successfully integrated into the wide area network, with much of the original development work having been carried out in Edinburgh.

ERCC is now actively incorporating integrated speech and data facilities into its network, a step towards offering Edinburgh users early access to full ISDN (Integrated Services Digital Networking).

To assist with the planning and management of such a complex communications arrangement, network information monitors, traffic modelling packages and terminal emulators for benchmarking, have all been developed in Edinburgh.

ERCC support engineer monitoring communications network



## Application Systems and Client Support

Faced with a multitude of software packages, libraries, machines, languages and operating systems, the choice is not easy, a wrong decision at the start may prove costly. The expertise available within ERCC assists new and experienced computer users to select the development path best suited to their requirement.

ERCC provides comprehensive training, advisory and consultancy services on all aspects of its activities. Its Training Unit presents a range of courses and seminars for staff and student users and can provide specially tailored training programmes to meet specific needs for University and external purposes. Specialists from other areas within ERCC and from Information Technology departments are utilised when required. A series of video recorded, self teaching material is also produced by the Unit.

General and specialist consultancy is available on an "open-door" and on a commercial contract basis, to computer users requiring assistance with for example:

- \* Problem analysis
- \* Choice of research methods
- \* Program design
- \* Evaluation of results
- \* Personal computing and office systems
- \* Numerical and business computing
- \* Network planning
- \* Real Time computing

ERCC has for many years been actively involved with the NAG library of numerical and graphical software and offers detailed advice on its use.



Client consultation in the ERCC

Distributed Array Processing (DAP) computing and advisory services are provided, the DAP providing parallel processing facilities which offer savings over sequential computing, particularly in the area of bit manipulation which has applications in image processing and character recognition.

## Software Engineering

In line with its commitment to look to the future requirements of the software producing community, ERCC provides a software engineering advisory service based on its current work in the language Ada.

With this and the advent of more portable development environments, the methodologies of software engineering are becoming an economic 'must' for anybody developing software of any substance.

Much research has gone into the design of different software development methodologies which are encapsulated in the domain of software engineering. The necessity of applying these techniques is without doubt since products can be produced and maintained so much more economically and closer to timetables.

The major requirements of applying the techniques are:

- \* A standard language
- \* A portable operative system
- \* A set of portable software development tools

A project based on Ada, a very practical and powerful language, has been set up in liaison with a Government agency and a commercial concern. This project is intended to develop the experience of introducing the techniques and hence the benefits of software engineering, to the software developing community.

**CENTRE FOR APPLICATIONS SOFTWARE & TECHNOLOGY**

The Centre for Application Software and Technology (CAST)'s services, can be categorised under five main headings:

- \* Information services
- \* Applications Packages services
- \* User Consultancy services
- \* Data Library services
- \* External Services

CAST maintains a program library environment on ERCC computers which supports a large collection of packages in terms of information provision, maintenance support and usage monitoring.

CAST provides a service to evaluate and provide applications packages in generalised areas such as statistics, databases and graphics across machines from personal computers to mainframes. Included in the wide range of packages available are statistical packages such as SPSS-X, BMDP and Minitab; database packages such as IDMS, Rapport, Oracle and ENUF (locally developed); and graphics packages such as GIMMS, SYMAP, ASPEX and SAS/Graph.

The Data Library is a collection of machine readable data files of interest to teachers and researchers from a range of disciplines. This service is provided jointly with the University Library.

A major holding is the 1981 Population Census data. CAST has provided the system design and implementation for SASPAC, a portable software package for handling the Census data, which is now used by about 150 UK government organisations.

Also provided by CAST are a variety of consultancy services of the type offered by software houses including:

- \* Advice on selection and use of packages
- \* In depth analysis of user requirements in data handling
- \* Support to user projects by the provision of expertise and staff resource
- \* Advice on DIY package conversion

The above services are also available to users outwith the University of Edinburgh.



Member of CAST Staff working on Micro based software package.



CAST provides a package conversion, marketing and sales service under the name of the Program Library Unit (PLU).

Most of the packages originate from the University communities of the UK and USA. The customer base for sales is worldwide. The PLU welcomes enquiries from package originators regarding package adoption by PLU.

**ARTIFICIAL INTELLIGENCE APPLICATIONS INSTITUTE**

The Artificial Intelligence Applications Institute (AIAI) complements the fundamental research carried out in the Department of Artificial Intelligence by providing an environment within which professional staff can develop and apply A.I. knowhow, tools and techniques to practical problems of industrial or commercial significance. It is a revenue earning activity, performing a technology transfer function on

the model of U.S. organisations such as Stanford Research International, or Information Sciences Institute.

A particular feature of the Institute's operation is its Industrial Affiliates scheme. In return for an annual fee, Institute staff work closely with each affiliated company to promote the use of A.I. techniques in its products. Services offered include consultancy, training,

library service, recruitment service and software licences for Institute products. In addition to the Affiliates programme, the Institute undertakes specific development contracts on behalf of clients who include commercial software houses, computer manufacturers and a research council.

# Associated Research & Application Areas

Linguistics, the scientific study of language and speech, has considerable relevance to Information Technology. The Edinburgh Department is one of the largest in Europe.

**Research in Linguistics**

The Department supports a wide range of research into speech and language. The Phonetics Laboratory is well equipped and houses the Centre for Speech Technology Research, whose function is to promote research into speech-based man/machine interfaces, in collaboration with other I.T. departments such as Electrical Engineering and Artificial Intelligence. The interests of the Laboratory and the Centre include not only automatic speech recognition and speech synthesis, but also automatic speaker recognition, automatic sentence-parsing programs, human factors' research into how users interact with computer systems through speech, and the use of computer modelling to understand how human speech production and perception work. A major current research interest is the use of automatic acoustic analysis for the detection of laryngeal pathology from tape recordings of patients reading a short text. This work is being carried out in collaboration with otolaryngologists and speech therapists in hospitals in Edinburgh and Oxford.

Associated with the Department of Linguistics is the Institute for Applied Language Studies, part of whose function is to conduct research into applied linguistics. This includes research into I.T. topics such as computer-aided language learning and testing.

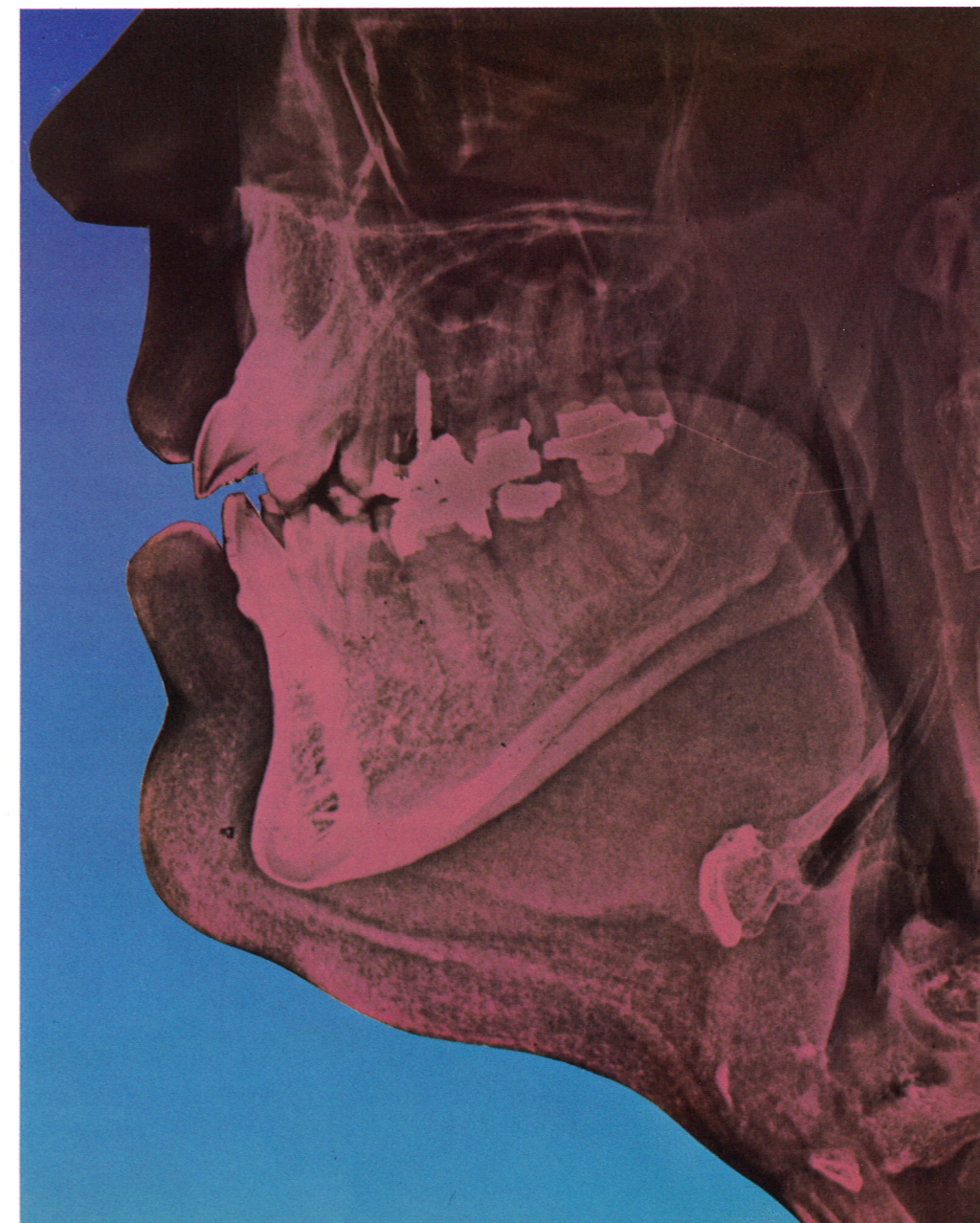
**Teaching in Linguistics**

The Department typically has about 250 undergraduate students and some 80 postgraduates. A specialist four year M.A. Honours degree in Linguistics and Artificial Intelligence and Psychology and Linguistics are offered as well as joint degrees with a number of European and other languages. Postgraduate courses include MSc degrees in Phonetics, General Linguistics and Applied Linguistics. The Department also teaches two

**LINGUISTICS**

modules (Speech Acoustics and Speech Signal Processing) for the MSc in Information Technology course.

A Xeroradiograph of the vocal apparatus showing the position of the organs of speech during the pronunciation of the 'ee' vowel in 'see'



## ASTRONOMY

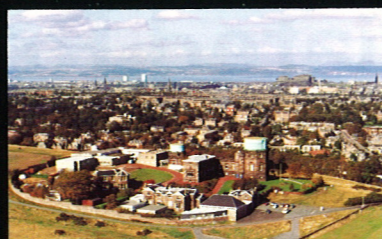
Information Technology is as appropriate to astronomy as it is to any other scientific discipline; astronomers currently use information technology over a wide range of activities, from the acquisition and transmission of raw data to the preparation of scientific papers.

The University Department of Astronomy is housed in the same building as the Royal Observatory of Edinburgh, which makes for close collaboration between scientists in these institutions both for research and teaching. Facilities at Edinburgh include some of the most advanced available in the U.K. for the processing and analysis of vast amounts of image and numerical data produced by modern detectors and telescopes.

### Research in Astronomy

There are several facilities at Edinburgh directly related to research which makes use of information technology. The COSMOS machine is a high-speed automatic plate measuring machine which produces numerical data describing the images on photographic plates taken with large telescopes such as the UK Schmidt Telescope. The analysis of these data may be done in Edinburgh, using the Observatory's in-house computer, or using image processing software available on the Edinburgh node of a network of computers (STARLINK) used for interactive processing of astronomical data.

The data produced by COSMOS or other similar machines from photographic plates, or from two-dimensional digital detectors on large telescopes, represent a very



The Royal Observatory of Edinburgh

Photograph from the U.K. Schmidt Telescope of the Orion Nebula

large amount of information. One of the problems the astronomer is now having to solve is the management of the enormous quantity of data involved, particularly when images are being processed.

Image processing is another field now of great importance to the astronomer; the STARLINK system was developed to help the astronomer handle the digital image data produced by, for example, two-dimensional CCD detectors on large telescopes and on the Space Telescope. The specialised techniques needed are just as important for applications such as the analysis of satellite Earth resources images as they are for astronomy.

Finally, there is the prospect of remote observing. In September 1982 an astronomer at the Royal Observatory in Edinburgh used a computer terminal to control the U.K. Infrared Telescope on Mauna Kea in Hawaii and to make infrared observations. The test link took in a large number of computer data links, including the Edinburgh Regional Computing Centre and the Public Packet Switching Service. It is intended that the new U.K. millimetre

telescope on Mauna Kea, will be controlled remotely, initially from the Hawaii base and eventually from the U.K.

### Teaching in Astronomy

The Department runs a one-year post-graduate MSc course on "Astronomical Technology" which is taught in collaboration with other departments in the University, particularly the departments of Computer Science and Electrical Engineering, and with the Royal Observatory. Modules from the MSc courses in Information Technology run by the other departments are available to MSc students in Astronomical Technology. Research scientists and technologists within the Observatory contribute to the lecture programme and to the supervision of project work, which is often a part of one of the current ROE projects.

The course is fulfilling a particular need at the present time when there is a demand both in astronomy in the university and the industrial community at large for graduates with the skills provided by this course.

Geography is one of the oldest disciplines and was part of the required course when the University of Edinburgh was first founded in 1583. Far from having an old fashioned approach, however, the Department of Geography is in the forefront of the development and application of Information Technology.

This is particularly true in the processing of information utilising maps, graphics and databases.

As well as being involved in the development of user tools and projects with government and industry, the Department also has a role in evaluating the effect, economically, socially, and geographically, of the effect of new technology.

### Software

The Department has been involved with the development of software for computer mapping and graphics for at least 15 years. Two products initiated within the Department are used externally. The most widely distributed of these are the GIMMS system for mapping and graphics, which in close co-operation with the Department, is distributed to more than a dozen countries by a company based in Scotland with a subsidiary in the USA. This system is arguably the most advanced thematic mapping system in the world.

The second system, CAMAP, is used extensively in the UK for the analysis and mapping of large data sets such as the Agricultural Census.

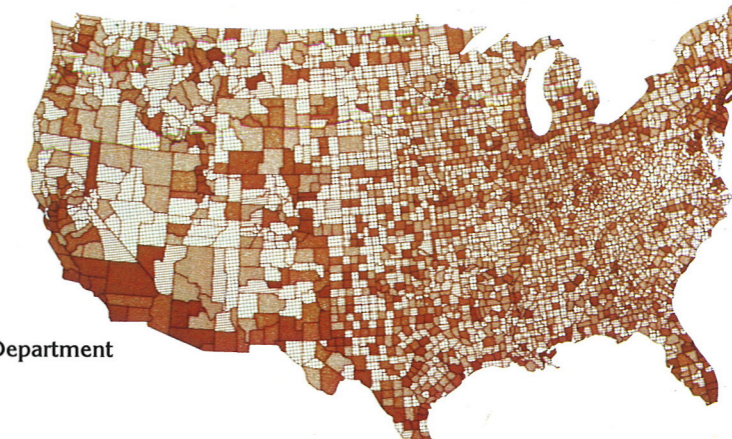
### Projects and Consultancy

Major projects recently have been with Stanford Research International, on financial restructuring for large organisations and the Scottish Development Department on using census data to evaluate, amongst other subjects, unemployment and housing deprivation. A major project with the Ministry of Agriculture, Fisheries and Food has involved the collection of land use data for the whole of England and Wales for use in computer mapping projects.

The department also provides a range of consultancy services in the area of the use of new technology, and its effects, for bringing information, as opposed to data, to the decision maker.

Members of the Department are, or have been recently, consulting on information technology matters to, for example:

- \* Readers Digest International
- \* World Bank
- \* Statistics Canada
- \* US Forest Service
- \* Canadian Forest Service
- \* Severn Trent Water Authority
- \* Greater London Council
- \* Department of the Environment
- \* World Health Organisation
- \* Scottish Development Department (Air Photo Library)
- \* Energy Mines and Resources, Canada
- \* Gibbs and Hill, New York

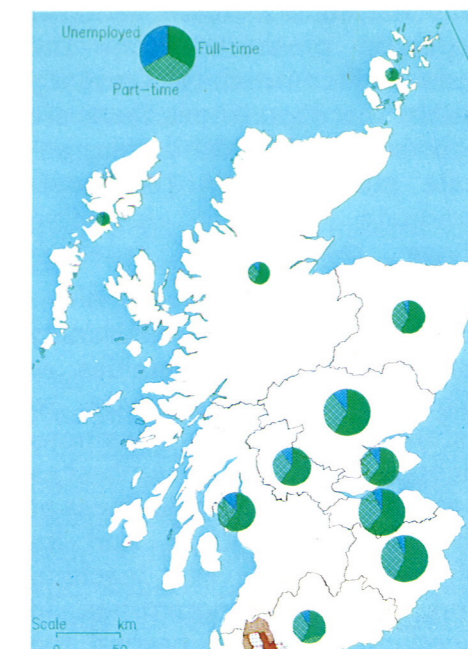


Digitised maps produced by the Geography Department

## GEOGRAPHY

### Teaching in Geography

The department provides an undergraduate course in the Science and Social Science faculties which uses computing techniques in all years. In the third and fourth years, students may choose from several Information Technology courses as well as the more traditional geography courses. A course to be offered for the first time in 1984-85 is a course on the continuing economic and social effects of computerisation, based on consultancy briefings for senior managers of the US Forest Service. More than a third of the members of the department are involved in these courses.



## BUSINESS STUDIES

Although it cannot be claimed that Business Studies figured prominently in the original 1583 syllabus, Edinburgh has a pioneering tradition in this subject.

The B.Comm degree was established in 1918, making Edinburgh one of the first British Universities to become involved in undergraduate Business Studies. In 1953 an evening programme for practising managers was introduced, followed two years later by the start of residential courses for middle and senior managers. By 1960 a full time postgraduate Diploma in Business Administration had been introduced which was later extended to a Masters Degree (MBA). In 1984 a part time MBA course was started as a consequence of repeated pressures from the industrial community. Currently within the department there are approximately 1000 undergraduate students and 100 postgraduate students including those reading for research degrees.

In 1972 Edinburgh University joined with the Universities of Glasgow and Strathclyde to establish the Scottish Business School (SBS) which embraces postgraduate work in Business at the three institutions and its objective is to develop teaching and research programmes in Scotland to a level beyond the capabilities of the constituent Universities on their own.

The teaching staff reflect a healthy blend of academic and industrial experience, and fields of study within the Department include International Business, Marketing, Personnel Management, Industrial Relations and Management Science. Information

Technology techniques are utilised in the teaching and research of all these disciplines and liaison with other members of the Edinburgh I.T. community is a continuous activity thus ensuring that industry's leaders of the future are not only familiar with the most advanced facilities, but have also played a part in shaping the technology to suit the business community's requirements.

In addition to providing practical exercises to help develop familiarity and understanding of the role of information technology in management, computer based business exercises are utilised. In these, each group, as the management team of a company, comes to a series of inter-related business decisions in competition with other groups, all operating in the same product market.

JiIG-CAL is a system which harnesses the power of the computer to the support of career education and guidance.

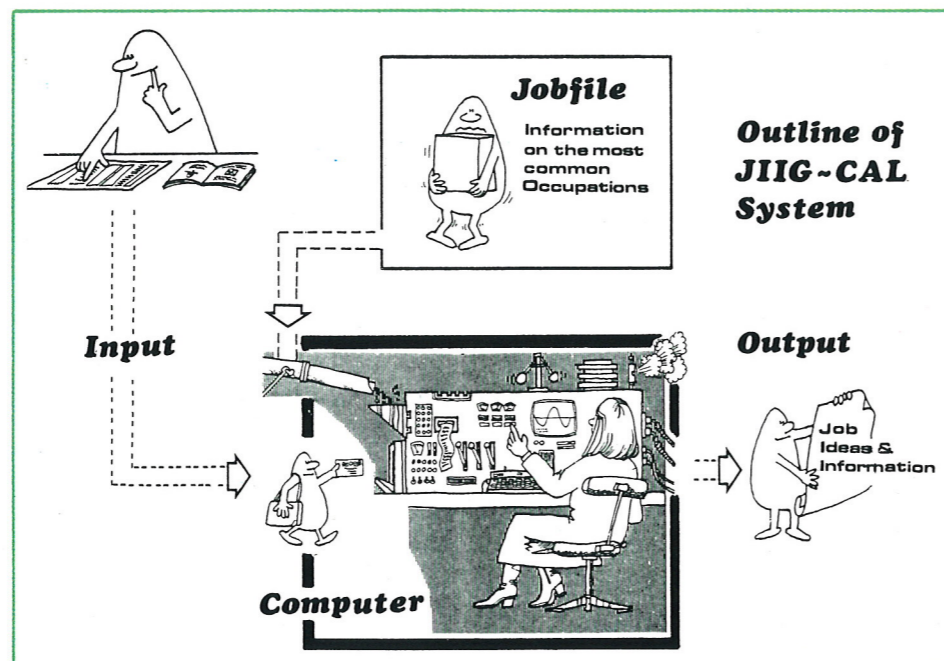
The initials stand for:

JiIG - Job Ideas and Information Generator  
CAL - Computer Assisted Learning

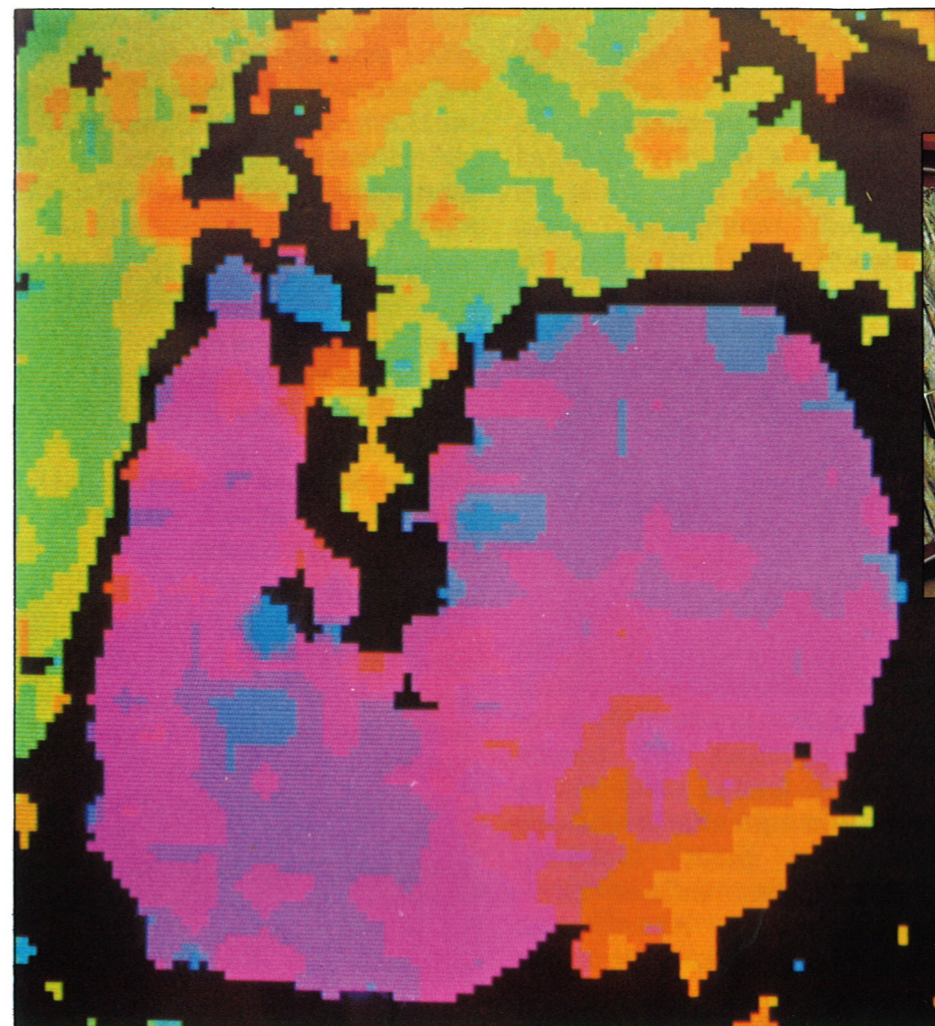
A research activity within the Department has led to the Job Ideas and Information Generator-Computer Assisted Learning system (JiIG-CAL). This package harnesses the power of the computer to the support of career education and guidance, and is widely used throughout the U.K.

B.S. staff in Edinburgh act as consultants to numerous local and multi-national companies and have a special interest in assisting management in under developed countries.

JiIG-CAL is a joint development with the Education Computer Centre, London Borough of Havering. It provides a resource which enables Teachers, Careers Officers, and Parents to help youngsters prepare for the transition from School to Work.



## MEDICINE



Digital Colour Phase Image of the heart used to assess response of damaged heart muscle to drug treatment



Gamma Camera/Computer system - developed in Edinburgh's Department of Medicine - used to measure patients' heart efficiency

The Edinburgh Medical Computing and Statistics Unit provides a wide range of services to assist medical research. This unit is actively involved in providing support to Breast Screening, Cancer, Lymphoma, Lead Poisoning and Young Child Nutrition Research projects.

The Faculty's Medical Information Unit provides a bibliographical advisory service for University and Health Service personnel.

The closely related Medical Research Council Clinical and Population Cytogenetics Unit, based at Edinburgh's Western General Hospital, is concerned with human genetics at cellular and sub-cellular level. In other words, its research concentrates on studies of cell nuclei, chromosome abnormalities (whether hereditary or environmental in origin), DNA and fundamental biochemistry. There is a large group of computer experts in the Institute collectively involved in the development of, for example, image processing and analysis hardware and software for cell and chromosome analysis.

Edinburgh's Medical Faculty, renowned throughout the world, has for many years made increasing use of Information Technology.

Techniques for the diagnosis of heart and lung disease have been automated and improved through the application of real-time on-line digital computing. Some results which previously required many hours of painstaking and tedious measurement from chart recordings can now be obtained immediately with little chance of human error. Other analyses which were too complex to contemplate by manual means have been successfully implemented on both mini-computers and microprocessor systems.

Pharmacists in Edinburgh have developed the use of micro-computers for the analysis of electrical activity recorded from sensory nerves. Data obtained is used to provide information concerning the functioning of sensory receptors which are involved in regulating blood pressure and respiration.

The Department of Medical Physics and Medical Engineering, within the Edinburgh Faculty, provides technical and scientific assistance to hospitals and associated areas within the Lothian Region and for some years has been involved in the design of dedicated micro-processor systems.

## AGRICULTURE

Throughout Scotland, Agricultural Colleges and Research Institutes make use of the Information Technology expertise available in Edinburgh and they are also active in its research and application.

The three Scottish Colleges of Agriculture carry out wide programmes of teaching, advisory development and research work on behalf of their related Universities and the Department of Agriculture and Fisheries for Scotland. Although some of their work is at the fundamental research level, much activity is concerned with the identification of the needs of the agricultural industry, the provision of appropriate applied research and the exploitation of research findings for the benefit of industry and the community. Information Technology plays an ever increasing role in this process.

In addition to the Edinburgh School of Agriculture, there are a number of Research Institutes closely related to the University.

The Scottish Institute of Agricultural Engineering (SIAE), use information technology in a wide variety of applications for example, data gathered from field experiments is transferred automatically



Electronic monitoring system for improving safety in tractors

to a central computer for analysis. The speed of this operation, only possible through the application of information technology, is essential in a country such as Scotland where work must be completed rapidly to avoid changes in conditions caused by weather or crop ripening. SIAE also use information technology techniques for building mathematical models for use in simulation. This can be particularly effective where the subject studied e.g. overturning tractors, would be both costly and dangerous to attempt with full scale equipment.

At the Scottish Crop Research Institute (SCRI), work is aimed at improving crop productivity in for example, potatoes and cereals and also in finding solutions to problems in agricultural research relating to plant breeding. Scientists from various disciplines such as bacteriology, electron microscopy, cytogenetics agronomy and climatology all employed by SCRI, make heavy use of information technology.

Research into animal production, animal nutrition, grazing ecology, plants and soils are some of the areas of activity of the Hill Farming Research Organisation (HFRO). This Institute also maintains a research programme in problems related to upland agriculture and hill sheep farming. Computer models have been developed by HFRO to assist scientists throughout the Institute.

The Institute of Terrestrial Ecology (ITE), provides specialist ecological research and impartial advice on the impact of the ecology of individual species and natural and man-made communities on areas such as:

- \* Improving productivity in forestry
- \* ameliorating the impact of mineral extraction
- \* monitoring the effects of pollution
- \* managing and conserving wildlife
- \* controlling pests.

Information Technology, particularly information systems, are used by ITE as aids in the development of ecological research and land use management policies. The British Forestry Commission's Northern Research Station (FCNRS), is located along with these other Research Institutes, on Edinburgh's Centre for the Rural Economy, an old Scottish estate, dedicated to agricultural research since the late 1940's. FCNRS apply information technology for research and advisory services in areas such as:

- \* Commercial silviculture in the British uplands
- \* Breeding improved trees of the important timber species
- \* The physiology of trees
- \* Investigation and classification of forest soils
- \* The protection of forests against disease and insect damage

Edinburgh Computer Aided Architectural Design is a multi-disciplinary research unit within the Department of Architecture. The work of EdCAAD is recognised internationally as being in the forefront of computer aided design and its research results are used in industry.

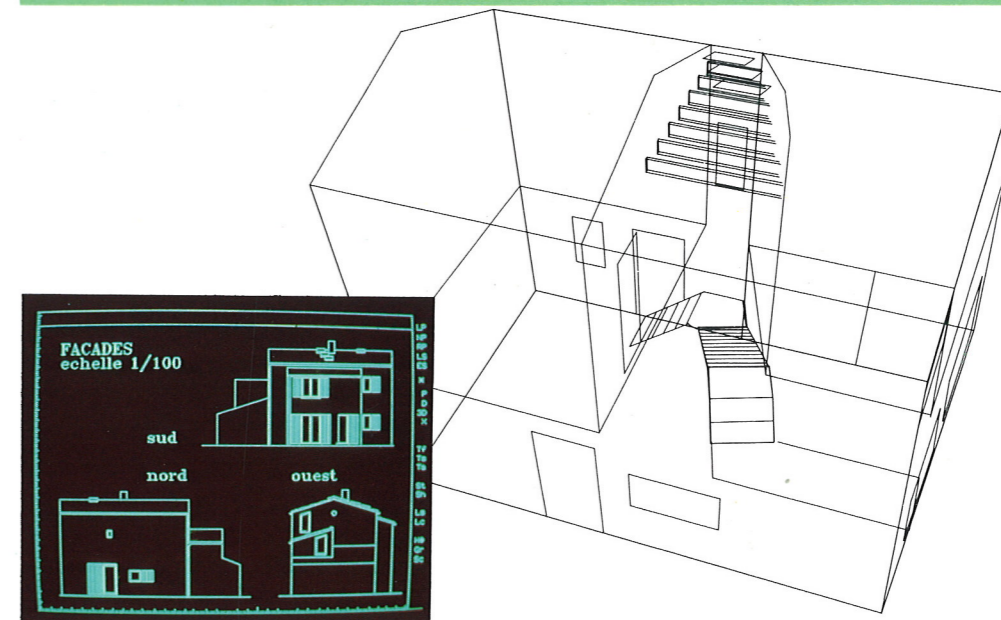
EdCAAD seeks to make computing technology more accessible to architects and other people who have varied work practices. Their research focuses on new technology that is more responsive to individual needs of users and less dependent on specialist programmers acting as interpreters between end-users and their computers.

The Library was founded in 1580 when Clement Little, an Edinburgh Advocate died, bequeathing his collection of 300 books to the Toun and Kirk of Edinburgh. A year after the founding of the Tounis College, now the University of Edinburgh, in 1583, these books were handed over to the college as a library for the college and public. From this collection, of which 276 books remain, Edinburgh University Library has grown to its present size of well over 1.6 million items.

To cater for the administration of this mass of documents, and also with the wide geographical split of faculty and class libraries on the Edinburgh campus, a full automation programme has been embarked upon. Using specialised computing facilities, which are integrated into the ERCC communications network, world-wide access is possible to Edinburgh catalogue and reference material.

The Library environment is a prime candidate for the introduction of information technology to enhance the service provided.

## COMPUTER AIDED ARCHITECTURAL DESIGN



In Edinburgh, close links exist between the IT research and technology transfer groups and the librarians, to facilitate the cross fertilisation of ideas.

## UNIVERSITY LIBRARY

IT being used to speed up book borrowing at the library

In the Reading Room



At the Main Service Desk



Staff tailoring library system to Edinburgh's needs



Network user accessing on line catalogue and accessions lists

# Pace Setter – Past & Present

Edinburgh University has been a pace-setter from its foundation in 1583; in the sciences, in medicine and in the arts. It enters its fifth century as one of Britain's largest and most modern universities, with more than 150 departments and units grouped in eight faculties of activity, 10,000 students and over 1,500 teaching and research staff, two-thirds of whom are in science-based disciplines. Edinburgh is Scotland's biggest university-based research centre. Its turnover of £70m a year includes over £11m gained from research grants and contracts, reflecting its standards and spread of expertise, particularly in sciences and medicine.

Edinburgh is active in providing services to industry, commerce and public agencies – particularly through the University's Centre of Industrial Consultancy and Liaison (CICL) – offering consultancies, patent-protected product development, lab-testing facilities and access to advanced research programmes in science, technology, medicine, and business. A range of departments can also offer standard or custom-made instruction programmes, on a short course or part-time basis, for individuals in mid-career and for industrial concerns as well as for the new graduate seeking high technology engineering skills.

The manpower training and research expertise of Edinburgh University in critical technologies is a potent factor in generating new companies and attracting new technology-based enterprises to Scotland's central belt 'Silicon Glen' – the major micro-electronics oriented industrial concentration in Europe. Equally important it stimulates firms, in the Lothians and further afield, to make use of the new technology.



## ACKNOWLEDGEMENTS

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The Scottish Development Agency.

Edinburgh University Departments of Artificial Intelligence,

Electrical Engineering, Geography and Linguistics.

Photolabs, Royal Observatory, Edinburgh.

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**With major contributions from:**

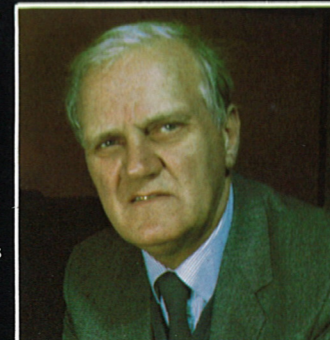
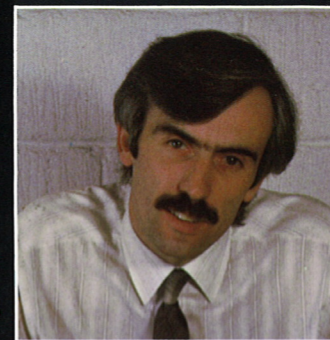
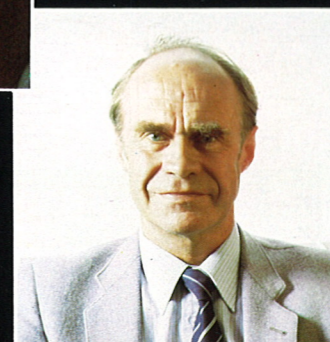
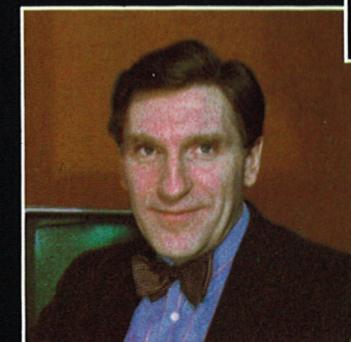
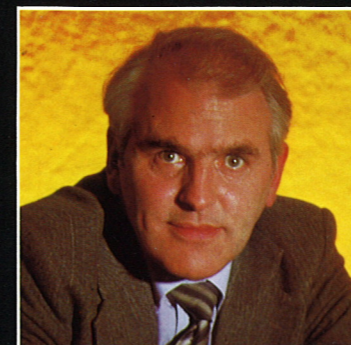
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**Printed by:**

John Swain & Son (Edinburgh) Ltd.



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