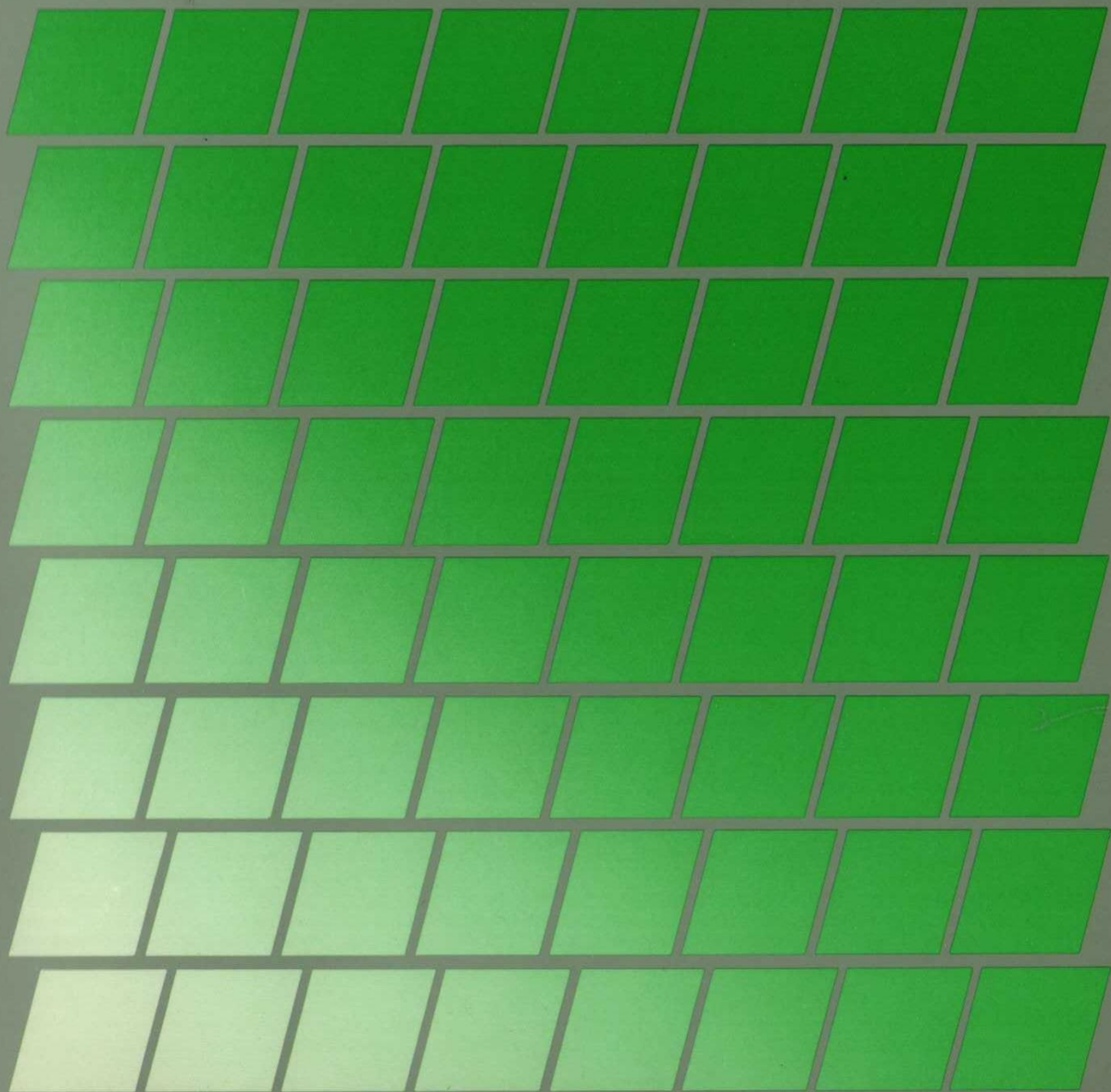


Computer Technology

for the BENEFIT of Industry

*The development of new applications must go hand in hand with
an understanding of the needs of the industrial user.*



HARWELL
Technology for Industry

Computer Technology for the BENEFIT of Industry

The development of new applications must go hand in hand with an understanding of the needs of the industrial user.

The key to Harwell's success has been in working for and in collaboration with industrial customers, to ensure that they benefit from the practical application of new technology. This is particularly so in the area of computer technology. In the following pages we give examples of programs and computer systems which are now routinely used by both British and Overseas Companies.

Working with Industry

The design of software and the development of computer applications are the responsibility of Harwell's Computer Sciences and Systems Division.

Major areas of expertise are:

Information systems

Scheduling and planning

Mathematical modelling and numerical techniques

Advanced programming and knowledge based systems

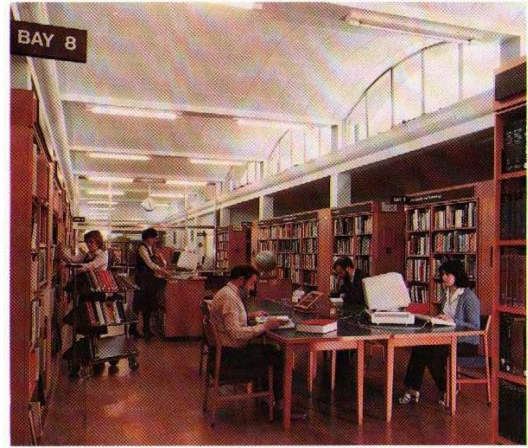
Decision support systems

Software engineering

Use of advanced computer systems

Networks, protocols and standards

From its various research and industry-funded projects the Division produces advanced, accurate and reliable computer programs and systems which can be easily used by people in industry.



Information Systems

Easy access to information is the key to production, commerce, administration, engineering and science. As the volume of useful information increases, many businesses and organisations are turning to the computer for help. However, computer information systems often deal only in figures and coded data, with the result that information becomes constrained to fit the computer program.

Harwell is one of the pioneers of text information storage and retrieval systems. Its STATUS package is marketed worldwide and it is used by a variety of organisations for a wide range of applications. The package can also be used in conjunction with other software products to provide such facilities as graphical and statistical analysis, and with knowledge based systems to enhance the effectiveness of the search for information.

Information Management

The STATUS Information Storage and Retrieval software package provides users with facilities to store and retrieve data with great flexibility. It is capable of handling information ranging from totally unstructured (or free) text to structured numeric data. It is equally appropriate to the needs of the occasional user and the information specialist. STATUS can be used for simple data retrieval or as a component of a specialised information management system; in the latter case it may easily be linked to other application-specific software. The package is largely machine independent and is installed on many different mainframe, mini and microcomputers.

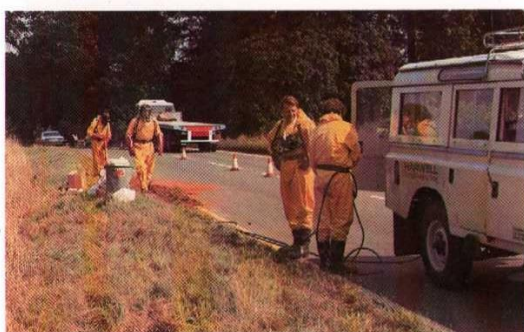
The flexibility of the STATUS free text system has resulted in its being used for a wide range of very different applications, even within one organisation. Advanced features allow the user interface to be tailored for specific applications without additional software.

STATUS

The major applications can be divided into two groups:

Full Text Systems

- legal statute, cases and related documentation
- documents in support of litigation
- technical reports, patents etc
- market intelligence
- 'accident or incident' information systems
- office systems



Harwell's Chemical Emergency Centre uses STATUS for the rapid retrieval of technical information from the hazardous chemical database.

Bibliographic Record Systems

- catalogues for special libraries
- catalogues of reports and document collections
- personnel records
- maintenance records

Many applications involve an integrated Information Technology system with word processors, electronic mail, information storage and retrieval, and report or bulletin production. A major feature of STATUS is its ability to link readily with other parts of a total system without the need for further software development.

STATUS is marketed and supported worldwide by a network of appointed franchise holders and it achieved its 100th sale in 1983. Central support is provided from Harwell and this includes the provision of general and specialised training courses for current and prospective users.

There are several public on-line services operating under STATUS, including the Eurolex legal information service.

Users include: Akzo, Netherlands; Attorney General's Department, Australia; British Gas; British Telecom; Esso Petroleum; Fisons; Orion, Finland; Science and Engineering Research Council; Woolworth, Australia; Wellcome Foundation.

There is an active STATUS Users Group which publishes a newsletter and organises regular conferences, and which influences the future development of the package.

Computer Typesetting of Documents

Software has been developed for the preparation of documents which is particularly suitable for typesetting scientific literature. TSSD allows the user to control typeface, typesize and to format lines of text to a professional standard of typography. It performs automatic paging, multi-column work, the floating of tables and boxing. A particularly useful feature is its ability to set mathematical expressions at any point in the text from a simple descriptive input language. Included is a powerful macro facility which allows the user to set up different house styles and to automatically generate indexes and contents lists.

TSSD can be readily used with many typesetters, including Pacesetter, APS-5, Linotron 202 and IBM/3800 laser printer. The interface between software and the user is independent of the characteristics of the typesetter. TSSD is in daily use on the Harwell computer and it has been installed by several customers.

Information Systems
Scheduling and Planning
Mathematical Modelling
Advanced Programming and Knowledge Based Systems
Decision Support Systems
Software Engineering
Computer Services
Computer Science and Systems Division

Managers in both commerce and industry are concerned with evaluating the best use of their company's resources and with making realistic plans for the future. In the past, the size and complexity of commercial planning problems have frequently defeated the capabilities of classical operations research methods.

Scheduling and Planning

Harwell has gained a reputation for developing new and effective techniques for these traditionally difficult areas of planning, scheduling and production control. Harwell's policy of close collaboration with industry ensures the practicality and cost effectiveness of its work and has resulted in a record of successful implementations.

Major areas of expertise include:

Scheduling and Planning

Production scheduling, road vehicle scheduling, bulk carrier, oil tanker and cargo liner scheduling

Control

Production control, contract management, project management

Optimisation

Optimised layout for waste minimisation, blending and mixing, resource allocation, optimised packing.

Major projects in this area include:

Strategic Planning and Scheduling of Shipping Fleets

FS&P is a management system designed in collaboration with major UK and Scandinavian fleet operators. The primary functions of the system are:

- long term scheduling of the fleet
- budget prediction
- evaluation of business opportunities
- assessment of alternative programmes of fleet renewal and expansion



FS&P is a package of programs that combines a comprehensive model of the shipping fleet with powerful software to construct economic fleet schedules and with an extensive range of reporting facilities. All normal transactions such as subletting, time chartering, and the taking of market opportunities are included. FS&P includes its own database management system to give easy access to information on commitment, contract conditions, ship positions, past performance etc. Maintenance and retrieval of information is made very simple by the use of screen menus.

Similar techniques have been developed for scheduling the movement of goods by road.

FS&P

Workshop Analysis and Scheduling

Designed for use by small batch manufacturing workshops and job shops, the WASP software analyses and schedules variable workloads according to the availability of operators and machines. Better scheduling improves productivity, reduces costs and ensures that target dates are met. WASP displays all shop floor loads and future schedules and produces progress reports and planned completion dates for every job in hand.



Versions of WASP for desktop computers or for specific customer requirements are available.

Contract Manager

Software has been developed to monitor actions and obligations in progressing deliveries under highly complex uranium enrichment contracts. The inter-relationship between events such as the sampling of raw materials and the delivery of products are modelled using a simple language and articles from the enrichment contracts are collated into chronological diaries of events for the responsible managers.

Optimised Layout

New techniques have been developed for reducing the wastage in guillotining printed circuit boards from sheets of laminate. The resulting microcomputer package has shown dramatic savings in material. Similar techniques have been applied successfully in the timber and furniture industries.

Scheduling and Planning
Mathematical Modelling
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Mathematical Modelling

Complex problems arise in many industrial or chemical processes, and the best solution is not always immediately apparent. Trial and error approaches are time-consuming and expensive, and produce uncertain results. However, by the construction of a computer model, the physical situation can be represented in a mathematical form, and a range of options can be simulated to determine the optimum conditions under which a system should be operated to achieve its objectives.

Several software packages which apply mathematical methods to solve complicated real life problems have been developed at Harwell. Areas in which these modelling techniques have been used include:

- fluid (liquid and gas) flow in systems
- chemical reaction kinetics
- oil reservoir extraction regimes
- general reservoir modelling
- reactor incident models

For the development of these packages, extensive use has been made of the subroutines in the Harwell Subroutine Library. The Library has a high standard of reliability and a world wide reputation as a source of good numerical codes.



SHELL



Computer simulation of the movement of a water flood through a faulted reservoir.

Major projects in this area include:

Oil Reservoir Simulation

Since 1976 a Harwell team has developed a general purpose three-phase (oil, water, gas), three-dimensional simulator called PORES for use by British Gas, Britoil, and the Department of Energy. It is now used on a routine basis to predict and monitor the behaviour of reservoirs in the North Sea.

PORES is a fully implicit simulator which uses a finite difference formulation to solve sets of differential equations, with pressures and saturations as the unknown variables, as a function of position and time. Although fully implicit techniques are normally computationally more time-consuming and expensive than semi-implicit or explicit techniques, the advanced numerical methods in PORES reduce the additional computation to competitive levels. This allows the solution of traditionally difficult problems such as dealing with high permeability contrasts, strong gravity segregation, small reservoir blocks with high flow rates, wells completed in many layers and coning. PORES was developed in consultation with its users and there is an on-going development programme to add new facilities and improve its performance.

PORES is marketed by Energy Resource Consultants Limited on behalf of British Gas, Britoil and the Department of Energy.

Flow and Chemistry Simulator

FACSIMILE is a rugged and efficient computer program for solving any (usually stiff) set of differential equations for which the initial values of all variables can be set at a given time. It is used, for example, for kinetic modelling to solve large or small simulation problems. Modelling is carried out using a high level problem description language. FACSIMILE contains a parameter fitting facility, enabling rate coefficients or other parameters to be chosen for the best fit of calculated results to experimental data. The program is widely used by research and commercial organisations.

Harwell Subroutine Library

The Harwell subroutine library is a collection of over 300 subroutines, mostly written in Fortran, for assisting with numerical mathematical tasks. Topics addressed include differential equations, mathematical functions, linear algebra, numerical integration, approximation and data fitting, sorting, optimisation and solution of non-linear equations, and there is an extensive range of utility routines for IBM installations. Its particular strength lies in routines that exploit sparsity in many applications. In addition to commercial licences for individual subroutines, a more restrictive but less expensive licence for the whole or part of the library is available for research purposes only. Copies have been distributed to more than 600 organisations.

For each i ,

$$\frac{\partial C_i}{\partial t} + \frac{1}{\rho} \nabla \cdot (\rho C_i \mathbf{u}) = \nabla \cdot (K_c \nabla C_i) + S_i$$

where

$$S_i = \sum_j (\beta_{ij} - \alpha_{ij}) R_j$$

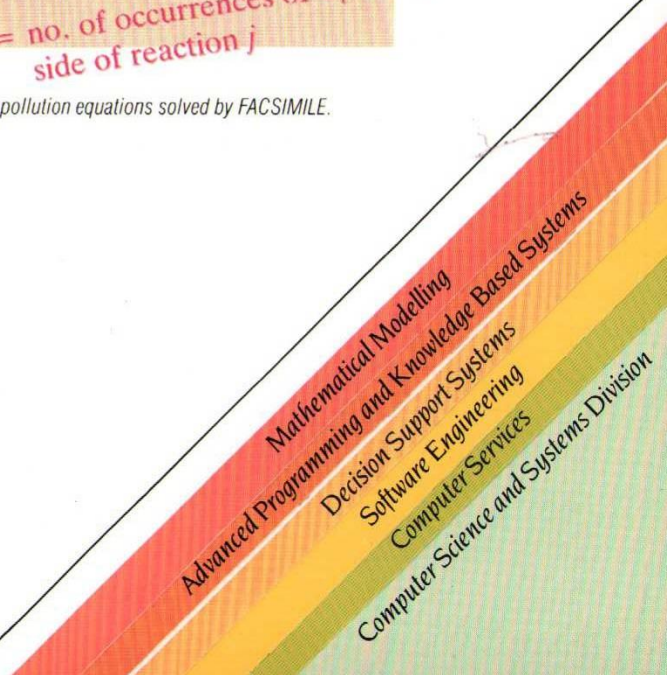
and

$$R_j = K_{rj} \prod_i C_i^{\alpha_{ij}} - K_{bj} \prod_i C_i^{\beta_{ij}}$$

α_{ij} = no. of occurrences of C_i on left side of reaction j

β_{ij} = no. of occurrences of C_i on right side of reaction j

Atmospheric pollution equations solved by FACSIMILE.



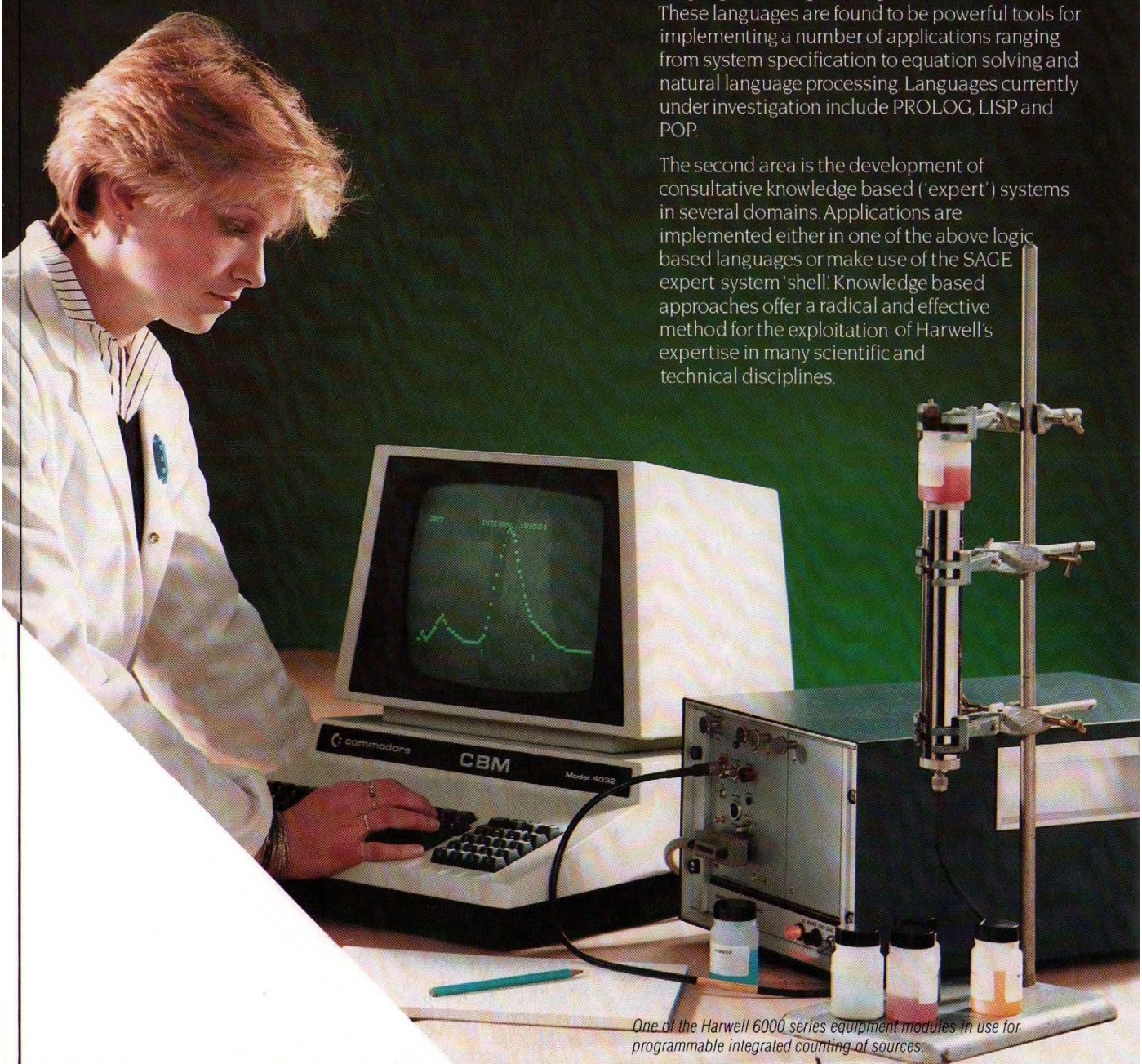
Computer Technology for the BENEFIT of Industry

The application of techniques derived from research in the field of artificial intelligence is providing many new approaches to the development of computer based systems. Two areas are being actively pursued at Harwell.

Advanced Programming and Knowledge Based Systems

The use of high level, logic based programming languages is being investigated in several areas. These languages are found to be powerful tools for implementing a number of applications ranging from system specification to equation solving and natural language processing. Languages currently under investigation include PROLOG, LISP and POP.

The second area is the development of consultative knowledge based ('expert') systems in several domains. Applications are implemented either in one of the above logic based languages or make use of the SAGE expert system 'shell'. Knowledge based approaches offer a radical and effective method for the exploitation of Harwell's expertise in many scientific and technical disciplines.



One of the Harwell 6000 series equipment modules in use for programmable integrated counting of sources.

Consultative expert systems are under development in a number of application areas. The objective is to exploit technical expertise in the areas of communications, training and problem solving. Intelligent knowledge based systems under development are:

Electronic Configuration

The Harwell 6000 series is a modular system of electronics designed for an extensive range of laboratory, plant and field applications. It provides facilities to enable electronic instrumentation to be developed rapidly, reliably and economically.

The expert system provides guidance and assistance in the selection of the appropriate 6000 series electronic units for a wide variety of nuclear radiation counting applications. It has been implemented using the logic programming language PROLOG. In addition to the knowledge base built into the expert system, the user is also able to access an extensive database which will eventually contain technical information on the design feature of all units in the 6000 series. This database is being implemented with STATUS;

Corrosion Applications

As part of the wide ranging information in the field of corrosion, two expert systems are under development. One deals with corrosion in sea water, the other with a particular corrosion process, namely pitting. These and other proposed expert systems in this field will be linked to provide "intelligent" assistance in accessing a STATUS data base containing extensive data on corrosion. The current versions of these are being developed using the SAGE package;

Chemical Plant Design

A prototype system for the selection of process equipment for specific applications;

Man Machine Interfaces

Preliminary investigations of interfaces to information retrieval and database systems.



Expertise in seawater corrosion is being compiled as a knowledge based computer system.



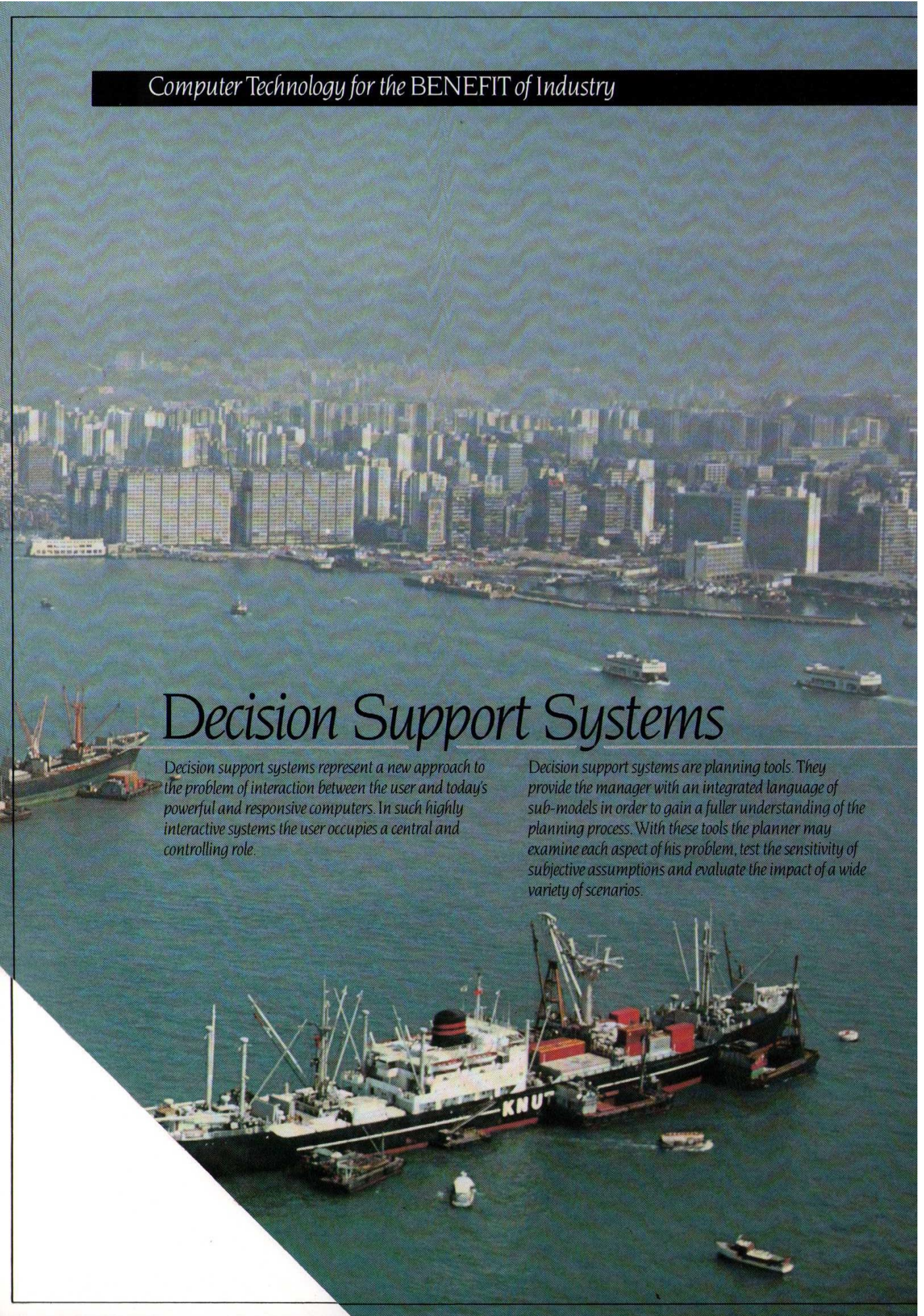
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Advanced Programming and Knowledge Based Systems
Decision Support Systems
Software Engineering
Computer Services
Computer Science and Systems Division

Decision Support Systems

Decision support systems represent a new approach to the problem of interaction between the user and today's powerful and responsive computers. In such highly interactive systems the user occupies a central and controlling role.

Decision support systems are planning tools. They provide the manager with an integrated language of sub-models in order to gain a fuller understanding of the planning process. With these tools the planner may examine each aspect of his problem, test the sensitivity of subjective assumptions and evaluate the impact of a wide variety of scenarios.



Recent projects include:

Solid Waste Management

A computer model has been developed to assist the Hong Kong Government determine future policy on waste management. An integrated system of sub-models has been developed to address all of the following major elements of waste management:

- to forecast the types and quantities of waste that will arise in the future
- to examine collection practice and the development of road networks
- to cost new treatment and disposal technologies
- to cost alternative sites
- to calculate minimum cost disposal strategies
- to assess long-term plans with their associated cost distributions, traffic implications and impact on the environment.

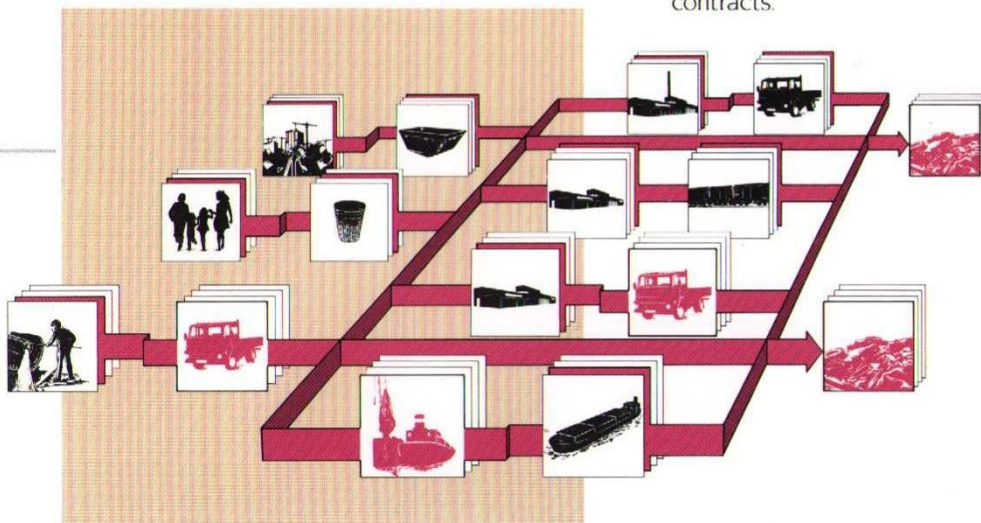


Uranium Enrichment Market Assessment

A system of programs has been developed as planning aids for a uranium enrichment consortium.

The capabilities of these programs include:

- exploration of demand for, and availability of, enriched uranium on a world wide scale
- scenario generation of demand and cash flow arising from the consortium's long-term contracts.



Each sub-model is controlled through a simple language of commands which are supported by substantial in-built tutorial and menu facilities. Although this decision support system has been specifically tailored to waste management, the techniques have general applicability to other capital investment and planning problems.

Decision Support Systems
 Software Engineering
 Computer Services
 Computer Science and Systems Division

Computer Technology for the BENEFIT of Industry

Software engineering methods and tools are needed to:

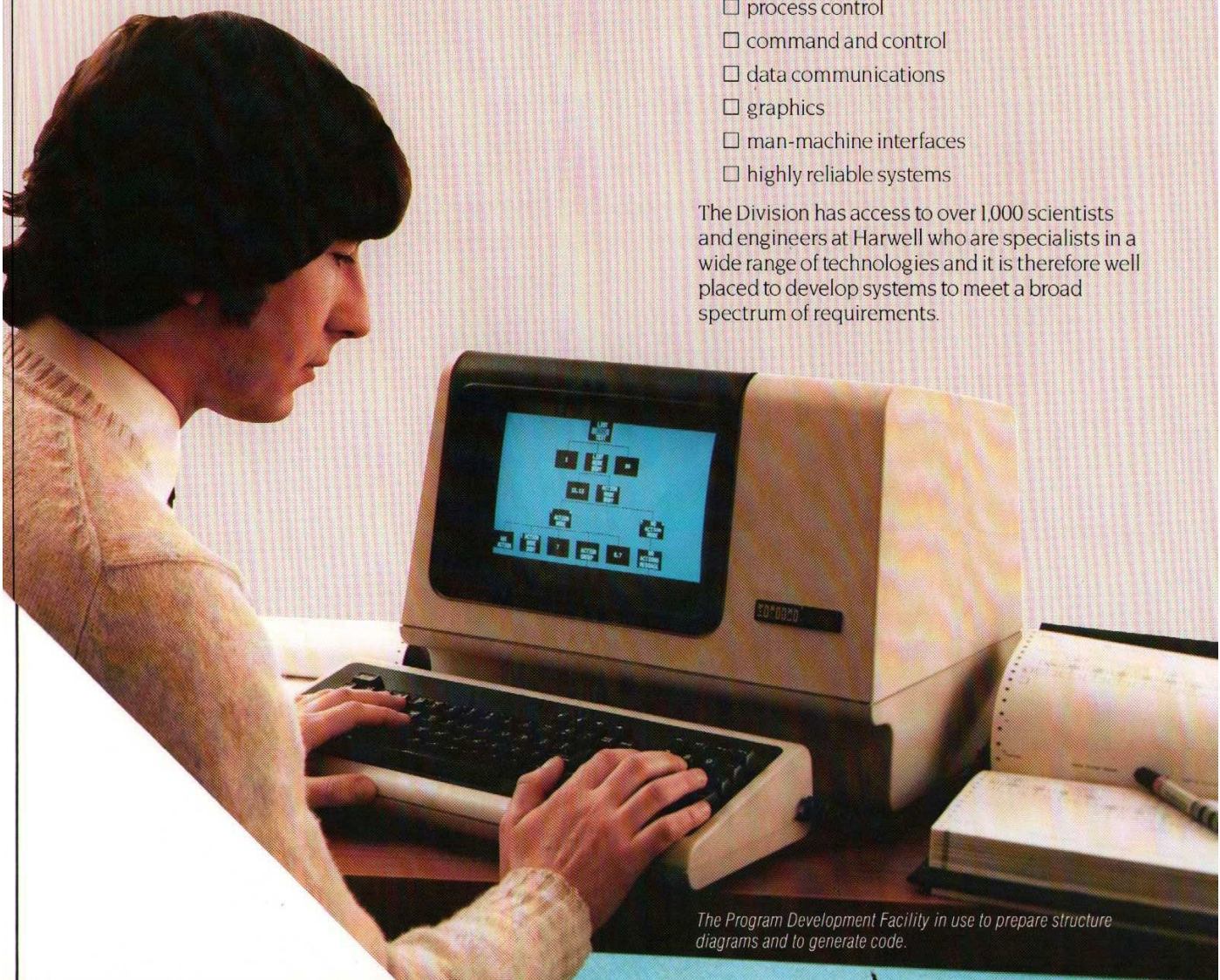
- improve the quality of design
- facilitate software production and maintenance
- support project management
- minimise software life cycle costs

The Computer Science and Systems Division develops and markets software packages for this purpose. The highly skilled work force undertakes consultancy, design and specialised systems development for industry. These systems may embody the Division's software products or its proven expertise in:

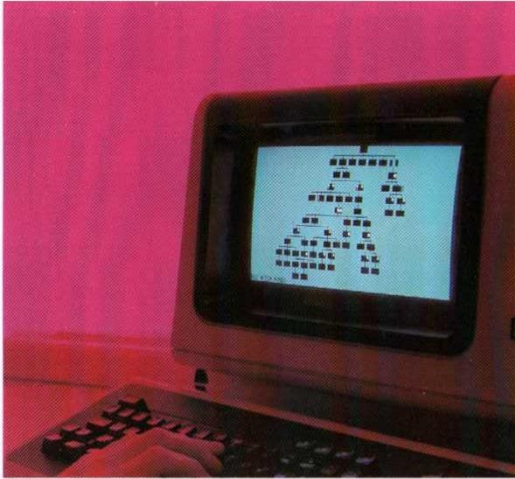
Software Engineering

- process control
- command and control
- data communications
- graphics
- man-machine interfaces
- highly reliable systems

The Division has access to over 1,000 scientists and engineers at Harwell who are specialists in a wide range of technologies and it is therefore well placed to develop systems to meet a broad spectrum of requirements.



The Program Development Facility in use to prepare structure diagrams and to generate code.



Software engineering tools created by Harwell include:

Program Development Facility

PDF is an advanced tool for the generation and maintenance of computer programs. PDF supports the widely accepted Jackson Structured Programming method. Structure diagrams and text are prepared and edited at the computer terminal prior to the automatic generation of the code. When requirements change, structure diagrams are modified with PDF, thereby removing the need to maintain programs at source code level. PDF offers code generation in a number of high level languages including COBOL, FORTRAN, PASCAL, RTL/2 and Ada.



SPECK

This is a software package which enables the design engineer to specify, analyse and animate a system given a statement of the requirement. SPECK gives the system designer an unambiguous expression of the system's functional specification and identifies any intrinsic constraints in the design. By performing a rigorous analysis, it helps the quality assurance department to assess that a design is meeting the specification; it offers customer feedback by animating the specification and demonstrates key features of the system at each stage of its development. SPECK has been applied to electrical thermal and gas flow, process control systems and computer communications.

Computer Technology for the BENEFIT of Industry

The Cray computer. Advanced computer facilities are used, for example in the design and analysis of stress in structures, such as reactor pressure vessels.



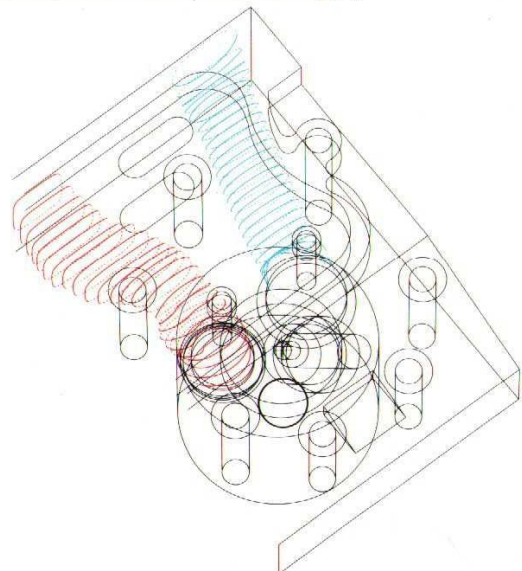
The development of software and computing techniques plays a significant role in Harwell's commercial activities in providing both products and consultancy services for industrial and government organisations.

Computer Services

Powerful computing facilities are important for much of Harwell's work and the Computer Science and Systems Division has the responsibility of providing the main service, which is currently based on an IBM 3084Q and a Cray IS/2200 processors, together with various peripheral computers to handle communications and special facilities. There are about 700 terminals, minicomputers and microcomputers on the Harwell site that are linked to these mainframes. In addition, there are a further 150 terminals from the other establishments of the United Kingdom Atomic Energy Authority. Authorised users from outside Harwell may access these facilities by various methods including dial up, direct leased lines, Kilostream and Megastream services and Packet Switch Stream (PSS) connections.

The operating system on the IBM 3084Q is MVS with TSO and SPF facilities. In addition IDMS, CADAM, APL, TASKMASTER and advanced graphics software are available. Other resources include VAX-11 and PDP11 computers and a variety of microcomputers.

Software has been written and developed at Harwell to enhance these extensive computer and user systems and to support the computer network. The central services are available commercially to external organisations who have specific requirements to use the advanced facilities which Harwell can supply.



Computer Aided Design to show the best location for a window for the entry of laser beams into the combustion chamber of petrol or diesel engines, for the study of fuel injection and combustion during normal running.

Packages developed to provide computer services include the following data communication and network products:

XN11

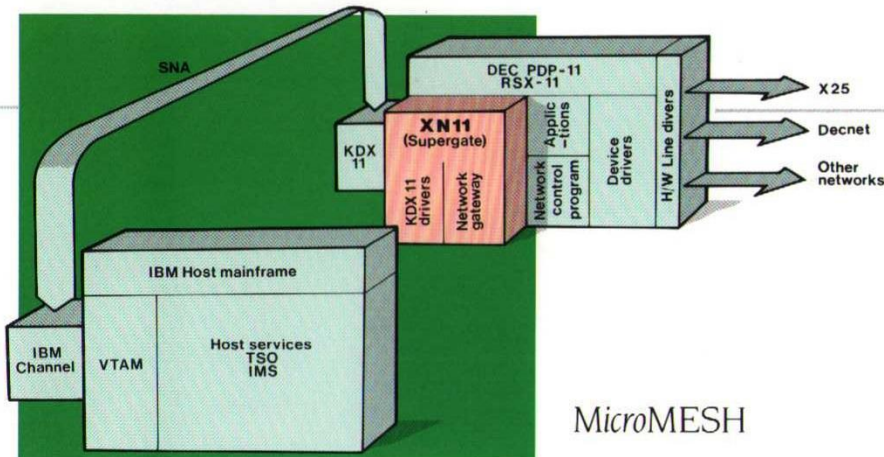
IBM-DEC link via Systems Network Architecture

XN11 provides a high speed gateway between Digital Equipment Corporation DECnet and IBM Systems Network Architecture (SNA) networks enabling non-IBM devices on DECnet to connect to IBM host services. XN11 runs in a PDPII processor which is simultaneously a DECnet node and a Physical Unit Type 4 Communications Controller channel-attached to an IBM mainframe operating SNA protocols. XN11 was developed jointly with Scicon Limited who market the product. Current users of XN11 include a large Belgian bank, the Bureau of Statistics, Canberra, Australia and a large insurance company.

SNAPI

Systems Network Architecture Performance Indicator

Efficient use of computer terminals depends on the speed and consistency of response time. SNAPI is designed to analyse response times for a network of IBM 3270 terminals. It helps users choose the most cost effective configuration of terminals and teleprocessing lines, by analysing the network delay experienced by a cluster of terminals. Response time data are collected and the program reports the average, maximum and minimum responses. SNAPI requires no additional hardware and operates without modification to existing software.



Supergate emulates a sub-area of an SNA network consisting of terminal clusters connected through an IBM 370X communications controller.

A version of XN11, called XN4000, has been developed at the Science and Engineering Research Council Establishment at Daresbury for General Electric 4000 series computers.

MicroMESH

MicroMESH is a range of microprocessor hardware and software products for improving communications between distributed computers and terminals. It is particularly suitable for mixed private and public networks via PSS. MicroMESH has three basic functional units – a terminal concentrator, a packet-switching unit and a network gateway unit. These can be configured to meet individual requirements and to provide a combination of communication services.

Computer Technology for the BENEFIT of Industry



IBM computer.



CSSD is one of the Harwell Laboratory's 15 high technology divisions. It carries out commercial developments, support and research work for the United Kingdom Atomic Energy Authority, Government Departments and Industry. It maintains a staff of 120, of whom 50 are professional computer scientists and engineers.

The expertise of the staff and the Division's extensive facilities provide for cost effective R and D and the production of special purpose software.

Computer Science and Systems Division

Research and Development

Harwell is a research and development organisation which relies extensively on the use of computers. The Computer Science and Systems Division is involved in the development of information methods; tools for the computer users; efficient, robust and accurate methods of numerical computations; system methodology; the development of various scientific computer languages; system reliability and data communications.

Much of the work undertaken by CSSD is funded by Industry and Government Agencies. Projects involve research in new areas and the further development of work originally carried out for internal projects.

Special Purpose Software

Research at Harwell into software engineering and development has led to a number of software packages. Many of the programs written for the Laboratory's own use are available commercially. The emphasis is on ease of use and adaption to meet customer requirements. Licences to use these packages are made available either directly from Harwell or through franchise holders.

*Commercial Products
Developed by Harwell*

Facsimile

Flow and chemistry simulator for solving differential equations

FS&P

Fleet scheduling and planning program for the movement of fleets of cargo ships

Harwell Subroutine Library

A collection of subroutines for numerical methods

HVRP

Vehicle routing program for scheduling road transport fleets

MicroMESH

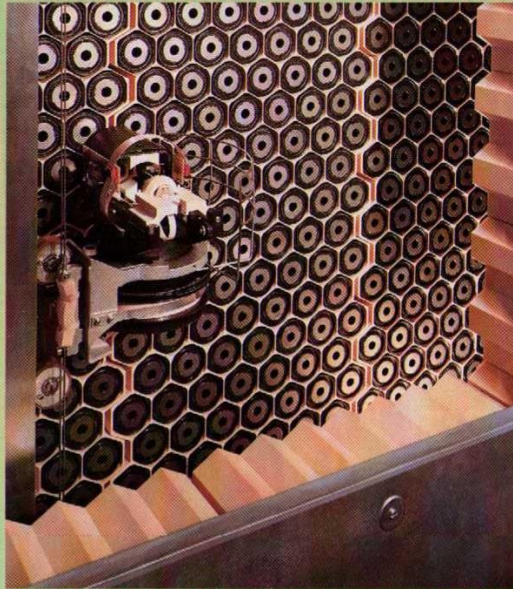
For communications between distributed computers and terminals

OREC

For minimising waste in cutting printed circuit boards

PDF

Program development facility for the generation and maintenance of software



IBM mass storage sub-system.

WASP

Workshop analysis and scheduling package for batch manufacturing and 'made-to order' work

Waste Management Model

For determining future waste management policies, including transportation, treatment and disposal

WUDCUT

For minimising waste in cutting wood panels

XNII

IBM-DEC link via Systems Network Architecture (Available from Scicon Ltd)

PORES

For the simulation of oil/gas reservoirs (available from Energy Resource Consultants Limited)

SNAPI

Systems Network Architecture Performance Indicator for efficient use of computer terminals

STATUS

Free text information storage and retrieval system

SWAP

Small works allocation package for scheduling single operations against fixed capacity facilities

TSSD

Typesetting for scientific documents including the reproduction of mathematical formulae

ZIP

A zero-one integer program for solving large scale set-covering and set-partitioning problems arising in scheduling applications

For further information of these packages, the central computer service or Computer Science and Systems Division's activities, please contact:

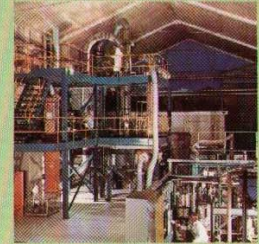
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Telex 83135 ATOMHA G

Computer Technology for the BENEFIT of Industry

Computer Science and Systems Division's Customers Include

Admiralty Nuclear Service
AKZO (Holland)
American Express Co
Amoco Products Co (USA)
Arnold Laver Ltd
Associated Nuclear Services
Attorney General's Department (Australia)
AWRE
Binnie and Partners
BNF Metals Technology Centre
Boart Hardmetals
BOC Ltd
Bohannon-Huston Inc
BP Exploration Ltd
British Aerospace plc
British Gas Corporation



Department of Energy
Department of Health (Australia)
Department of Trade and Resources (Australia)
Dowty Meco
East Midlands Electricity Board
EDP Software Engineering (Australia)
Electronics and Avionics Requirements Board
Electrowatt Engineering Services Ltd
Energy Resource Consultants Ltd
Energy Resources Co Inc (USA)
English Clay Lovering Pochin and Co Ltd
Esso Australia Ltd
Esso Petroleum
ETC Foulness
European Law Centre
Ferranti Computer Systems
FICO (Holland)
Finsbury Data Services Ltd

Computer Science and Systems Division

British Nuclear Fuels Ltd
British Telecom
Britoil plc
Building Research Establishment
Building Services Research and Information
Association
Bulkhandling (Norway)
Bureau of Statistics (Australia)
Burma Oil Exploration Ltd
BV Koninklijke Maatschappij "de Schelde"
(Holland)
Central Electricity Generating Board
Commisariat a l'Energie Atomique (France)
Computervision Corporation
Copenhagen School of Economics and Business
Administration (Denmark)
Cray Research (UK) Ltd
Data Processing Support Services Ltd
Davy Computing Ltd
Davy Loewy

Fisons plc
Ford Motor Co
GEC Energy Systems Ltd
GEC Reactor Equipment
General Electric Corporation (USA)
Goodyear Atomic Corporation (USA)
Grasslands Research Institute
Hall Automation Ltd
Health and Safety Executive
Home Office Central Research Establishment
Hong Kong Government
Howson-Algraphy Ltd
Hunting Engineering Ltd
Hydraulics Research Station Ltd

Imperial Food Group
IMSA
Inspectorate of Flight Safety (RAF)
Institute for Structural and Functional Studies (USA)
Ispra Establishment (Italy)
John Holland Group (Australia)
Kam Circuits Ltd
Klaverness Chartering (Norway)
KLUWER Groep Rechtswet en Schappen BV (Holland)
Leif Hoegh and Co
Local Government ORU
Los Alamos National Laboratory
MBD
Metal Box Ltd
Michael Jackson Systems Ltd
Ministrie VRO (Holland)
Ministry of Defence
MITEL
Mobil Data Services
Morgan Grenfell Co Ltd
Mt Isa Mines Holdings Ltd (Australia)
Mullards
Multifunction BV (Holland)

Orion Corp Ltd (Finland)
Peterborough City Council
Philips (Holland)
Pilkington Brothers Ltd
Plessey Radar Ltd
Police Scientific Development Branch
Port of Melbourne Authority (Australia)
Ricardo Consulting Engineers Ltd
ROF Cardiff
Rolls Royce and Associates
Ross Foods Ltd
Royal Aircraft Establishment
Royal Armament Research and Development Establishment
Royal Military College of Science
Salen Shipping (Sweden)
Scicon Ltd
Science and Engineering Research Council
SCK/CEN (Belgium)
Selection Trust Ltd
Sheffield Company of Australia
Shell UK
Simulation Sciences Inc (USA)
South of Scotland Electricity Board
System Programmers Limited
Systime Limited
Tayside Regional Council
Transport and Road Research Laboratory



Nabalco Pty Ltd (Australia)
National Coal Board
National Engineering Laboratory
National Nuclear Company
National Physical Laboratory
National Radiological Protection Board
Nature Conservancy Council
Navios (USA)
Nederlandse Omroep Stichting (Holland)
Neste Oy (Finland)
Network Technology Ltd
Northeast Utility Service Co (USA)
Nutech Engineering Inc (USA)

Unit for Retail Planning
United Glass Ltd
University College London
University of Leeds Industrial Services Ltd
University of Tokyo
University of Trondheim
Ureco Ltd
Vickers Ltd
WS Atkins Group
Warrington and Runcorn Development Co
Wellcome Foundation Ltd
West African Bulk Services
Woolworth (Australia)

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