UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

MICROELECTRONICS MONITOR

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Dear Reader,

The Industrial Development Board (IDB) of UNIDO, which is the policy making organ of UNIDO, met in Vienna on 13 to 31 May 1985. In the general debate as well as in the discussions on the work of the secretariat in the field of transfer of technology, appreciation was expressed concerning the work of UNIDO in the field of microelectronics. It welcomed the secretariat's initiative in a number of areas including the convening of the regional meeting for the initiation of a regional network for microelectronics in the ECLAC region (REMLAC) to be held in Caracas from 3 to 7 June 1985. You will find more details on this meeting as well as the documentation prepared for it inside these pages.

Although not on the agenda, the participants of the IDB gave their attention to the forthcoming conversion of UNIDO into a specialized agency. In this sense many considered the present session as the last session of the IDB in its present form. While a considerable amount of preparatory work still needs to be done for the process of conversion, consideration is being given to see whether the First General Conference of UNIDO could be convened in 1985 or 1986. A decision on this matter is expected to be made in a one day meeting in New York to be convened by the Secretary General of the United Nations some time in June 1985.

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NEWS AND EVENTS

News from UNIDO

REMLAC Meeting

As already reported in earlier issues, UNIDO is organizing a regional meeting for the initiation of a regional network for microelectronics in the ECLAC region (REMLAC) in Caracas on 3-7 June 1985. Countries invited to participate in the meeting are Argentina, Brazil, Chile, Colombia, Cuba, Guatemala, Guyana, Jamaica, Mexico, Peru, Trinidad and Tobago, and Venezuela. The meeting is co-sponsored by the Sistema Economica Latino Americano (SELA) and ECLAC.

The preparatory mission of experts to the region found that there was general enthusiasm for the idea of setting up a regional network of microelectronics, and based on discussions the experts had with policy makers, some preliminary activities of the network have been proposed which will be discussed at the meeting. UNIDO's initiative is also supported by the recommendations of high-level governmental experts in a meeting held by SELA as well as relevant decisions of the Consejo Latinoamericano. We will report on the outcome of the Caracas meeting in the summer issue of the Monitor.

Kenya workshop on microelectronics

A national workshop on the applications of microelectronics and development of software capabilities in Kenya was organized by UNIDO in co-operation with the Kenyan National Council for Science and Technology and held in Nairobi on 15-24 February 1985. Representatives of neighbouring countries such as Ethiopia, Sudan, Tanzania and Zambia also sent representatives. The workshop came up with several very relevant recommendations for specific actions to be taken under five areas, i.e. (i) overall policy guidelines; (ii) manpower development; (iii) manufacturing; (iv) systems development; (v) repair and maintenance services. The workshop also requested the National Council for Science and Technology to form a core group of national experts in the field of microelectronics to crystallize the recommendations and to promote the application of microelectronics in the country. The workshop also recommended the creation of a national body for electronics and information technology within the office of the President.

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NEWS FROM COGIT MEMBERS

UK Council for Computing Development

UKCCD to publish international journal

An international journal called "Information Technology for Development" will be published by the UK Council for Computing Development and the first issue is timed for January 1986. This proposal was originally tabled at the Discussion Meeting organized by UNIDO in March 1984 and supported by the meeting. The Journal is intended to provide a forum in which management and information technology practitioners can present their experience in the application of information technology in developing country environments. The target audience will be threefold. practitioners in developing countries who wish to learn of projects and methodologies; practitioners from the industrialized world who need better to understand the issues in order to apply themselves to assisting their developing country colleagues; users, particularly senior management, in developing countries who want better to understand the ways in which they should initiate and manage information technology programmes.

The language of the publication will be English. However, it is intended to aim towards a multilingual publication as soon as possible.

Advanced management course for developing countries

The first UKCCD Advanced Management Course for Developing Countries took place at the Polytechnic of Central London during June and July 1984 and attracted delegates from Egypt, Ecuador, India, Saudi Arabia, Singapore and Tunisia. The course is expected to be repeated in June 1985. For further information contact Prof. Y. Paker, The Polytechnic of Central London, 115 New Cavendish Street, London W1M 8JS.

The British Computer Society

List of experts

The Society maintains a list of Members and Fellows prepared to act in the role of counsellors and consultants which is published in the form of Handbook No. 7. A sixth edition is planned for issue in the Spring of 1985. Members who are not already included in the current edition who wish to be included in the sixth edition must be Fellow Members and have been practising in the profession for at least eight years. Firms and organizations are also eligible for inclusion. Applications and further details are available from the Deputy Secretary of BCS at Headquarters.

Microcomputers in transport

The use of microcomputers in transport planning and traffic management was the theme of a two-day conference organized jointly by the BCS Specialist Group for Developing Countries and PTRC (Passenger and Transport Research & Computation) during last summer at the University of Sussex. The conference was integrated with PTRC's own summer annual meeting. This arrangement fulfilled a dual purpose: it provided transport planners and other professionals practising in the UK and the continent with an insight into the capabilities of micros and it also offered a forum at which some informed views on the advantages and disadvantages of using micros in the developing countries context could be expressed. The conference was organized in four sessions. Each comprised of an overview presentation on a theme area - for example transport planning or public transport - followed by two shorter accounts in the form of a case study or experience in using a package. The proceedings were of a high standard and speakers included some leading industry names such as Luis Willumsen, Hugh Neffendorf, Malcolm Buchanan and John Wootton.

At several points in the proceedings there was discussion on the pros and cons of using micros and the problems faced in implementing packages in developing countries. The advantages identified were mainly organizational:

- Avoiding the bureaucracy, delays and down-times associated with mainframes
- Direct control and access; the machine is available when needed
- Cheap and powerful - can be bought from one's own budget
- User friendly software

Among the disadvantages were:

- Slow for large problems
- An organization with many micros could end up paying as much for software as it would cost for a mainframe
- Maintaining data integrity and reliability when faced with unexpected power cuts.

From the discussions it was clear that micros could handle almost all the data capture and modelling applications needed by the traffic engineer and transport planner. In developing countries such use of micros would allow the specialist to work more effectively and enable a much wider range of options to be placed before the decision-maker. Some speakers did strike a note of caution on the suitability of computer models. For example Malcolm Buchanan noted that a characteristic feature in many developing countries was the pace at which change could take place. If a bus system was introduced very rapidly, modelling systems which relied on extrapolating from an existing pattern of demand would be inadequate as there was no past demand to look at. Similarly models frequently required calibration to reflect the local environment, such as the average length of cars. If this was not done the results would not be credible. (By J. Sherif)

The conference papers are available from PTRC:

Proceedings of Seminar F: Microcomputer applications in Developing Countries (120 pages; 12 pounds sterling, PTRC, 110 Strand, London WC2).

<u>Board on Science and Technology for International Development (BOSTID)</u>
<u>Symposium on Microcomputer application in developing countries</u> *

In addition to providing information on the ways in which microcomputers are currently being used, the Symposium on Microcomputer Applications in Developing Countries was organized to highlight the policy issues that need to be considered to integrate this technology in a nondestructive manner. The symposium, held near Colombo, Sri Lanka, 4-9 November 1984, was sponsored jointly by the Computer and Information Technology Council of Sri Lanka (CINTEC) and BOSTID with funds provided by the U.S. Agency for International Development. This first symposium in the Microcomputers for Developing Countries program was concerned with their applications in <u>agriculture</u>, <u>health</u>, and <u>energy</u>. Future symposia will consider microcomputer applications in education and training, expert systems and use by paraprofessionals, policy implications, and the institutional impact of this technology. Participants included microcomputer users from 16 countries: Bangladesh, Costa Rica, England, Germany, India, Indonesia, Malaysia, Morocco, Nepal, Pakistan, the Philippines, Sri Lanka, Sudan, Taiwan, Thailand, and the United States. They came from research organizations, universities, government ministries, and the private sector. Commercial vendors in Sri Lanka organized a trade exhibition in conjunction with the symposium and opened it to the public to display microcomputer hardware that is locally available. University students demonstrated programs they had created, for example, one to teach good nutrition and another to print the Sinhalese alphabet using a dot matrix printer.

The importance of training for policymakers was emphasized by Mohan Munasinghe, chairman of CINTEC, in his welcoming address to the symposium. He pointed out that developing country policymakers must understand microcomputer technology to enable them to make valid decisions. "Since much of the technical development will take place abroad, we must develop sufficient indigenous skills to extract the best elements from among these advances and adapt them for use in the Third World."

A number of policy recommendations for developing country governments and for donor agencies were drawn out of the deliberations of the symposium. The importance of training was brought out by many speakers. Training needs include computer literacy for the public and for policymakers, a fostering of awareness of possible computer applications in various technical professionals in fields such as health, energy, and agriculture, and technical training at the professional level to create a corps of computer professionals. It was suggested that computer-aided training can help potential users of the new technology strengthen their analytical skills. Emphasis was placed on the fact that the training must be done in a developing country context and must involve people with sectoral expertise rather than be confined to computer specialists. Fostering the spread of computer training in an individual country was seen as the responsibility of the local government. It was unanimously agreed that government could best foster the growth of computer literacy in all sectors by a policy of encouraging the dissemination of microcomputers rather than by trying to regulate them. Individuals should be permitted to acquire hardware and software that they believe fulfills their needs, and government can encourage this individual acquisition by a favourable import tax policy. Service and support are two other areas in which government can encourage the spread of computer use. It was recommended that each national government, with funding from donor agencies, establish a computer center as a resource for users. The center should offer advice and assistance for the selection and installation of both hardware and software and be available for consultation on issues of standardization and compatibility without playing a decision-making role. The center should also serve as a clearinghouse for microcomputer applications developed in other countries with similar needs. Information and software available at the center would limit the amount of investment the individual microcomputer user would have to make. It was also suggested that user groups including members from developed and developing countries could be co-ordinated through such a center.

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* By Jack J. Fritz' Program Director and Elizabeth McGaffey, Program Assistant for the Microcomputers for Developing Countries Program. The symposium in Sri Lanka was the first of four to be held over a three-year period. The objective of the program is to aid developing countries to apply microcomputers for national development.

Discussion of the value of national centers led the group to recommend the creation of an international center to provide a permanent focus for the sharing of information. A strong recommendation was made by the group that a study be commissioned to design a clearinghouse on microcomputer applications in developing countries to determine appropriate functions, administrative requirements, and budget for such an organization. Some of the functions discussed for the clearinghouse are providing a library of software, offering information on hardware availability and reliability, serving as a "hotline" for clarification of documentation, conducting training programs in computer use and maintenance, publishing a newsletter and/or setting up an online information board to disseminate advances in the field, and co-ordinating training, hardware, and software requirements for technical assistance projects.

The BOSTID Program on Microcomputer Applications in Developing Countries will publish a series of microcomputer handbooks including a general introduction to microcomputer use in developing countries. Sector-specific handbooks on microcomputer applications in agriculture, energy, and health, are scheduled for publication in 1985. The next symposium, on microcomputer use in science and technology education, is planned for mid-1985.

International Federation for Information Processing (IFIP)

This year in March the International Federation for Information Processing (IFIP) celebrated its 25th Anniversary. The anniversary ceremony took place in Munich at the same place where one of the first congresses was held. During the Conference the following papers were presented:

- An assessment of the conception and the position of information processing;
- Man and machine viewed from different cultural backgrounds;
- Must we do everything? Sense and nonsense in information processing;
- Better performance at lower costs: Are there limits to the evolution of hardware?
- Computer technology - Computer industry;
- Management and performance of software.

The papers covered the main problems of the data processing field, discussed past achievements, existing trends and foreseeable future developments. The meeting created a unique opportunity for leading computer science specialists to get together and exchange their views.

During the conference the president of IFIP, Mr. K. Ando, outlined also the future of IFIP. In the prevailing opinion among computer scientists developing countries are now essential for IFIP activities. Also in the speech of the first president of IFIP, Mr. Auerbach, outlining past and future activities of IFIP, its activities in developing countries have been identified as one of the most important future tasks of the organization. The next World Computer Congress of IFIP will be held in Dublin, Ireland, from 1 -5 September 1986.

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UN Connects!

The General Assembly has approved funding for the first stages of a UN communications network. Work will commence this year. Between January and September 1985, a network of leased AVD circuits (allowing Alternate transmission of Voice or Data) is to be established between Addis Ababa, Baghdad, Bangkok, London, Montreal, Nairobi, Paris, Rome, Santiago, Vienna and Washington D.C. In addition, United Nations satellite earth stations installed in Geneva, Jerusalem and Naqoura will allow communications with INTELSAT's Atlantic Ocean satellite.

During February 1985, the members of the ACCIS Technical Panel on Computer-based Communication Services are carrying out an experiment. Existing commercial communication carriers will be used to interconnect the following locations of organizations of the UN system: Geneva, Nairobi, New York, Paris, Rome, Tokyo, Vienna, and the regional offices of the economic commissions. The experiment will examine the impact of new communication media (e.g electronic mail and teleconferencing) on the transmission of information by UN system organizations, and will explore the potential for establishing communication links between UN system organizations world-wide. (ACCIS Newsletter, Vol. 2, No. 5, January 1985)

Informatics in Ports and Harbours

The 2nd International Port Exhibition "Portex '85 Hamburg" will be organized from 7 to 10 May 1985 by the Hamburg Messe und Congress GmbH in conjunction with the 14th World Convention of the International Association of Ports and Harbours (IAPH) and with the sponsorship among others of IBI. As in 1981 IBI will contribute to the programme of these events by organizing a Symposium on "Informatics in Ports and Harbours", with the promotional aid of the Authority for Economics, Transport and Agriculture of the Free and Hanseatic City of Hamburg and the co-operation of the Hamburg Messe und Congress GmbH, the International Association of Ports and Harbours (IAPH), the Central Association of the Electrical Industry (ZVEI) and the International Maritime Satellite Organization (INMARSAT). The IBI Symposium will consist of two parts: Part I will focus on the "Aims and Objectives of the Use of Communication Technologies in Ports" and Part II on the "use of EDP in the Transport Chain". (IBI Newsletter, No. 22)

News worldwide

Tsukuba Science Expo '85

The international science and technology exposition "Dwellings and Surroundings - Science and Technology for Man at Home" opened in Tsukuba Science City, Japan on 17 March until 16 September 1985.

Exhibitions at the Exposition can be classified into three categories: government exhibitions, domestic exhibitions and foreign exhibitions.

Domestic exhibitions will be presented by 28 Japanese enterprises. They explore the themes of the Science Exposition using huge video images, fantastic three-dimensional presentations, and the most advanced electronic, information and telecommunications technologies.

The government exhibitions include a "Theme Pavilion," which expresses the close relationship between man and science and technology; a "History Pavilion," which focuses on the evolution of science and technology in Japan; a "Children's Plaza" which teaches children through play; an "Expo Plaza" for special events, and the "Tsukuba Expo Center" which will remain as a symbol of Tsukuba Science City after the exposition is over.

At the Theme Pavilion, the featured themes "This Varied Land of Ours," "Sun and Water," "Life in the Future" and "Universe," are illustrated with visual presentations on a 70 mm-wide movie screen, with models of dwellings and other representations.

At the History Pavilion, areas are set up which present Japan's progress toward independence in technology, the history of the iron and rice cultures in this country, and the development of modern science and technology. The ancient origins of Japanese science and technology, the introduction and absorption of Western science and technology beginning in the Meiji era, analyses of modern science and technology, and other topics are vividly presented in various exhibits.

Domestic exhibits present such themes as "Roots of the Japanese and Their Culture" (Matsushita Pavilion) and "Human Electronics" (Toshiba Pavilion). At all the pavilions, the video and audio presentations employ the best technology that modern science has to offer. A wide variety of robots with very human characteristics will make their debuts. Visitors will experience the new kinds of relationships with evolving communications media, some of which are already in practical use. These are wonderful worlds, which most people cannot yet experience in their daily lives. (AEU, March 1985)

Information Technology and Education - the new ESRC Programme

The Economic and Social Research Programme (ESRC), U.K. has started a three-year programme for research and development in the field of Information Technology and Education in the United Kingdom. The ESRC will endeavour to support those active in the field in universities, colleges, schools, local authorities and industry in all parts of Britain. The activities of the Programme are being co-ordinated by a Co-ordinator rather than establish a single new centre who acts as the focal point for the development of the initiative as the research community concerned is widely scattered and has relatively few large groups of researchers. The Co-ordinator is Prof. R. Lewis, Department of Psychology, University of Lancaster, UK. His duties include the review evaluation and dissemination of recent and current activity in the field of Information Technology and Education; the identification of the needs of education in relation to IT, the stimulation of relevant research and the formulation of research guidelines; the establishment and maintenance of a data base of relevant work and making arrangements for co-ordination and networking of those active in the field including cognitive scientists, educational researchers, practitioners and policy makers.

One of the first research activities will be to investigate questions surrounding IT literacy and the barriers to innovation in classrooms. It is intended that these will be explored through selected case studies and demonstrator projects.

One proportion of the Programme's resources will be directed to support research and development work. The main areas for practical research investigations are likely to be: IT literacy; AI in CAL development; and implanting innovation and teacher training. A series of seminars is planned for 1985.

The Programme will also co-sponsor the next conference in the series "Computers in Higher Education", organized by the University of Lancaster, on "Trends in Computer Assisted Education", to be held on 15-17 April 1986. A new Journal of Computer Assisted Learning, edited by Professor R. Lewis will be published by Blackwell Scientific Publications. It will be published three times a year at an annual subscription price of £10 (for overseas).

International Symposium on Microelectronics and Labour

The Executive Organizing Committee for International Symposium on Microelectronics and Labour plans to hold, with the support of the Japanese Ministry of Labour, an International Symposium on Microelectronics and Labour in Tokyo from Setpember 25 through September 27, 1985 and in Kitakyushu City in September 20 and 21, 1985.

Scholars, government officials, trade union and business leaders from industrialized countries and neighboring countries of Japan will be asked to participate. The main theme is the betterment of workers' welfare in the field where microelectronics is progressing. The Symposium will aim at exchanging the fruit of research into such labour problems as economic growth and employment, human resources development, industrial relations and working condition, and safety and health. Since we are on the verge of full microelectronization, it is strongly hoped that the Symposium will provide an important opportunity for government officials, workers, and employers to exchange opinions on ways to cope with these problems. (Secretariat of International Symposium, c/o National Institute of Employment and Vocational Research, 4-1-1, Nakano, Nakano-ku, Tokyo, 164 JAPAN, Tel: 03-387-4808)

DPU runs short course on computers and development planning

Development Planning UNIT (DPU), an academic centre within the Bartlett School of Architecture and Planning of University College London, specializes in academic teaching, practical training and research in the field of urban and regional development in developing countries.

The basic purpose of the DPU is to contribute to the increase of skills in the developing countries, to improve capacities so that government responses to the problems and potential of urbanisation can be better informed and more effective. It seeks to achieve these purposes by offering long and short specialised courses in London and in the developing countries themselves. These courses are supported by all the relevant international agencies as well as by national governments.

A course on "Computers and Development Planning" will be held by DPU from 8 July - 2 August 1985. (Course director, J. Lindsay) This course is aimed at urban planners who either have access to computing facilities but not experience of how to make use of them, or those who are responsible for a systems specification designing operation and who want to get an idea of current developments. It will presume no knowledge of computing or mathematics. For more information write to: Admissions Secretary, Development and Planning Unit, 9 Endsleigh Gardens, London WC1H OED, United Kingdom, Telephone: 01-388 7581, Telex: 896559 GECOMS.

Third annual workshop on microcomputers and development

The Stanford microcomputer workshop, now in its third year and to be held on 5-30 August 1985, is a response to the growing need for microcomputer training that has special relevance to the decision-making and data analysis problems of developing countries. It is aimed primarily at people without previous microcomputer experience who wish to gain a broad overview of the technology as well as to develop skills in the use of selected commercial software packages.

The workshop, held at the Food Research Institute on the Stanford campus, is a combination of general lectures on the topics listed below plus intensive "hands-on" work with the commercial packages indicated. A machine will be provided for each student to ensure that participants will have the opportunity, not only to learn about the latest software and hardware developments, but to gain a working knowledge about microcomputers upon which subsequent self-teaching efforts can be built. The identification of problems and the application of software packages that will be discussed draw on extensive experience with microcomputers in Egypt, Kenya, Portugal, Sudan, Tanzania, Zambia and Zimbabwe.

Topics include:

- Introduction to Microcomputers - Potential (and problems) for Improving Policy Analysis and Program Management in Developing Countries
- Microcomputer Components - Rudiments of Hardware, Operating Systems, Languages, Software Systems and Communications
- Spreadsheets - Planning and Budgeting, Project Analysis, Food Management, Macro Projects: (Lotus 1-2-3)
- Word Processing - Getting Information on Paper. (WordStar)
- Data Base Management Systems - Inventory and Expenditure Control, Survey Data Collection and Analysis, Project Monitoring: (dBase III)
- Project Management Software - Project Planning, Project Management (Harvard Project Manager, Microsoft Project)
- Communications and Local Area Networks - Linking Peripherals, Accessing and Sharing Data Between Micros and Between Micros and Mainframes
- Software Integration - Linking Packages Thru Common Formats (DIF, SDF, BASIC), Integrated Programs (Ashton-Tate's Framework, Lotus' Symphony)
- Software for Quantitative Analysis - Statistics, Linear Programming (Microstat, Micro TSP, LINDO)

Further information may be obtained by contacting Professor Carl H. Gotsch at the Food Research Institute. (Telephone: 415-497-0693; Telex: 348402 Stanford STN; Cable: FOODRES).

Computers and policy for development seminar

The Institute for Technology Policy in Development of the State University of New York (SUNY) in co-operation with the International Law Institute (ILI) is presenting its first seminar on computers and policy for development on 23 June - 2 August 1985 at Washington (ILI) and Stony Brook, New York (SUNY). The course is designed to give a comparatively short, intensive training for middle and upper level planners and managers to prepare them for dealing with the economic and social consequences of the impact of computer technologies on the economic well-being of all countries. The syllabus will include an overview of computer technologies; development applications of computers; social and economic impacts of computers; the world computer industry; evaluating national potential for computer technology development; negotiating computer technology transfer; national computer technology policy formulation and implementation. A visit to a computer laboratory will provide participants with hands-on experience with computers.

For further information get in touch with the Computer Seminar Administration, ILI, 1920 N Street, N.W. Washington D.C. 20036.

NEW DEVELOPMENTS

IBM: Mainframes in 1990

This forecast is based on an analysis of three factors: the needs of IBM's large customers; the potentials of technology, particularly the kinds most familiar to IBM; and IBM's self-interest. Although the forecast is unlikely to be correct in every detail, we believe its overall direction is accurate.

By 1990, IBM will have evolved an integrated architecture encompassing all its multiple product lines. This architecture will be based on the following components:

- The SNA overall communications architecture,
- The DCA document content architecture,
- The DIA document interchange architecture, and
- Office and factory-floor local area communications architectures.

These integrated architectures will operate under an evolving MVS/XA umbrella with VM/CMS playing an important role for interfacing end users. According to its February 23, 1984 guideline statement, IBM does not intend to implement these facilities in DOS/VSE. Therefore, by 1990 we expect DOS/VSE will have been stabilized and its use will be declining. As the primary host operating system, MVS/XA is expected to be able to operate on mainframe systems composed of a variety of functional subsystems. The stabilized versions of DOS/VSE and the then-current version of VM/XA will thus remain operable as job entry subsystem (JES) or application processors under MVS/XA. The IBM modular mainframes will also permit IBM processors with older architectures to operate as subsystems. This will be especially useful for customers who resist conversion to the new architecture systems.

Within this overall architectural framework, DISOSS will be primary subsystem for all document filing, search, retrieval, and output functions. While initially text-oriented, DISOSS is expected to evolve to have a full spectrum of integrated storage and retrieval capabilities, including ones for image, graphics, and voice (both limited voice recognition and speech synthesis). DISOSS is expected to provide compatible, revisable form document storage and interchange facilities for all of IBM's office automation systems. PROFS will continue to evolve (under DISOSS) as an easy-to-use end-user subsystem in the evolved VM/XA environment. Its functions will be enhanced to encompass full revisable text interchange among the IBM multifunction workstations, as well as enhanced forms of the professional office automation functions it currently supports. IBM's 1990 mainframe, then, will still play a central role in its overall architecture. It will be central file manager and switch not only for data, but for objects in other media, and will of course retain its original role as a large scale batch and interactive processor when job sizes exceed the capabilities of network nodes. By 1990, the electronic components available to IBM for use in its mainframes will cost no more than one tenth of current prices. Semiconductor memory chips, the largest of which now store 262,000 bits of information, will by then be storing 1 million to 4 million bits in the same area at about the same cost.

The cost of logic will also be lower. The 16-bit microprocessors now used in most personal computers have just passed the $10 price level; by 1993, they should be approaching $1 each. Similarly, 32-bit microprocessors with approximately four times the computing power will have dropped below the $10 level and will continue downward. These will be widely used throughout IBM's mainframes, and the still-needed higher-speed logic chips will also cost less.

Speed may improve fivefold

Speed may prove to be somewhat more of a constraint. Faster circuits require denser packing of circuit functions on the microchips, an arrangement that creates problems of signal strength, heat dissipation, and quality control. Gallium arsenide should be available as a substrate, however, together with smaller feature size and better cooling for silicon chips. We expect about a fivefold improvement in the speeds of the fastest routinely available electronics, and even higher performance with new technologies. To take advantage of the low-cost but relatively low-speed components that will be available, IBM's mainframe system of 1990 will contain multiple processors dedicated to specific functions. Each processor will contain a very large cache (in excess of 1 MB) that will in effect be a loosely coupled main storage facility. The specific function of each processor, e.g., the instruction set to be processed, will usually be determined by alterable microcode. The processors will communicate with one another via messages and data blocks in standard form, regardless of whether the content is a program, data, digitized text, image, or voice. The processors will also be able to back one another up, should any one of them fail (fail-safe). Fault tolerance will be available both at the system level and at the device and component level to accommodate the increasing demands of users for high system availability. Users will be able to choose degrees of increased cost to obtain increased levels of fault tolerance. The largest mainframe models will be capable of supporting up to 16 general purpose processors as well as several special purpose processors. Smaller members of the mainframe product line will be able to support fewer and less capable processing subsystems.

This mainframe-federated functional subsystem architecture will employ a fiber optic main data bus to interconnect the various functional elements, and probably a separate control bus.

Among the various optional functional subsystems offered in the product line will be:

. Several sizes of input-output processors,

. Relational database processors and buffered file processors,

. Application processors (for various programming language environments),

. Array processor modules,

. Image processors, and

. Expert system modules.

Many of these modules will have hardware architectures specific to their intended tasks. Other will be software/microcode variants of the standard processing modules.

The input-output processors' sizes and characteristics will vary, including the capabilities of conventional channel groups and also new high-speed communication controllers. Among them they will be capable of communicating with several kinds of attached communications facilities and of switching messages between terminals (whether they contain data, text, digitized images, or voice). They will also control local batch input-output devices such as line printers, and existing DASD controllers if file processors are not used. The application processors will be dedicated to particular computational environments. Some will be oriented to direct execution of programs written in specific programming languages (for example, COBOL or FORTRAN), while others will support problem-oriented languages (for simulation). Still others will run the software of obsolete machines. The orientation of each application processor will be specified by alterable microcode; within limits, the processor orientations can be changed via the supervisory processor to meet different workload requirements. The database and file processors will evolve especially rapidly, based on evolution of the cache disk controllers (3880-21 and 23) and on hardware to support processing of relational databases.

Special processor versions

Also available for different kinds of applications will be specialized versions of file processors. Text, voice, and graphic data will be stored in the same databases as computational data, with unique query, search, and report generation routines to account for the special characteristics of the data processed. One type of specialized file processor will emphasize high throughput to handle 1,000 to 5,000 file updates per second. (Today's largest general purpose computers have difficulty handling more than 1,000 updates per second). This processor will involve sophisticated computer control to stage data up and down a hierarchy of storage devices with different access speeds (in accordance with patterns of use), and to handle a variety of storage devices arranged in parallel for simultaneous access. Such high-throughput storage systems will be useful in centers with the largest processing networks. Other types of file processors will employ less structured methodologies so that associative or content-related inquiries can be made. These less structured file processors will be useful in office applications or research and information-retrieval applications. They will be useful in collecting and retrieving a variety of text and graphic materials, as well as data from a number of sources not subject to a common structure or indexing system. Such unstructured file processors are likely to evolve from the relational database software now available as programs for use in conventional computers. They will eventually employ arrays of microprocessors that will make exhaustive searches of large databases practical for the first time. Other versions of file processing systems are possible for such things as voice or graphic information (which may be stored in noncoded forms). In the late 1980s and early 1990s, some processors will have special architectures adapted for artificial intelligence and/or data-driven applications. In 1990, IBM will offer a broad family of these modular systems. This family will be headed by a tightly coupled confederation of very high speed general and special purpose processors with an aggregate processing power of over 1000MIPS; the low end will extend down to workstations with processing power of approximately 1MIPS.

IBM's current mainframe product line is characterized by two distinct price/performance levels. At the low end (4300), the systems average approximately $150/KIPS (one thousandth MIPS). At the high end (308X), the systems average approximately $250/KIPS. According to these price/performance trends, we project that in 1990, the low-end systems will be priced at approximately $20/KIPS and the high end at approximately $80/KIPS. The small systems pricing advantage will primarily be due to the lower performance components needed at the low end of the mainframe line, and the higher level of manufacturing automation that can be applied to production of smaller systems. These prices are exclusive of separately priced system programs. By 1990, most IBM mainframe users will likely pay more on a life cycle basis for system programs than they do for hardware. MVS/XA will form the primary system software environment for IBM mainframes in 1990. The current MVS/XA product will, however, be significantly modified between now and then. Most of the changes will take the form of additional and enhanced capabilities. IBM will be careful to change the existing program and JCL interfaces as little as possible to minimize customer compatibility and migration problems.

We expect the major MVS enhancements to include

- The addition of more functional subsystem capabilities,
- The addition of autonomous monitors to operate the various functional subsystems,
- The migration of increased amounts of code into the microcode of the various functional subsystems.

These enhancements will be needed because the operating systems accompanying modular computers must also become modular. Already, MVS/XA is undergoing a long-term, gradual transition from an easily identified, integrated collection of software to modular software and microcode-implemented sets of elementary functions whose major purpose is to allocate and control subsystem resources on a millisecond-by-millisecond basis. Since the user and his application software are far more sensitive to changes in the operating system than they are to changes in the hardware, this transition has to be a long and gradual one, avoiding major discontinuities or conversions, whenever possible.

Microcode assists a trend

Microcode assists have appeared primarily to speed up processing. Although many of these assists are not necessary for operating the system, a trend toward making the assists a prerequisite for higher-level software is becoming more marked. System interfaces are beginning to disappear from the user's view. being replaced by easier-to-use, more logical interfaces in the higher-level support software systems. During normal operations, the operator's interaction with the system will be primarily to mount and dismount removable printing and storage media. Other interactions will take place only in the event of unusual situations like the failure of one or more of the major components of the system. Most operators, except those involved with physical media, will probably be located in an operations control center away from the computers. Expert system components such as IBM's YES/MVS will be used to implement overall system scheduling and configuration policies. These operating systems will be completely self-sufficient. Other than management-level priority setting, they will require no human intervention. Within the computers, operations will be almost completely implemented in microcode of one type or another; the remaining software will function primarily at the supervisory level. Any modifications made on the operating system will probably void any system warranties.

We anticipate that existing database management software will continue to evolve along with the file processors discussed above. Emphasis will be on integrating the DBMS with other software to form a unified applications development and operations environment. In addition to the DBMS, four important parts of this environment are the data dictionary, the application generator (for producing transaction processing programs), the end-user language for ad hoc inquiry and small database applications, and the extract relational database system. Downloading of data from the mainframe hierarchical and/or extract relational DBMS to personal computers and back again is already a reality; this facility will be enhanced in the coming years. Relational database systems will evolve quickly over the next several years, now that DB2 and SQL are mature products. They will be used as accessory DBMS for mainline hierarchical DBMS systems (and sometimes as the main system) in mainframes, as well as in file processors for offices.

By 1990 IBM's hierarchical database IMS (DC/DB) will be mature. By that time CICSDL/1 is expected to be the primary system with IMS DC/DB relegated to a secondary role. In many cases, however, DB2 or a successor product will be the primary database system for at least most new applications. By that time, most of the current relational database inefficiencies will undoubtedly have been corrected or will be unimportant. Where DB2 does not have the primary role, it will be heavily used as a major professional computing and office automation database. In this role it will contain data extracted and/or summarized from the main DL/1 corporate databases. Such data, which are much more useful to most end users, will form the basis of most non-operational applications. The use of such an extract database will have the effect of protecting the security, usability, availability, and integrity of the main operational databases. Integrated development environments oriented toward data dictionaries will be heavily used. These environments will contain a mature set of integrated development, project management, and documentation tools.

4 GL will improve by 1990

Fourth Generation languages will have been improved significantly by 1990. They will be employed primarily for user-driven systems where their efficiency and self-structuring limitations are more than offset by their advantages of ease and speed of development. The primary reason for using these packages will be to obtain greater user satisfaction with the finished system than can be obtained with other development methodologies. By 1990, professional computing tools will have proliferated. The emphasis in these tools will be on information retrieval and management, rather than on number crunching. Compatibility and interaction between the workstation environment and the mainframe environment will be stressed. Many applications will be written in two or more parts, with each part intended to run in a different environment. IBM will continue to stress professional solutions that involve the use of mainframes. Development tools will be provided for professional mainframe programmers so they can set up menus and batch work-streams for workstation users. In turn, these users will lead other users through the more complex workstation applications without long periods of user training. We also expect expert systems from IBM to be of increasing importance for specialized applications. These systems will not be in widespread general purpose use by 1990, but will be important where they can be successfully applied.

These changes in mainframe architecture and price performance will have significant implications for users' information processing systems. Special-function-oriented mainframes will be common with significant capabilities in one area, such as file processing, and little capability in another area, such as scientific computing. Thus large users will be able to economically configure special purpose processors that can be distributed to departmental locations without special environments. The new architecture will also allow mainframes to be incrementally updated and enhanced with the specific modules required. Complete computer systems will rarely be replaced. Modules will often be replaced, however, and plug-compatible, specialized modules will be offered by small vendors. The significance of these 1990 mainframes to the industry's competitive structure has yet to be determined, but it appears that as many doors will be opened as are closed. (By Norman Weizer and Frederic Withington;* published in Datamation, 1 January 1985. Reprinted with permission of DATAMATION[r] magazine[c] copyright by Technical Publishing Company, A. Dunn and Bradstreet Company, - all rights reserved).

How to grow diamond semiconductors

The National Institute for Research at Tsukuba (Japan) claims to have formed the world's largest industrial diamond weighing 0.7 grams. Two grams of carbon were held at 60 kBar at 1500°C for a week to make the stone.

Another carbon-based technology under development is the coating of substrates with a layer of diamond. The coatings are laid down on a substrate such as silicon by exciting a mixture of methane and hydrogen with microwaves. The technique, called chemical vapour deposition, is likely to be taken up by the machine-tool industry to create harder cutting edges. The synthesis, texture and properties of these layers are being investigated to develop new semiconductors, heat sinks for very large scale integration (VLSI) circuits and photo-luminescent sources. Researchers also suggest that doping diamond with boron and nitrogen may lead to a VLSI that can go on working quickly at high temperatures. ... (The Economist, January 1985)

Here comes the fastest chip on earth

The first time that Lester F. Eastman went public with his notion of a "ballistic transistor," all hell broke loose. "I felt like Custer at Little Big Horn," recalls the Cornell University electrical engineering professor. Scientists attending the 1981

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technical meeting completely lost their cool, he says. "Some people were standing up and shaking their fists and shouting, 'You're crazy.'" Eastman's theory got that kind of ripsnorting response because it flew in the face of all that was then known about semiconductor behavior. He figured that if a transistor is made small enough, an electron can shoot straight through without any impediment: A point will be reached when the electrons that carry signals won't collide with any atoms in the semiconductor material, something that happens in conventional transistors and slows them down. The ballistic effect will be similar to a jet passing through the sound barrier. If Eastman is correct - and a growing body of research data now supports his thesis - transistors will one day switch on and off hundreds, maybe even thousands, of times faster than today's fastest devices. These ballistic transistors are likely to yield a whole new generation of superfast computers, satellite systems with greatly increased communications capacity, and vastly improved radars that will be able to spot far smaller objects at much greater distances than they can now.

Ultimately, some scientists predict, ballistic transistors will make possible computers that are fast enough to tackle problems that stump even today's biggest systems: accurate global weather forecasting for weeks and months ahead, or simultaneous voice recognition and translation. Because of such potential, scientists at leading laboratories in Japan, Europe, and the U.S. are racing to develop the first ballistic transistor. (Science & Technology)

Japan superconducts JJ development

When it comes to developing superconductive digital integrated circuits for potential computer applications, the accomplishments of Japanese researchers dwarf those of others currently working in the field. As a U.S. government task force report on the topic last year noted, the Japanese have devised several superconducting logic families, set new records for logic-circuit speed, developed both lead-alloy and niobium-based fabrication technologies, and demonstrated large-scale integrated logic and memory circuits. Only IBM Corp., which has shut down its superconductive mainframe effort, can boast of comparable achievements. One of the latest examples of Japanese prowess came at the recent International Solid State Circuits Conference in New York, where NEC Corp. reported on a 4-by-4 multiplier that relies on 850 Josephson junctions configured as 250 gates. Featuring an execution time of 280 ps, the multiplier achieves speeds that are some 14 times quicker than the fastest comparable gallium arsenide circuit yet reported, researchers say. Extremely fast memory circuits have also been produced. The Atsugi Electrical Communication Laboratory of Nippon Telegraph & Telephone Public Corp., for example, has reported on a 1-K lead-based Josephson memory chip that exhibits a 3.3-ns access time, with gate delays of 4.2 ps, among the fastest in the world. NTT has an estimated equivalent of 40 full-time researchers working in the field in an effort that is completely separate from the supercomputer program sponsored by Japan's Ministry of International Trade and Industry. An additional 40 researchers are believed involved in the latter program at NEC, Hitachi, Fujitsu, and at the government's Electrotechnical Laboratory. The eight-year supercomputer project is reportedly funded at between $100 and $150 million and is examining several technologies including conventional silicon, high-electron-mobility transistors, and Josephson junctions. According to Hisao Hayakawa, chief of the laboratory's Fundamental Science Section, a decision on which technology to use for the project will be made by the end of the first quarter of next year. Though much early Japanese work has involved use of lead-based junctions, the emphasis is shifting to refractory materials. The Electrotechnical Laboratory is concentrating on niobium nitride junctions, and has current goals of producing 1-K and 16-K memories with access times of 300 ps and less than several nanoseconds, respectively. NEC is also working with pure niobium, which it currently prefers to niobium nitride because pure materials are easier to oxidize during the fabrication process. If the laboratory has success with niobium nitride, however, NEC researchers say they will likely go that route.

Even if Josephson junctions don't make the cut for the supercomputer project, Japanese researchers stress that work in the technology is aimed at the long term and will probably be continued. This is in contrast to the previous IBM effort, which appeared to be aimed at producing a superconductive-based computer by 1986, points out Kazuo Ayaki, who is general manager at the Microelectronics Research Laboratories of NEC Corp. At the same time that IBM terminated its effort in September 1983, the firm said that a probable two-year delay in developing a high-speed 4-K cache memory chip would put the project too far behind schedule against rapidly advancing conventional chip technologies. For a twofold-to-threefold performance edge over conventional machines, instead of the fivefold-to-sixfold advantage originally envisioned, IBM decided the effort to develop a Josephson-based computer was not worth continuing. But IBM is working on a three-terminal Josephson chip that could be useful in future computer applications, says Alex P. Malozemoff, manager for magnetism and superconductivity at IBM's Thomas J. Watson Research Center. Hitachi has already built a highly experimental three-terminal superconducting chip in silicon. (Reprinted from Electronics Week, 25 February 1985, Etching advance could lead to lower costs

A researcher from the University of New South Wales, Sydney, has developed a vacuum chamber for etching VLSI circuits on to silicon wafers which promises to dramatically boost the yield, speed and accuracy of chip production. Already IBM and RCA in the US are running tests on their own working prototypes of the new chamber, designed by Dr. Chris Horwitz, a researcher with the Joint Microelectronics Research Centre (JMRC) and NSW University. Unisearch, the university's marketing arm, has applied for patent protection for the chamber, which is claimed to be at a definite marketable stage. The US firms, particularly RCA, apparently built their prototypes by following details in a research paper written by Dr. Horwitz, published in November 1983 by Applied Scientific Letters, as well as a follow up paper presented by Dr. Horwitz to a conference in New York last June. One local company which is not traditionally involved with hi-tech products, particularly microelectronics, approached the university and has carried out detailed discussions with Uni-search regarding manufacturing. Dr. Horwitz said that VLSI etching machines normally cost around $A120,000 to $A50,000 for what he claims is a rather simple device. "What is sophisticated is the wafer handling robotics, and I haven't made any innovations in that area." A conventional dry-etching chamber consists of an aluminium box with a hole where a vacuum pump is attached.

The anode is the box itself and the cathode is a separate electrode situated on the bottom of the box. Conventional techniques rely on a plasma discharge to etch the circuit on to the silicon. The key to Dr. Horwitz's vacuum chamber is a third electrode, placed in the top of the chamber facing the lower electrode and electrically connected to it. This arrangement provides a highly concentrated and accurate discharge which etches the VLSI circuit, already masked on to the silicon wafer with photo-resist.

When the silicon wafer is in position on the lower electrode of the chamber, the vacuum pump empties the chamber and gas as low pressure floods in. A radio frequency voltage is then applied to the electrodes and the circuit is etched on to the wafer. A typical change is delivered at 13MHz with a power 2KW. The use of RF voltages for etching circuits with a hollow cathode arrangement is claimed to be unprecedented. Dr. Horwitz also claims that the discharge from the cathodes, rather than a single cathode, is so intense it boosts chemical reaction in the process which results in etching 10 to 100 times faster than plasma methods. "There is an incredible discharge between the electrodes. They seem to concentrate the discharge into a fireball," he said. The improved accuracy of the chamber is also expected to boost yields of VLSI chips in mass-production. Dr. Horwitz said that rejects in IC runs, generally around 50 per cent of the total run (sometimes higher) are normally due to etching inflexibility, in that the wafer can only be etched with one etching angle. (Electronics Weekly.)

Development of Bioelectronics

Hitachi, Ltd. will form a biotechnology project team by mobilizing more than 200 research and development staff members. The subjects of the project range from gene recombination to mass-production systems. The project is aimed for developing and supplying various techniques making biotechnology industrialization possible, machinery and equipment. Furthermore, the company plans to develop these techniques into bioelectronics, in preparation for the production of biosensors and biochips. Electronics manufacturers have been making approaches to biotechnology rapidly. An active attitude of Hitachi, Ltd. is noticeable, together with that of NEC Corporation and Matsushita Electric Industrial. The development of biotechnology-related products is expected to proceed at a quick tempo in consideration of the scale of potential technical capability. Biotechnology will expand from pharmaceuticals and seeds to industrial needs. Hitachi, Ltd. has produced many culture cells and plants for producing antibiotics and amino acids since the end of the Second World War when it first developed a large scale culture cell for penicillin production. Also in the field of analysis, the company has supplied liquid chromatographs, gas chromatographs, amino acid analyzers, electron microscopes. Although biotechnology support equipment has been manufactured formerly, social needs of biotechnology are now expanded, centering on genetic engineering. Biosensors and biochips as key devices are now in a stage of research and development. Incorporation of biotechnology into electronics is an important development subject for the next generation. The company has already studied technologies for colony transfer units, automatic measuring equipment for protein components, high-speed separation columns for physiologically active substances, precision automatic control culture units, high-efficiency fluidized bed type bioreactors, and enzyme immobilization. As the next step, bioelectronics related products such as robot parts will be developed. (Chemical, Economy and Engineering Review, December 1984.)

Bipolar IC Manufacturing Technology

Sony announced that it has developed a new technique for the manufacture of bipolar IC's (integrated circuits). Samples of a television tuner IC that is made using the new technology were shipped in October 1984. By using this technique, the process for making the bipolar IC can reportedly be reduced by 27 per cent, and high density integration can be easily achieved. Sony plans to adopt this new technology in the production of its bipolar IC's. The technique (high planar) for manufacture of the new bipolar IC involves the injection of ions into a semiconductor wafer immediately after the wafer has been exposed using a mask aligner (an exposure device that is used in the manufacture of semiconductors), and the subsequent formation of a layer of impurities. Until now, an etching device was used to remove portions of an oxide film and impurities were then injected to make the impure layer. However, Sony has made it possible to insert the ions directly by making the impure layer 50 per cent thinner for low voltage (5V) applications. Using this method, most of the etching procedure can be omitted and the upstream process of forming the electronic circuit on the wafer can be reportedly reduced by 27 per cent. Also, due to the simplicity of the process, IC production is more efficient and even IC's with a high degree of integration have a yield of 95 per cent. (Nikkei Sangyo Shimbun, in Japanese, 9 October 1984.)

Sandia's self-developing polymer materials point to cheaper, better computer chips

A novel class of silicon-based polymer materials that "self-develop" upon exposure to ultraviolet light has been discovered by scientists at DOE's Sandia National Laboratories. The discovery, the scientists say, could eventually eliminate several costly and troublesome steps in the manufacture of microelectronics circuitry on silicon chips. This, in turn, could lead to commercial computer chips that cost less to make and are more free of defects. The development also points a way toward simplified manufacturing of Very Large Scale Integrated (VLSI) circuits with line widths of less than one micron - a goal of circuit designers desiring to pack more electronic components into less space. Patent applications have been filed in the United States and a number of other countries. The materials are a new class of polysilane copolymer consisting of long chains of two kinds of simple units, or monomers, based on silicon. The polymers have a silicon-silicon backbone and various organic side groups bonded to the silicon backbone. They can be synthesized from inexpensive and readily available chemicals widely used in the manufacture of silicon rubber ... (DOE [US] This Month, January 1985.)

Laser light increases computer's capacity to think

Alex Szabo, a physicist with the National Research Council (NRC) in Ottawa, has developed and patented techniques which some consider could revolutionize the computer industry and create a business worth literally billions of dollars within the next decade. His discovery, "optical hole-burning", which was an offshoot of his 15-year investigation in an esoteric field known as "the laser spectroscopy of solids", may be used to construct a powerful and sophisticated computer memory. While the earliest computers worked only with numbers, computers today listen to language and shuffle text. At their deepest level, however, even their "non-numeric processing" capability still uses numbers.

The "fifth generation" machines of tomorrow will not seem like mathematical drudges to their users. Such machines will be asked to reason, to learn, and to perform billions of operations at incredibly high speeds. User-friendly abilities will include comprehending and translating spoken languages, and reading maps, photographs and handwriting. Researchers are agreed that fifth generation computers will almost certainly rely on innovative computer architecture known as "parallel processing." ... Parallel processing is already found in Canada's Cray-1 supercomputer, a "fourth generation" computer inaugurated in Montreal in February 1984 as the country's central weather forecasting computer ... The number of calculations is extensive. Even for supercomputers like those in Montreal with lightning-fast speed of 50 million arithmetical operations a second, a ten-day weather prediction takes seven hours of computer time and involves in the order of 10^{20} calculations.

Dr. Szabo is one of many experts who suggest that the complexities of full parallel processing may pose intractable problems for computers based on electronic circuitry and that optical computers, where beams of light replace circuits, may be the only feasible way of building such advanced capabilities. For Dr. Szabo, his powerful optical memory is the first clear demonstration of this potential, and promises to provide the storage capacity required by parallel-processing architecture. His invention is based on the fundamental physical properties of matter and light. A prism, for example, demonstrates that sunlight contains the rainbow of colours or frequencies which make up the visible spectrum. Thus a leaf appears green because its chlorophyll reflects back the green light and absorbs the other visible frequencies. At the atomic level, the interaction of light and matter is more complicated. An atom can be considered to consist of a nucleus surrounded by electrons in discrete orbits or energy levels. If an electron is given the precisely correct amount of energy, it will jump to a higher energy level, absorbing the activating energy in the process. It is however unstable at the higher energy level. When it falls back to its ground state or original energy level, it gives off the energy it absorbed in the form of light. The precise frequency of this light will depend on the difference between the two energy levels. The clearest everyday demonstration of this is in fluorescent lamps, where electrical energy pushes electrons to a higher energy level and they emit light as they fall back. Dr. Szabo's optical memory relies on these basic physical principles of the electromagnetic spectrum and of atomic absorption and emission ...

Within the past couple of years, memories have taken a leap in storage capacity, with the introduction of video discs. These can store about 100 times more data per square centimetre than magnetic media. The bits are recorded by literally burning pits about one micrometre wide with a laser in a thin metallic film layer on a plastic or glass disc. But even this most advanced of current storage technologies pales in comparison with the capacity of as much as 1,000 trillion bits per square centimetre made possible by Dr. Szabo's invention. According to Dr. Szabo, "this memory will be as much as a million times bigger than conventional memories and will undoubtedly completely change the computer game". The 1,000 trillion bits which could be stored on a fingernail-sized square centimetre of material in such a memory, he points out, surpass the 100 trillion bits estimated capacity of the entire human brain. Dr. Szabo predicts that computers with such memories will eventually be impossible for humans to program. They will require the development of a true learning algorithm or self-programming capability. And such computers, he says, will be the first true examples of artificial intelligence, of machines with the ability to learn from experience as humans do. In short, Dr. Szabo's memory may not only aid the development of fifth generation computers, it may require them. ... (Canada Weekly, 16 January 1985.)

Power ICs

Today, solid-state power switches are discrete devices that mount on circuit boards together with control logic. But indications are that the discrete solid-state switch may be supplanted by a new breed of power integrated circuit (PIC) in many applications. This component combines high-power solid state switches on the same silicon chip with the logic circuits that control it. The arrangement provides more reliable voltage, current, and temperature protection for power switches. And some PICs contain enough built-in intelligence to send and receive data over transmission lines.

Techniques emerging from laboratories now make possible an increasingly large array of new PICs. The automotive industry is the primary driving force behind the burgeoning technology, but other industries will likely reap equal benefits. Power ICs, for example, may allow the multitude of loads in an automobile to be powered from a single bus, and to be turned on and off with coded signals from a central microprocessor. But PICs also promise to revolutionize the design of motors, controls, and the distribution of electricity in homes, offices, and factories.

A wide variety of techniques are becoming available for fabricating PICs. Some are based on bipolar processes, others on MOS. But the most recently built chips combine these and other techniques. A single PIC now can contain small-signal and power bipolars, DMOS, CMOS, and high-voltage CMOS components, power MOSFETs, SCRs, and triacs. Both vertical and lateral power structures can be used. Components in some cases are self isolated, junction or oxide isolated in others. Ratings up to 20 A at over 400 V are feasible. The choice of components, structures and isolation depends on application requirements ... (Machine Design, 21 February 1985.)

Micro improvements

This year's buzzword in microcomputing is multi-tasking. Acorn and ICL are among British computer companies which plan to build micros capable of running several programs at once, a feat known as multi-tasking which is common on larger computers but not on micros. At the moment, few microcomputers allow their users to, for example, print out a document while they work on something else, or receive a telex message while they are doing their accounts. The problem is that the operating systems which control the housekeeping activities of micros will not allow it. Now, with the appearance of faster 16-bit and 32-bit microprocessors, capable of handling larger chunks of computer memory, software companies, such as Digital Research, and hardware firms, such as IBM, are working on multi-tasking operating systems. Both Acorn and ICL have taken out licences for Digital Research's Concurrent DOS-286, a multi-tasking operating system for the 80286 Intel chip. With this operating system the firms can set about preparing software which is more in tune with the way people work at a desk: jumping from one piece of work to another, transferring figures, or text from one file to another.

Business programs which offer this style of computing have already been produced. In Britain, Psion has brought out an integrated package of programs called Xchange in which several different types of program are incorporated on a single disk.

But these integrated programs have to have their own operating system which replace the operating systems of the computers on which they run. "A lot of people have developed applications by building an operating system into their applications software" says Martin Healey, professor of micro processor engineering at University College, Cardiff. "They had no alternative." Multi-tasking operating systems, says Healey, capable of handling up to 256 tasks at once, will make for much easier microcomputing. (This first appeared in New Scientist, London, 24 January 1985, the weekly review of science and technology.)

Novel breed of industrial sensors emerges

From cars to chemical plants and from military bases to mushroom farms - a new breed of sensing equipment is about to make its presence felt in a variety of diverse areas. The new sensors, which are based on semiconductor technology and measure chemically-related quantities such as the concentration of gases or the conductivity of solutions, are likely also to figure in equipment in the home.

The active parts of the new equipment will often be semiconductor chips that cost no more than a few tens of pence. In one class of such sensors, called ChemFETs, the semiconductor material (in this case in the form of a transistor based on silicon) is bonded to other substances whose chemical or physical form is changed in the presence of a gas or liquid. The change would alter the electrical characteristics of the semiconductor, triggering a pulse of electrons that, in turn, activates a display or some other signalling device. In a second type, thin layers of chemicals are impregnated into a crystal such as quartz that vibrates at a specified frequency. Any change in the chemical state of the layer, caused by the action of gases or liquids, alters the vibration rate. Detecting the change in the vibrations indicates the type of substance that is present. A third category of sensors incorporates microscopically-thin optical fibre that acts as a conduit for light pulses of specified frequencies. Light channelled by a semiconductor-based device (a light-emitting diode for instance) into one end of the cable is reflected or absorbed by a chemical at the other end. A sensor (another diode) detects the intensity of radiation due to reflection or absorption, so providing information on the nature of the chemical. Fibre-optic sensors could, for instance, monitor colour changes in an enzyme reaction used in medical diagnostics or analyse spectroscopically gases or liquids in a food-processing equipment.

The new sensors could have a big impact in process industries, which turn out anything from cement to chocolate. Virtually all the sensors used in process plants are simple devices that detect physical parameters such as temperature, pressure or flow rate. The current generation of chemical sensors are largely bulky and expensive and confined to laboratory instruments. The new equipment could improve the ability of plant managers to control reactions with automated equipment. Information from the sensors could be channelled to computerised control units which adjust valves and other equipment. Few companies have announced products in new chemical-sensor technology but industry observers say the annual market for new products based on the devices could be worth tens of millions of pounds by the early 1990s. ... (Excerpted from an article by P. Marsh, in Financial Times, 20 March 1985.)

ARTIFICIAL INTELLIGENCE

Artificial intelligence experts worry about lack of applications

The hardware building block needed for effective artificial intelligence is a billion-gate processor chip. Over 100 of them, in diverse organisations, would be required in a system able to perform some of the rudimentary tasks only humans are now capable of. So prophesied Professor Raj Reddy of Carnegie-Mellon University in Pittsburgh, as he delivered the keynote address for the ISSCC (International Solid State Circuits Conference) held in New York in February. No matter how far semiconductor technology goes in device density there will be a need for it, said Reddy. That was a comforting and well-received statement by the attendees who often ask if there are enough applications for the functional densities they are developing.

But Reddy's view of the future challenged them to anticipate technologies none has yet conceived of. He dismissed some common misconceptions, such as 32-bit processors being too complex and not widely applicable, and that Lisp machines are adequate for artificial intelligence applications. The belief held by many that demand for 32-bit microprocessors is comparatively limited does not recognise "the computational need for error-tolerance and user-friendliness that are essential if we expect ordinary mortals to use tomorrow's microcomputers effectively," said Reddy. He maintained that Lisp architecture is only one of many that will be needed, because problems involve a wide variety of computational abilities. When the essential technical and economic breakthroughs come in equipment, they will pervade education, health, industry and service sectors.

It is now possible to perform a simplified form of many tasks at the very bottom rung of the ladder leading to full-fledged artificial intelligence, but they are economically unfeasible because the device integration is not high enough. These tasks might include comprehensive spelling checkers and other specialised expert system tasks. And even when a billion-gate super chip comes along, Reddy says it will barely be capable of meeting the technical needs for artificial intelligence. He foresees that within 15 years secretarial assistant systems will be designed. They would provide voice recognition for dictation, spelling correction with a million-word dictionary, grammatical advice, online thesaurus and an intelligent database. He cited some of the basic artificial intelligence tasks that must be performed economically and with high performance: interpretation of visual scenes, autonomous vehicles that can navigate and avoid obstacles, robotic manipulations, combinatorial searches in game playing, computers that learn speech and natural language, and expert systems.

Image processing can easily involve 10 to 100 billion operations per image. And computational requirements for navigation and mobility, which extend the image processing, can easily go beyond a billion operations per look, Reddy estimated. For robotic manipulation and considering numerous alternatives in near real time simulation, the need is for from 100 to 1,000 million operations per second.

An even higher level problem is that of recognising speech and natural languages. Here the computer must be able to process from many sources of knowledge, such as syntax and semantics of language, number and pronunciation of words, acoustic and phonetic properties of sounds, and dynamics of the vocal apparatus. Reddy explained that interpretation of the speech signals requires a complex set of pattern-matching processes operating in the presence of error, noise and uncertainty. Current estimates are that computational power of over a billion instructions per second is needed along with a memory of over a billion bits. Processing a hierarchy of rules and conditions in an expert system would need a trillion operations per second, he added. And the architectures of computers are "woefully inadequate" for the instant recognitions that humans are capable of without conscious thought. Matching this human ability will take a massively parallel processing architecture in which simultaneous comparisons would contain a large number of facts, he said.

To carry out the tasks he cited, about 100 of super chip artificial intelligence would be required, with one billion gates in a processing system. Because the jump from current maximum practical gate densities of about 50,000 per chip to the billion gate level was too much for Reddy's listeners to bridge conceptually, he suggested an evolutionary approach to achieving the billion gates over 15 years. A million-gate processor chip might include functions now in four or five chips: CPU, floating point arithmetic, array processor, virtual memory and cache memory. Then, a 100-million-gate chip might contain 100 of these processors, with common buses to a larger external shared memory. All processors would not be identical. The processors in this multiprocessor system would need dynamically alterable logic structures for designers to tailor them to specific tasks. The billion-gate chip might offer a 100 Mbyte common memory and 100 of the multiprocessor systems, all on a single super chip. The processor groups on the super chip would be devoted to specific tasks needed by the overall system. Communication among the co-processing sections of the super chip would require transmission rates over a gigabyte per second. However, even this super chip, conceived in a near fantasy of extrapolation, would not be solely capable of performing the artificial intelligence tasks Reddy outlined. It will take "100 or so super chips appropriately specialised for various functions," he said. (Computer Weekly, 14 March 1985)

Finding the truth at the bottom of ai

Professor John Searle's BBC Reith Lectures on 'Minds, brains and machines' hit at least one crack in the armour of artificial intelligence (ai) researchers. Searle seized on a claim by John McCarthy that even a thermostat has beliefs. Most people have some trouble with the idea that the closure of two contacts in a thermostat constitutes a 'belief' that the room is too cool. Why, then, should we say that a computer program believes something when all that has happened is the setting of one bit in the computer's memory? Searle further argues that human minds possess a quality of 'intentionality' that no computer program can reproduce. He has yet to explain what, in the structure of the brain, could account for such a difference. Many ai workers would not yield the 'intentionality' point to Searle. But most would accept that computer models of belief, desire, reason and other mental phenomena have so far failed to reproduce the richness and subtlety of their equivalents in the human mind.

The whole ai enterprise has been based on abstractions. Details have deliberately been ignored. But what Searle sees as a fatal flaw has in fact been the secret of ai's success. No-one really thought that a belief was a binary digit stored somewhere in the brain. Ai researchers deliberately chose simple-minded representations of mental states because they had to start somewhere. Later on, they hoped to have the chance to investigate the rich and complex thing that a belief or a concept really is. Whatever Searle says, this top-down approach has been successful. And this success extends beyond the well-publicised expert systems, most of which operate in areas where knowledge can easily be compartmentalised.

Among the many researchers who have made progress in more problematic areas of knowledge are Roger Schank at Yale, and Douglas Lenat at Stanford University. Schank and his colleagues have modelled the network of relationships between concepts, which they believe underlie language. Lenat's program, Eurisko, improves its own strategies for learning, reasoning by analogy, and problem-solving. Of course, Eurisko's concept of 'two' does not have all the rich associations (two eyes, two ears, two's company, tea for two, two-finger salute ...) that surround two in a human mind. But Eurisko demonstrates that a good deal of serious reasoning can be performed with deliberately simplified versions of human concepts.

In a Scientific American article, Lenat pointed out that ever when it has run for weeks at a time, Eurisko's experiences are not nearly so varied as those of a human infant. He suggested that the way to improve the program's analogical reasoning would be to expand its knowledge base. More knowledge is the solution often proposed by the top-down school of ai. It could be a very powerful way of increasing the subtlety, richness and general wisdom of ai programs, since the added knowledge may include knowledge about knowledge, and knowledge about thinking. Even if this meta-knowledge is not supplied, perhaps because humans have difficulty in making it explicit, there is still the hope that given the chance, learning programs like Eurisko will bootstrap themselves to higher levels of performance. Lenat is perhaps in a minority when he doubts whether parallel processing will greatly increase the power of programs like Eurisko. By contrast Japan's fifth generation computer project, deeply committed to the 'more knowledge' thesis, assumes that as knowledge bases grow there will be a corresponding need for highly parallel machine architectures. Both Schank and Lenat have been attacked for using ad hoc devices, and working without formal theories. What no one questions is that they have achieved results. Japan's fifth generation architectures, in common with most of the parallel architectures proposed in Europe and the US, are born of top-down thinking. The details of the hardware are determined by the need to run Prolog or Lisp or a group of similar languages. And those languages are modelled on the way logicians or computer scientists believe knowledge can be manipulated.

But there is now a resurgence of interest in bottom-up architectures, inspired by the nervous system or other complex systems with interesting emergent properties. Neural nets, Boltzmann machines and cellular automata fall in this category. In these architectures, stability and instability, rather than logical truth and falsehood, are the important issues. Knowledge is never represented by the setting of a single bit of memory. Instead, subtle changes occur throughout the system whenever an item is added to its knowledge. In theory any parallel machine can be simulated on a sequential machine. But if the simulation runs a million times slower than the real thing, it becomes essential to build some hardware. Proponents of these alternative architectures believe that though the quantity of knowledge stored in a given amount of hardware may appear to be less, in some sense its quality is improved. And hardware, they point out, is cheap in the age of the 256-Kbit memory chip.

Propositional representations of knowledge, based on truth and falsehood, have lost their charm even among some practitioners of top-down ai. In 1969 Marvin Minsky and Seymour Papert of the Massachusetts Institute of Technology proved that single layer neural nets or perceptrons could not do such simple things as counting objects. Their proof helped to discredit bottom-up architectures for a decade or more. But now Minsky tells his students that the idea of 'truth' is dangerous. He is working on a model of learning and memory which does not use symbols or representations. In developing his concept of K lines, Minsky has tried to find a way of re-activating processes that were going on when something deemed to be interesting happened, without falling into the trap of crude stimulus-response behaviourism.

Alan Kay of Apple Computer admires the work of Schank and Lenat. Schank, he says, 'is closer to having his finger on what needs to be done than anybody I've seen.' His main reservation about Schank's work is that it still uses symbols. 'I don't think that representation based on symbols, in the sense that they're used in computer science, has any bearing whatsoever on the kinds of memory structure that these systems will use in the future,' says Kay, a former biologist whose work in computer science has often been inspired by biological models. It is one thing to suggest that biology can provide models for artificial minds. It is another to say, as Searle does, that mind is an intrinsically biological phenomenon. Searle's lectures contained hints that he does not really believe that wet protein has magical properties absent from silicon or green slime. However, he was adamant that mind is rooted in the physical structure of the brain. He attacked ai and the whole 'cognitive science' approach, which seeks to understand the mind in terms of the logical structure of brain or computer, rather than its physical implementation.

This was the approach of the English mathematician and computer pioneer Alan Turing, as Andrew Hodges stresses in his biography Alan Turing: The Enigma. Turing produced the first precise logical prediction of a general purpose computer, some years before anyone physically built such a machine. Anyone who attempts to model mental processes with digital electronics of any kind bows to Turing's belief. If it is logical structure that counts, a mind could be based on electronics. If physical implementation is crucial, then we have no reason to suppose that anything other than living neurones can do the job. Even those who work with electronic models of the neurone, like Geoffrey Hinton at Carnegie Mellon University, have broken with Searle and joined Turing. Hinton plans to build a machine made of many small units which are logical models, but not physical models, of the neurone.

Igor Aleksander of Imperial College, London, and his colleagues at Brunel University, are probably the first people in the world to commercialise a bottom-up parallel processing system capable of performing non-trivial tasks. Their Wisard system can learn to recognise a human face in five seconds. It can learn to recognise a class of patterns, given a few well-chosen examples. Wisard's randomly connected single-layer net has led some people to suppose that the people who designed the device do not know how it works. 'We have a complete and developed theory of how this works,' Aleksander explains. 'The only problem about this theory is that it is probabilistic.' But this is not a new problem for science. At the microscopic level, the steam engine and the laser are also based on probabilistic theories. Hinton's group at Carnegie Mellon call its proposed architecture the Boltzmann machine after the scientist who produced a statistical theory of thermodynamics. Aleksander is now seeking ways of grafting knowledge-based programming on to unconventional architectures similar to Wisard. 'There has been this crazy division between top-down and bottom-up approaches,' he says, 'which isn't a correct division anyway, because nobody works entirely top down and nobody works entirely bottom up.'

Boltzmann machines and neural nets with feedback tend to settle down in stable states. Each stable state lies at the bottom of an energy well in the space of all possible states. Training the system creates new energy wells. An energy well can represent a learned concept. Networks of wells, linked by valleys, might represent semantic nets, decision trees or other data structures used in ai intelligence. Such ideas may sound exotic, but with very large scale integrated circuits it may at last be possible to put them to the test. (By Tony Durham in Computing The Magazine, 10 January 1985)

Talking at the speed of Lisp

'The difficulty in all parallel architectures is getting the correct data to the correct place at the correct time,' says Tom Knight of the Massachusetts Institute of Technology (MIT). 'Performing the computation is the easy part.' That is why the highly parallel machine that Knight and his colleagues are designing in the MIT artificial intelligence (ai) laboratory is known as the Connection Machine. The idea for the machine springs from the work of Scott E. Fahlmann in the late 1970s. Fahlmann proposed a system for representing and using what he called 'real-world knowledge' - in other words, an ai database. He also proposed a hardware architecture which would support the ai database. This 'futuristic' architecture was impractical at the time, according to Knight. But after Fahlmann left MIT to go to Carnegie-Mellon University, Knight and Danny Hillis picked up and developed his ideas. They went to companies seeking funds to support the building of the machine. 'IBM never said no, but it never said yes,' Knight recalls. Then came the split. Hillis abandoned the idea of collaborating with IBM, and went in search of venture capital for a start-up company. The academic and commercial versions of the machine are similar in concept but have diverged in matters of detail.

Like earlier, sequential computers designed at MIT, the highly parallel machine is specifically designed to run the Lisp programming language. This does not preclude the use of other languages, since Lisp is regarded as a good language for writing compilers and interpreters for other languages. Any substantial Lisp program calls for the construction of a large data structure. Most, or all of this data structure will consist of what is known as list structure. The basic element of list structure is called a 'cons cell'. It usually occupies one word of memory, and contains two pointers. They point either to further cons cells, or to Lisp 'atoms'. An atom, in Lisp, is a word, a number, or any other data item which is not itself a list. Cons is the Lisp function which adds a new item (which may itself be a list) to the head of a list. Repeated application of the function can build up lists which are very long, or very complex, or both. Cons cells are the forks of the list structure tree; atoms are its leaves. A fair-sized Lisp package such as one of the major Lisp programming environments occupies many millions of cons cells. Future knowledge-based systems may run into the billions.

A conventional computer fetches one word at a time from memory to the central processing unit, examines it and decides what to do with it. Like other database machines, the

Connection Machine is designed to abolish this time-consuming traffic between memory and cpu. The intention is to give every cons cell its own processing power. The machine will have a single instruction, multiple data stream architecture. All processors will execute the same instruction at the same time. This architecture is expected to speed up the process of searching the database for a particular structure.

The plan is to build a prototype machine with 4,000 processor chips. Each chip will contain 64 simple processors. Each processor will have registers for the two forward pointers, and a few local 'Scratchpad' registers. Each processor will also have a register holding a 'back pointer', so that the data structure can be traversed in the reverse directon, from leaf to root. The machine's other key component will be a switching chip which functions something like a telephone exchange. A number of these chips will allow signals to be routed between any processors. The design allows for 3,300 signal paths between processors to be active at any one moment. But with 256,000 processors trying to talk to each other, Knight admits that even 3,300 paths may prove to be too few.

Since communication is known to be the major problem in highly parallel computers, it may be wrong to expect a prototype machine to abolish the communication bottleneck in one fell swoop. Often a new computer design is simulated on an existing computer before any hardware is built. But no attempt has been made to simulate the Connection Machine.

The likely uses of the machine fall into two categories loosely described as 'robotic' and 'cognitive'. A major concern in the robotic area is the control and planning of physical actions, but similar importance is attached to the machine perception of sounds and images. Machine vision systems often operate in two stages. In the first stage, the image is represented by a grid-like array of picture points. Contrast is enhanced, noise is reduced and edges are located, by signal processing operations. Time can be saved by processing many points in parallel. The second stage of processing uses a symbolic representation of the scene, and may bring knowledge-based programming techniques to bear. A typical task is to identify a known three-dimensional object in an unknown orientation.

His machine will support both stages of the vision process. The main routing network will come into play later on, in the symbolic stage of vision processing. To support the early, signal processing stages, there will be additional connections which link the processors into a two-dimensional grid. One processor would be allocated to each picture point, and for signal processing purposes it would only communicate with its immediate neighbours. Work in the 'cognitive' area is likely to focus on ai databases, reasoning by analogy, commonsense reasoning and also language processing. As far as the hardware is concerned, the toughest technical problems evolve around the design and performance of the machine's interconnection network. (Computing, The Magazine, 1 November 1984)

Expert system uses ai for natural sound

Seemingly lost amid the energetic emphasis that research laboratories are placing on speech recognition is the fact that the effort to synthesize attractive, natural-sounding speech from text has been languishing on a plateau for some time. But a team of researchers at the Centre National d'Etudes des Télécommunications (CNET) is putting the finishing touches on a development tool that just might get things moving again. The fruit of their work is an expert system called Synthex, for System Synthesis Expert. It is aimed at using artificial-intelligence techniques to study the problems involved in synthesizing speech from a written text as well as to formalize the resulting knowledge so that it then can be transferred easily to practical applications. Synthex is based on synthesis by diphones. A diphone is a pair of phonemes, which are the smallest significant units of speech. Its basic tool is prosody - manipulations of duration, loudness, and pitch. Instead of the machine-like speech that afficionados of science-fiction films know and love, Synthex can produce oratorical styles that range from normal reading through the kind of intonation typical of a sales pitch. And while CNET is surely not alone in its approach and objective, its specific way of configuring Synthex's operator interface may well be unique.

One of the stumbling blocks retarding the application of expert knowledge to speech recognition has been that experts in phonetics and prosody are not necessarily experts in data processing. To make Synthex available to such specialists, CNET developed a system with which the operator can enter commands in a quasi-natural language - that is, one using a restricted grammar but including in its vocabulary prosody's usual jargon. The operating language takes only a few days to learn, estimates Abderrahmane Aggoun, CNET's data-processing specialist on a Synthex team otherwise made up of linguists. Written in Lislog, a language derived from Lisp and Prolog, Synthex consists of three basic modules: a written-text-to-phonetic converter; a prosody-computation module that calculates the duration, loudness, and pitch of the text to be synthesized; and a command generator to drive the synthesizer. Both the prosody module and command generator depend on a dictionary stored in a data base to provide such spectral parameters as variations from a fundamental frequency, intensity, and rhythm. The operator can add to and vary the dictionary's rules during the course of his effort to produce various styles of synthesized speech.

At a recent demonstration, sentences synthesized by Synthex were of excellent quality and the system generated clear differences in speech styles for a given text. What's more, although commands are currently entered in French, for synthesis the system is language-independent. This makes its appeal far broader than that of a development tool destined for use on a single language. Used as a development tool, Synthex requires a memory capacity of 40 kilowords of 32 bits each, or about 160-K bytes. Using it, however, an operator can develop a command generator of about 20 instructions that requires a negligible amount of memory. This, in turn, can be translated into assembler language to considerably improve upon the one minute that the full version needs to synthesize a 30-phoneme sentence. Synthex currently works on a 16-bit multiuser SM 90 computer, developed in-house before such machines were available on the market and now commonly used throughout CNET. Adapting it to commercial machines should prove to be little problem, according to the firm. - Robert T. Gallagher (Electronics Week, 7 January 1985)

French form research team for artificial intelligence

Intended to become one of the leading research centers in the world in a technology that will become tomorrow the basis of industrial power, an Intelligent Machine Institute (IMI) is now being set up at the INPG (Grenoble National Polytechnic Institute). Covering four disciplines, the IMI will combine long-term research and activities oriented toward the industry. The IMI will employ 150 researchers coming from several INPG laboratories. To date, three laboratories have been installed on part of the 3,500 m^2 allocated to the IMI on the premises of the Grenoble Institute. These are the Research Group on Computer Architecture and VLSI (Very-Large Scale Integration) Design, which will employ some 40 people; the Voice Communication Laboratory (LCP) with 40 researchers; and the LTIRF (Image-Processing and Form-Recognition Laboratory) which would consist of 25 researchers. These teams could start working as scheduled in 1985, when the Institute becomes operational. (Electronique Actualités, in French, 14 September 1984)

Westinghouse Turbine Component Plant, Winston-Salem, North Carolina, USA controls the production process with artificial intelligence. At first the computer will make proposals to the management as to which machines should carry out which processes. This is done on the basis of stored information and knowledge about performance and capacity of individual machines as well as orders for production to be carried out. Decisions are made by the computer according to economic aspects. This is especially important when unexpected interruptions in the production process occur and new decisions have to be taken. The expert system can propose these immediately. The next step will be direct control, i.e. orders given to the machine operator or the machine. The system was developed by Carnegie Group in Pittsburgh Pa. USA. (Breakthrough, 19 September 1984)

MARKET TRENDS

Semiconductor technology, an international commodity

The remarkable sales growth experienced by the semiconductor industry during the past year tended to overshadow the expansion of the worldwide industry. Last year, the semiconductor industry rose to record heights with total sales of $25.5 billion, an increase of approximately 44% over 1983. While the media played up the impressive book-to-bill ratios, there were other equally important events taking place; specifically, the building of new facilities and the expansion of semiconductor fabrication technology.

Both the United States and Japan continue as the dominant centers of manufacturing and technology development, however, the increase in momentum throughout Europe and the movement to increase front-end fabrication in Korea are seen as positive moves toward increasing the role of these centers in the world market. In the past, the companies within the mix of European countries had been content to provide products to serve their own nationalistic programs, and Korea, generally, played the role of specialist in assembly and packaging. This is changing.

England and Scotland in the United Kingdom have made significant progress in building a strong base of multinational companies in electronics and, more specifically, in semiconductors. The government programs, such as the "Invest in Britain" program, have enticed both U.S. and Japanese companies to establish manufacturing facilities. (The incentives the British Government offers to lure companies into the U.K. appear to be quite attractive; for example, development grants of up to 22% toward buildings and equipment, project grants, training grants, advantageous loans, etc.) Continued efforts will be rewarded by additional investments in these two countries and in Wales and Northern Ireland. The multinational companies are targeting Europe as the initial market for their products via their manufacture in the U.K., and EEC-member country. Other European countries such as Spain and Italy are said to be establishing similar programs, although fruition is years away. The companies in Central Europe are strengthening their manufacturing and technology bases through co-operative programs to extend their marketing reach beyond Europe.

On the other side of the world and in the backyard of Japan, Korea is awakening to the glitter of gold in manufacturing semiconductors. While eager to offer technological assistance and to sell processing equipment, Japan is said to be very wary of the prospects of Korea becoming too competitive in the world semiconductor market. Nonetheless, the Korean competitive pressure can be expected to increase not only for Japan, but for other international semiconductor suppliers as well.

There is no question that the semiconductor industry is expanding internationally. New companies bring in new people and new ideas. As these new ideas are evaluated and then implemented in production, the technology of semiconductor manufacturing also will flourish. The growth of knowledge from many different sources and its spread to many different manufacturing centers will truly make the technology of semiconductor manufacturing an international commodity, rather than restrict it to a few high technology oriented countries. (By Donald E. Swanson, Editor, Semiconductor International, January 1985.)

Market prospects for ICs

A number of well-known IC manufacturers have recently announced reductions of one type or another. For instance, Zilog are expected to lay off about 400 of their employees as a result of low orders. National Semiconductor have closed their plant in California for two weeks and are considering a further shut-down period in April. Signetics and Intel may be laying off people in the near future. However, all of these are American companies and perhaps it is worth contrasting the situation with what is currently happening in Japan. Up to the end of 1983 Japanese manufacturers were producing 70 per cent of all 64K DRAMs and by 1984 it was estimated that Hitachi and Toshiba had captured 80 per cent of the world market for 64K COSMOS and SRAM memory chips. Total world market for these chips in 1984 is estimated to be between 30-35 million units. In 1984 Toshiba invested $450 million in semiconductor plant equipment and this figure is expected to increase to $490 million in 1985. The Japanese firmly believe that there will be a significant upturn in the demand for memory products by the end of 1985 and they are already ramping up their production to meet this anticipated demand. This contrasts strongly with the situation in the United States where US semiconductor manufacturers are not investing in new plant and equipment to anything like the same extent as their Japanese counterparts. For example, National Semiconductor's recent announcement that they were not going to go ahead with their 6 inch wafer fabrication line in Scotland typifies the current thinking in the United States. Fujitsu who have a test and final assembly plant in Ireland, invested about 314 million in 1983 and it is anticipated that their total investment for 1984 will have been approximately 500 million. Both Hitachi and NEC are expected to invest over 300 million each in 1984 and most of the other large Japanese IC companies anticipate investments well in excess of 50 million for 1984.

To put this into perspective consider the turnover of some of the "large" IC companies in England. According to figures put out by NEDO (National Economic Development Office) the revenues achieved from IC sales by Ferranti was only $68 million, Plessey $58 million and GEC a mere $23 million. Contrast again these figures with the cost of a modern IC factory which will require an investment of somewhere between £60 and £100 million. Thus summarising the situation, it is obvious that the British cannot afford to go into the IC market in any serious way, the Americans have cold feet and the Japanese are jumping in with both feet. Data Quest estimate that there will be a requirement for an additional 200 wafer fabrication plants by the year 1988. It should be borne in mind that the market is still very much technology driven rather than demand-driven but in time the situation must change. One trend which has become very apparent and is growing in importance is the demand for customised chips. The market for uncommitted logic arrays, gate arrays, standard cell and full customised chips is continually expanding. The European market for these devices is estimated to be growing at around 50 per cent a year which is about twice the rate for ICs total. However, the market is still very small and these chips only account for approximately 5 per cent of all ICs sold. As designers of electronic equipment become more sophisticated and knowledgeable the benefits offered by customised chips are more apparent. Also the advances which have been made in CAD and automated layout have made the task of the designer much easier when specifying customised chips. For example, the logic can be captured in one of three ways. One, using a digitiser to input the logic diagrams. Two, the use of direct net list input and, lastly, by the use of interactive graphics terminals. Once the data has been fed into the syste . the logic design may be simulated to ensure that the proposed IC will operate correctly.

One of the great benefits of application specific chips is that it gives the system designer a unique competitive product. It is also pertinent to point out that many system designers in the States today are in fact being trained to design ICs. However, it should be borne in mind that were it not for the advances in process technology to a point where gate arrays and standard cell equivalents having up to 10,000 gates can be fabricated, all of this would not have been possible in a realistic sense. According to figures put out by the Integrated Circuit Engineering Corporation the total worldwide market for non-standard Integrated Circuits in 1984 was worth approximately $1.6 billion. It is anticipated that by 1990 this figure will have increased to $7.7 billion giving an annual compound growth rate of 31 per cent. One of the more spectacular growth areas is likely to be MOS gate arrays which will increase from $153 million in 1983 to just over $1 billion in 1989 which represents 38 per cent annual compound growth rate. Standard cell designs which in 1983 only represented $43 million in revenue are likely to climb to $1.2 billion by 1989 which represents an annual compound growth rate of 72 per cent. One of the factors underlying these rapid growth rates is the technology evolution which is likely to see the number of active elements per chip increasing from the NSI range to large scale integration with densities of more than 100,000 devices on a chip.

Within the next five years it is likely that the Integrated Circuit industry will implement ultra large-scale integration (ULSI) which will result in standard chips containing 1 million devices. As a result of design processes having been considerably simplified the lead-time required to develop to customised chips has been reduced significantly and it is anticipated that by 1990 the time involved will be reduced even further despite the increase in complexity. The dominant technology by 1986 will be CMOS silicon-gate technology using geometries using one-microsymbol. Increased system complexity in the future will be accommodated for the use of a greater number of pins. These changes combined with the strong growth in application specific Integrated Circuits will mean a major shift for both the semiconductor industry and its customers. Indeed there will be a closer level of operation between customers and IC manufacturers which in the long term is likely to lead to a more stable industry which will ultimately be market-driven rather than technology-driven.

The largest manufacturer of ICs in the United States is of course Texas Instruments who will probably have a turnover of approximately $2.23 billion in 1984. Number 2 is Motorola with a likely turnover of approximately $1.6 billion followed by National and Intel both of which have turnovers in the region of $1.2 billion. Advanced Micro Devices, who will be setting up a factory in Greystones, are likely to have a turnover of approximately $890 million in 1984 and Mostek who are the eighth largest in the States are predicted to have a turnover of $430 million. It is interesting to note that the growth rate for the top ten in the United States' Integrated Circuits producers was projected to average slightly over 50 per cent for the year 1983-1984. The highest growth rate was expected from AMD whose growth rate was projected to be 82 per cent. It is also interesting to note that AMD is one of the few American companies who are not talking about laying off employees or cutting back on production. (By N. Williams, Electronics Report [Ireland], February 1985.)

Estimated 1984 Worldwide Top-10 Semiconductor Companies

Rank	Company	Est. 1984 Total Semiconductor Production (Millions of dollars)	Location
1	Texas Instruments Inc.	2 350	U.S.
2	Motorola Inc.	2 255	U.S.
3	NEC Corp.	1 985	Japan
4	Hitachi Ltd.	1 690	Japan
5	Toshiba Corp.	1 460	Japan
6	National Semiconductor Corp.	1 270	U.S.
7	Intel Corp.	1 170	U.S.
8	Philips*	1 150	Europe
9	Advanced Micro Devices Inc.	935	U.S.
10	Fujitsu Ltd.	815	Japan

* Including Signetics Corp. Source: Integrated Circuit Engineering Corp. (Electronics Week, 1 January 1985.)

Half of IC usage by 1988 will be custom

A new report estimates that by 1988, more than 50% of all IC usage will consist of some form of full custom and semicustom ICs. The report also forecasts that 68% of full custom and semicustom circuits designed by 1988 will use gate arrays and standard cells.

According to "Customizing VLSI Integrated Circuits," due to competitive pressures to reduce system size, cost, and to improve performance, design emphasis has turned to the customization of VLSI circuits and subsystems. The 320-page report from Electronic Trend Publications also notes that full customs will become less and less a factor in new designs, in favor of semicustom. The study is available from Electronic Trend Publications, 10080 N. Wolfe Rd., Cupertino, Calif. 95014. RI (Semiconductor International, January 1985.)

Semi-custom ICs: poised for growth

Semi-custom IC technology has been heralded as the most important recent development in electronics. But although gate arrays and standard-cell based techniques and products have been available for several years, their use is still very limited. For example, a recent study of US designers conducted by EDN Magazine reveals that only 34 per cent of all engineers are currently involved with the design of custom or semi-custom ICs. Correlation with data about the number of designs actually completed this year suggests that only a small portion of these designers - perhaps as few as 3.5 per cent of all designers - are actually directly involved in custom or semi-custom IC design. If increased access to silicon truly promises to add dramatically to the effectiveness with which electronic systems can be designed, and if more than 100 vendors worldwide offer gate-arrays, standard-cell libraries, and foundry services, then why are so few designers using semi-custom chips? Clearly the reason lies in the fact that semi-custom IC technology has only begun to shed its image as a high-risk, expensive, hard-to-learn component of the engineering toolbox. As it sheds that image, however, the industry is poised for explosive growth, and monumental changes.

Growth in the semi-custom IC industry has been rapid over the past few years, despite the reluctance of most designers to begin IC-design activity. Industry revenues from merchant-market gate-array and standard-cell design fees and chip sales grew 67 per cent between 1982 and 1983, from US$ 180m to nearly US$ 300m. The Technology Research Group estimates that this year's revenues will top last year's by 113 per cent, reaching nearly US$ 640m. Revenues next year could reach US$ 1.2bn. But rather than reflecting a rapidly increasing base of semi-custom IC users, this growth stems from initial production of chips designed during 1982 and 1983. In 1982, for example, 70 per cent of the semi-custom IC industry's revenues came from design activity. Sophisticated designers realised the potential of newly economical gate-array technologies and began to develop prototype systems. By 1984, most of the 1982 designs and many of the 1983 designs destined for eventual production have begun to contribute significant production revenues to the semi-custom industry.

The Technology Research Group estimates that this year, design fees and sales of vendor-specific design systems will account for less than 40 per cent of overall semi-custom industry revenues; the production of nearly 2,000 designs accounts for the remainder. In addition, those designers active in semi-custom IC design are developing more semi-custom chips. The 1984 EDN study showed that the average number of chips in design within companies already using gate arrays and standard cells grew 44 per cent between 1983 and 1984. Thus, even if no new designers become involved in semi-custom technology, the industry could sustain healthy growth over the next few years. But new designers will become involved with semi-custom technology, contributing to growth over the next few years that's likely to surpass all but the most optimistic projections. Of designers polled in the 1984 EDN study, nearly 60 per cent indicated that they expect to use semi-custom chips by 1986. Thus, the technology will begin to infiltrate the mainstream of system designs.

This surge in acceptance of semi-custom technology will result from several factors. First, semi-custom technology is beginning to show signs of maturity. Most large semi-conductor companies have admitted the long-term importance of semi-custom ICs, promoting increased user awareness and increasing confidence in decisions to use gate arrays and standard cells. The second factor contributing to the mainstream penetration of semi-custom ICs is the perception of reduced risk. Semi-custom chips have historically carried a burden of expensive and lengthy development, prone to delays and failures. But users who once reported the need for several prototype iterations before the delivery of working chips are now reporting first-time success for most designs. Increasingly stable fabrication processes and improving modelling methods contribute to growth in first-time success rates by allowing increasingly accurate simulations. In addition, most serious semi-custom vendors now offer their customers local design support. This support not only provides users with access to the proper tools for chip design, but also furnishes assurances that inevitable design problems can be solved quickly and effectively. Most important to semi-custom IC penetration, though, is the fact that non-users are now faced with the task of designing products to compete with those of users. In the personal-computer industry, for example, it's no longer possible to develop a competitive product without using some form of custom or semi-custom device. Price and functionality constraints have made the chips imperative. The same situation now holds for several types of computer peripherals and communications systems, and it promises to develop quickly in areas of instrumentation, consumer electronics, and industrial control systems. Therefore, even designers and managers who, on a technical level, are reluctant to engage in chip design will be forced by marketing considerations to use semi-custom devices.

The Technology Research Group predicts that by 1988, the use of some form of semi-custom IC will be required by marketplace considerations in the production of all new electronic systems. A rapidly expanding base of new designers will fuel growth in the semi-custom IC industry, but it will also cause change. Designers who became involved with semi-custom technologies early in the industry's development did so because of severe technical neds. In most cases, the risk associated with semi-custom chip use was justified only in light of extreme performance or packaging-density requirements. Thus, early growth of the gate-array industry centred around ECL processes and high-density, easily produced bipolar processes such as CML and STL. But new semi-custom users have speed requirements that are less severe than those of early users. And as speed requirements abate, requirements for low power consumption become increasingly important.

Decreased emphasis on operating speeds, coupled with the immediate speed improvements that use of semi-custom chips offer over standard ICs will contribute to high process stability as the semi-custom industry grows over the next several years. Currently producible 2um to 3um CMOS processes satisfy easily most requirements for CMOS semi-custom chips and will continue to do so over the next four years. CMOS processes involving 2um to 3um gates currently account for approximately 55 per cent of all production revenues from CMOS semi-custom chips. By 1987, the Technology Research Group estimates that 2um to 3um processes will contribute to nearly 80 per cent of all CMOS semi-custom production dollars, or 64 per cent of the production revenues from all semi-custom chips. By that time, sub-2um processes will have only begun to contribute significantly to CMOS production revenues, accounting for less than 5 per cent of the total. Indeed, as the number of semi-custom chips in production increases rapidly, the need for a standardised process will become acute. As the impetus for semi-custom chip use shifts away from issues of speed and toward concerns of economy, mature, easily producible processes will become most attractive. These processes not only allow the production of the most cost-effective silicon, but, through standardisation, they also facilitate second-sourcing.

Although feature sizes will stabilise somewhat over the next several years, metallisation rules will not. In most CMOS semi-custom chips, ultimate area is now determined by metal pitch, as well as by gate lengths. Thus, as diffusion characteristics stabilise, continued improvements in metallisation methods will contribute to decreasing chip areas. Most important, the trend toward double-metal technologies will hasten. Not only does double-level-metal allow denser chips, but it also contributes to higher operating speeds, enhanced circuit routability and more easily predicted chip-timing. Trends toward double-metal processes might alleviate some layout and timing problems but they will only exacerbate one significant production problem: mask shortages. As semi-custom technology moves into the mainstream, production and prototyping requirements will demand an enormous number of process masks.

Consider, for example, the standard-cell market. The Technology Research Group predicts that, in 1987, 15,000 standard-cell based chips will be designed worldwide and 4,700 will be in production. A 10 per cent market share, therefore demands the production of 1,500 prototype and 470 production designs. Assuming an average of 12 masks per design, this level translates to a requirement for the production of 18,000 new masks and the management of 5,600 existing masks. Industry-wide, as many as 300,000 masks could be required in 1987 to accommodate all semi-custom chips.

This requirement presents both opportunity and concern. Opportunity is created for those vendors that can find ways to manage the production of large numbers of designs and that can secure sources for needed masks. Concern arises for those vendors that can't.

Success will come to those vendors that provide effective external design automation - the tools and programmes geared toward successfully transferring design responsibility to customers. However, vendors of semi-custom chips cannot count on CAE workstations to help fill all external design-automation needs. Vendors that augment workstation software with access to mainframe-based design tools and personal-computer-based data-entry systems prepare themselves to address a much larger segment of the semi-custom market than do vendors that restrict their support to CAE workstations. More important, as new designers become involved with semi-custom IC development, the average experience of chip designers will remain low. Although current users are designing semi-custom chips in greater numbers, first-time designers will continue to account for a significant percentage of the semi-custom market. This year, 34 per cent of all semi-custom designs were undertaken by designers with no prior semi-custom design experience. By 1987, this figure will fall to no less than 15 per cent. Thus, there will remain a need for design centres and services geared to help first-time designers learn the vagaries of chip design. In addition, as design methodologies evolve, there will remain a constant need for services aimed at training and supporting designers. (Andrew Rappaport, Technology Research Group, USA, in Electronics Weekly, 20 February 1985.)

CUSTOM MICROELECTRONICS

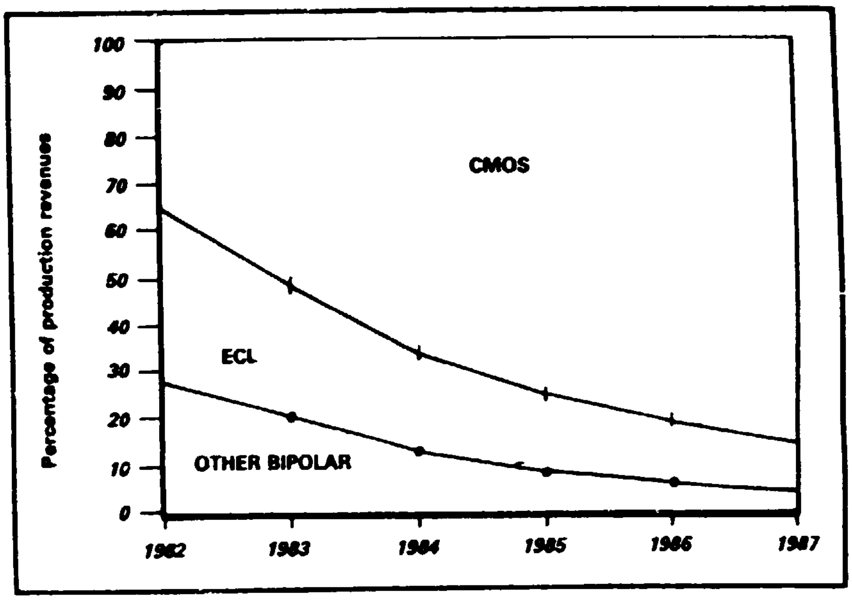


Fig 1 Shares of semi-custom production.

SC design centre for Toshiba

Toshiba Corporation is to construct a 14-storey electronics engineering centre in Kawasaki City near Tokyo to speed up the creation of new semiconductor devices and other electronic components. It will also offer customers computer-aided design (CAD) systems and other equipment and space, as well as engineering support, to help them design and evaluate their original chips. The centre, construction of which will start this June and end in December 1986, will cost approximately Y20bn (US$ 80m). It will have a floor area of 50,000 square meters and house some 2,300 Toshiba engineers and staff members. The new centre will have two main functions:

(1) An integrated designing facility for commercial products. (Standard LSIs for general-purpose use, such as memories, logic ICs and microcomputers.) Engineers can utilise a state-of-the-art computer-aided design (CAD) system and an LSI evaluation and data processing system, all connected by a local area network (LAN), thus shortening the development timeframe and improving efficiency in designing various types of LSIs.

(2) A custom products development centre.

The trend in the semiconductor industry is that, to meet the increasing diversity of chip-using electronic equipment, a rising number of custom or semicustom devices, such as gate arrays, are required. Customised products call for frequent contacts and agreements with users on technical arrangements.

To meet this demand trend, the new building will function as a design centre for such custom or semi-custom chips. It will house: customer design rooms, where client personnel can independently (or together with Toshiba engineers) operate terminals to design devices for their own use; customer experiment rooms, in which clients examine circuits to assure that they have the appropriate attributes; and customer training rooms, where seminars will be given for present and potential customers. (in Electronics Week, 6 March 1985)

Fuelling the ASIC explosion

The industry shift towards customised semiconductor technology will have as profound and significant an impact on the world electronic industries as did the microprocessor revolution that occurred in the 1970s. And yet, despite the fact that custom ICs have been widely available commercially for over 15 years now, it is only recently that their impact is being felt. This impact, we believe will not really be fully appreciated until the end of this decade. ... Today the typical installed base of personal business computers contains 256Kbytes of DRAM, 40Kbytes of ROM as well as the processor chips and other standard logic. (Incidentally, it offers 20 times the performance of an IBM 360 at 1.4 per cent of the cost.) In total, it contains some 200 ICs. A latest state-of-the-art machine using technology already in production today, incorporating ICs of the type that are readily available today, would reduce this chip count to 18 VLSI ICs. On the other hand, if you were to build a machine with 200 VLSI chips, (that is, keep the chip count constant and increase the complexity) you would end up with a desk top machine that would have the logic equivalent of between three to five Cray computers. And that is a technical reality today. A single chip VAX 11/780 is a practical reality. Just what you could do with 200 state-of-the-art VLSI chips, nobody really knows.

With all this capability, the entire electronics industry faces an enigma. On one hand, the present VLSI capability of today gives us unparalleled power to build complex, high performance devices. On the other, the traditional design techniques that have been satisfactory for the last decade have now become ineffective for VLSI. The VLSI circuits are becoming as complex as the systems they replace. And since few systems of this complexity have been built, the standards do not exist at the system level that can be converted to standards at the chip level. In other words, the ability to put transistors on a chip has outpaced the ability to use them. Beyond the obvious memory products and complex CPU, it is becoming more and more difficult to define standard devices with sufficient universal appeal - in short the semiconductor industry has run out of things to copy - the age of substitution is over, creativity is in.

As IC complexity increases, obviously so the systems made from them will be more complex as well. It becomes more and more difficult to incorporate these products into new equipment designs - the so called "applications gap". It is becoming increasingly apparent that the key to the future growth of the world semiconductor market is applications growth - and yet complexity makes applications more difficult.

We at Dataquest firmly believe that there is no fundamental lack of applications. It is not a lack of applications that will be the pacing item - merely a lack of creativity. And this is really where we are today. It is what I choose to call the VLSI complexity crisis. You can look at this in two ways. For example, given today's technology (i.e. the ability to put a million transistors onto a single piece of silicon) what can we define at this level that is meaningful? Or conversely, what does it take in order to utilise what is becoming ever more possible?

The answer lies with ASICs. The term ASIC is used to cover all ICs that are customisable to meet a particular application and it includes gate arrays, standard cells, full custom circuits, and programmable logic arrays, see Figure 2. By the end of this decade, in excess of 23 per cent of the then US$ 85bn world IC consumption will be in ASICs. Currently ASICs account for less than 16 per cent of the total IC consumption. The captive manufacturers, that is those companies whose total IC production is consumed within their own organisations, for example, IBM, currently account for over half of the total ASIC consumption. This is expected to reduce substantially as the traditional merchant IC suppliers become more active in this market area. From a technology point of view, CMOS is seen as the dominant technology, more specifically, a sub-2 micron, double-layer metal, CMOS silicon gate technology will predominate. Bipolar processing will still account for around 20 per cent of the dollar revenues but will be used exclusively for either very fast systems, for example sub-1ns gate delay ECL systems, or applications which can invoke fully integrated "systems-on-a-chip" solutions and where a substantial degree of non-digital functions and interface to high power devices is required.

Figure 3 shows the relative world market ASIC consumption in billions of dollars for 1983 through 1989. The share of full custom ICs will decline from 61 per cent today to around 46 per cent. Standard cell ICs will increase from the present 3 per cent share to 14 per cent. The share already occupied by gate arrays and programmable logic arrays will change only very slightly from 30 per cent to 32 per cent and from 6 per cent to 7 per cent respectively. It is the substantial advances that are currently being made in CAD for ICs that is fueling the growth of standard cell ICs. PALs have emerged as a major force in recent years and offer a very low (design) cost solution to custom ICs. This will continue to remain a significant factor especially as recent technological improvements now make large logic arrays feasible and with the further promise of CMOS versions in the future.

A review of the market forces currently at work reveals the following. From an electronic equipment point of view, the users are being more and more forced to shorter design cycles (time to market), shorter equipment product life cycles, better security of design, lower manufacturing cost, lower power consumption (especially for portable systems), better system reliability, and the ability to add low cost incremental features. At the same time, there has been a universal acceptance of powerful and inexpensive microprocessors, a substantial improvement in IC CAD, an increased sophistication of the semiconductor user community, an acceptance and "coming-of-age" of CMOS VLSI, and a high focus of new start-up companies in ASICs. Since 1977, the number of semiconductor start-ups has increased dramatically - something approaching 50 per cent of these start-ups are firms offering some kind of applications specific integrated circuits. All these factors have served to fuel the ASIC explosion.

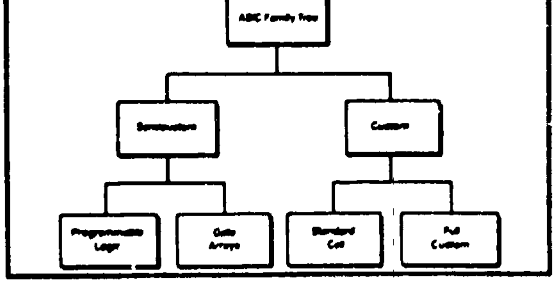
The integrated circuit content of systems has been increasing rapidly in the past decade and we forecast that it will continue to increase rapidly. Figure 4 shows our estimates of integrated circuit content as a percentage of sales. Many companies are in the 5 to 7 per cent range today. The content is expected to increase in the future. Integrated circuit content is a measure of the degree to which VLSI has been applied to the system problem. The higher the integrated circuit content, the lower the total system cost is likely to be. Therefore, for the systems company, the race is to integrate its requirement as fast as possible so that costs can be reduced. Converting designs to VLSI is much more important than getting the best price on old components. Those companies that survive in the future will have the highest rate of design conversion.

Clearly, someone is going to have to design all these circuits, and we at Dataquest believe that the engineers will have to come from the band of TTL designers that currently work for systems companies. There are at best 2,500 experienced IC designers in the world today. At the same time, there are at least 200,000 systems engineers who are potential IC designers. The succesful electronics companies of tomorrow will be those companies who successfully integrate the system design with silicon and thereby exploit the advantages of VLSI.

And that is where the emerging design centres will fulfill that role. These design centres provide the means to integrate the system engineer to silicon. They will be the catalyst that translates creativity into silicon - and thereby silicon into successful products. The future trends are heading towards combined gate array and standard cell structures. The current distinction will blur as gate arrays merge with standard cells and vice versa. The trend towards microprocessor, microcontroller, and microperipheral functions along with ALUs, logic arrays, static RAM, ROM, and Register functions will accelerate. There will be an increasing proliferation of mixed linear and digital functions on-chip, software data sheets will predominate and a much higher degree of industrial standardisation will be achieved at all levels of ASIC activity.

As an indication of the latter, the Electronic Design Interchange Format (EDIF) is the first industry-wide attempt for an ASIC interface standard. This standard is aimed to provide a common format for interface between the design community, the semiconductor manufacturers, the IC design workstation manufacturers, and the system hardware and software vendors. The overall objectives are to eliminate IC development duplication and redundant interfaces, improve communication and allow access of the IC user community to several appropriate IC manufacturers. The VLSI component choice profoundly affects the manufacturability, performance, quality, and cost of the resultant and equipment. Early control of the selection process will result in reliable products that can be manufactured at target costs. ASICs will play an increasingly important role in this question. It will be impossible for an advanced industrial society to exist without a sound manufacturing base in the advanced electronics industries. Early exploitation of the advantages and capabilities offered by the ASIC solution will play a substantial role in securing this position. (By Malcolm Penn, vice-president of Dataquest UK, in Electronics Weekly, 20 February 1985.)

Fig 2: ASIC family tree. (*Source*: Dataquest).



CUSTOM MICROELECTRONICS

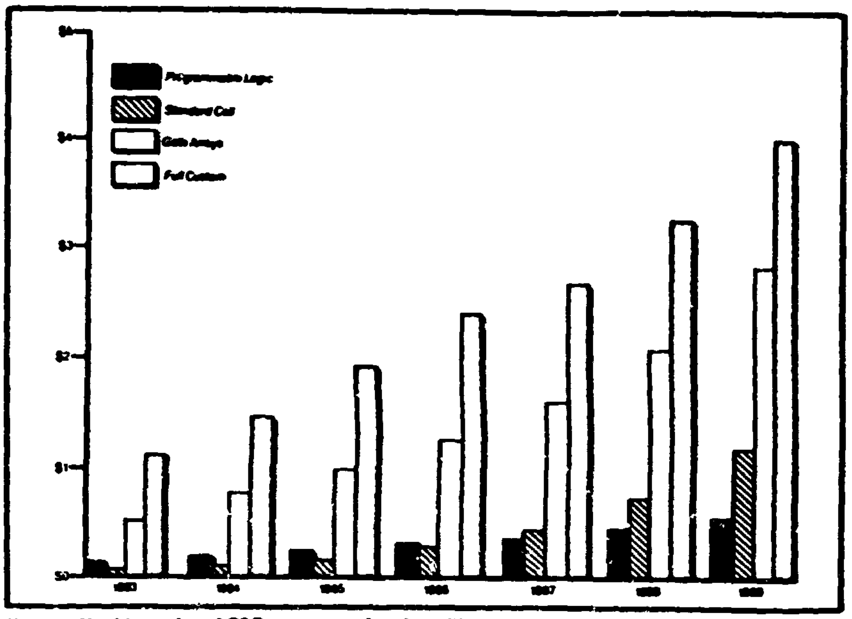
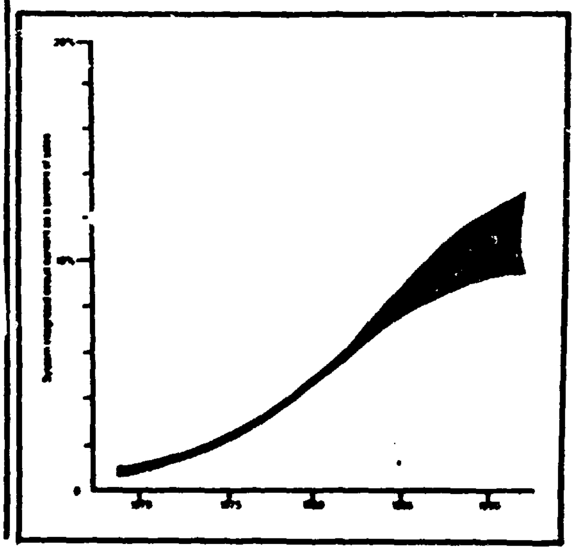


Fig 3: World market ASIC consumption in billions of dollars. (*Source:* Dataquest).

Fig 4: Estimates of IC content as a percentage of sales. (*Source:* Dataquest).



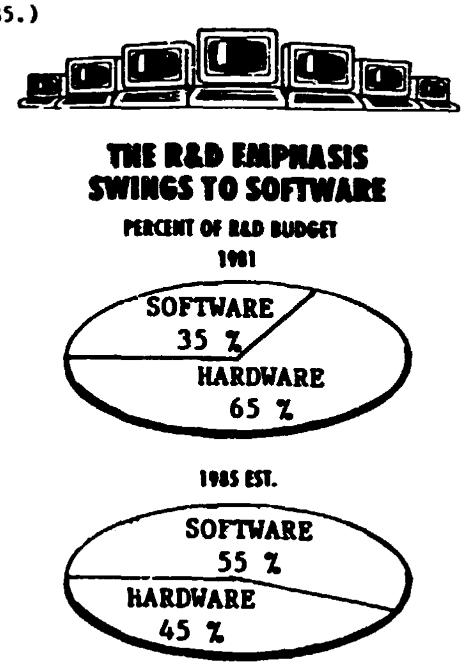
Computer makers plug into the customer

Marketing will be the name of the game in the $300 billion information processing industry in 1985. Ready availability of inexpensive components has created an age of "me-too" hardware in everything from mainframes to personal computers. Both startup companies and highfliers have tried - and failed - to differentiate their products technologically. Now some are abandoning hardware manufacturing and buying basic machines from competitors for resale.

These days, computer manufacturers try to personalize their products mainly after they reach the market, with so-called applications software - the programs that enable users to do specific computer tasks.

Computer companies once sold just hardware. Their customers or third parties wrote the applications software. Now clients want the vendors to do both. A company's ability to respond to such demands may determine whether it survives, and the research and development budgets of the top minicomputer and mainframe makers seem to reflect this (Figure 5). ... (in Business Week, 14 January 1985.)

Figure 5



DATA: PAINEWEBBER INC., FROM SPENDING OF FOUR OF THE LARGEST MAINFRAME COMPUTER MAKERS AND THREE OF THE LARGEST MINICOMPUTER COMPANIES

Comparing power ICs

Today, solid-state power switches are discrete devices that mount on circuit boards together with control logic. But indications are that the discrete solid-state switch may be supplanted by a new breed of power integrated circuit (PIC) in many applications. This component combines high-power solid state switches on the same silicon chip with the logic circuits that control it. The arrangement provides more reliable voltage, current, and temperature protection for power switches. And some PICs contain enough built-in intelligence to send and receive data over transmission lines. Techniques emerging from laboratories now make possible an increasingly large array of new PICs. The automotive industry is the primary driving force behind the burgeoning technology, but other industries will likely reap equal benefits. Power ICs, for example, may allow the multitude of loads in an automobile to be powered from a single bus, and to be turned on and off with coded signals from a central microprocessor. But PICs also promise to revolutionize the design of motors, controls, and the distribution of electricity in homes, offices, and factories. A wide variety of techniques are becoming available for fabricating PICs. Some are based on bipolar processes, others on MOS.

Mosfets vs bipolars in PICs

Comparisons of MOSFETS and bipolars are generally straight-forward where both are discrete components. But the differences are not as readily apparent when the components are on PICs. Discrete power MOSFETs, for example, generally switch on and off faster and exhibit better safe operating areas than corresponding discrete bipolars. One reason is that discrete MOSFET fabrication use 5 to 7-micron photolithography; discrete bipolars use 25 micron. But in PICs, the fine rules apply to both, minimizing the differences in speed and safe operating area.

Power MOSFETs in PICs generally require less drive power than corresponding bipolars because of their high-impedance gate. MOSFETs, however, require large voltage swings from full off to full on, a result of transconductance that is one or two orders of magnitude lower than in bipolars. The swing is sometimes not compatible with IC control circuitry. And when switching at high frequency, slew rates sometimes exceed the capability of IC drive circuits. Appreciable drive power is required, moreover at high frequency, a result of a high gate-to-drain capacitance. Drive power requirements for bipolars sometimes exceeds 10% of the total power dissipated in the device. Darlington configurations require less drive power, but have higher on-resistance. Thus the configuration generally is used only for high-voltage devices. For 50 to 100-V devices, MOSFET on-resistance approximately equals that of bipolars. But for higher voltages, bipolar on-resistance is appreciably lower.

MOSFET on-resistance increases with rising temperature but decreases for bipolars. The negative coefficient for bipolars sometimes leads to device failure. The characteristic can be offset with suitable protective circuitry, but the price is complexity and cost. But the most recently built chips combine these and other techniques. A single PIC now can contain small-signal and power bipolars, DMOS, CMOS, and high-voltage CMOS components, power MOSFETs, SCRs, and triacs. Both vertical and lateral power structures can be used. Components in some cases are self isolated, junction or oxide isolated in others. Ratings up to 20 A at over 400 V are feasible. The choice of components, structures, and isolation depends on application requirements. ... (Excerpted from Machine Design, February 21, 1985.)

Inmos a success, says chip guru

Jack Kilby, who patented the first chip and thereby started this industry, told Electronics Weekly at the International Solid-State Circuits Conference in New York that the UK has had a great success with Inmos and that other companies who want to get back into the mainstream chip business via some hoped for future opportunity provided by a major change in technology, are waiting in vain. "General Electronic (of the US) and Westinghouse", said Kilby, "both have very large programmes going in gallium arsenide. That's not a strategy that's going to work in the sense that they'll regain the position they would have had if they'd stayed in the silicon business. People search for a universal replacement (for silicon)", said Kilby. "But it's not likely to happen. Josephson Junctions aren't going to get very far; the use of organic substances in molecular computers is not something I can take very seriously." The right strategy for the UK chip companies is, says Kilby, to "watch for chances". He explains: "Hopefully, in this watching process, they'll see the niches and small areas where there's a need and where they can compete. Ferranti has done this with gate arrays."

Kilby believes that it is unfair to judge Inmos by the criterion that it does not supply much of the UK requirement for chips. "No country", he said, "can expect to set up an IC industry nowadays that will supply all of its needs." The goal of self-sufficiency is not attainable. There was a time when that was possible. Not now. Even Japan is not trying to do that." If what Kilby calls "unrealistic expectations" are discarded, then, he said, "you have to consider Inmos a success and a useful contribution to the British technology base." Asked to be specific about the nature of that contribution, Kilby said: "It's rather taken for granted, I guess, that to be a modern industrial country you must have a domestic semiconductor manufacturing capability. That isn't very well reasoned, just taken for granted. Most countries think it's desirable not because they're going to become self-sufficient in this day and age, but because if they're doing good work that provides knowledge and insight to people within the country. It works out in a very indirect fashion. I think it would be wrong to expect more of Inmos than that."

Asked why the Koreans had such a different strategy to the UK, Kilby said: "That's gambler's money, and lots of it. I don't suppose any US or British or German company has taken a chance on that scale ever." The Korean chip industry is "being built as an export industry", said Kilby. The reason why it was possible to pursue such a chancey strategy in Korea, while it would not be possible in other countries was, he said, because "far East investors take a very different view of markets and the risks they're prepared to take". However, an exception to that rule is seen by Kilby in the Philips/Siemens collaboration which represents, he reckons, "that urge for countries to acquire self-sufficiency." That urge is evidenced by the strategy to manufacture RAMs. "RAMs are a good technology vehicle," said Kilby. "They are the price-leaders and they use the newest processes, and there are other things you can do with those same techniques. If you're looking for self-sufficiency, then RAMs has to be the first thing."

In the US chip industry, Kilby does not expect to see structural change. The established companies will continue to co-exist with start-ups because the former recognise the contribution to innovation in chip technology made by the latter. However, he questions the assumption that start-ups were necessarily the best vehicle for promoting innovation. "In order to get their money", said Kilby, "start-ups have to accept a more rigid structure than any of the established companies. And you could wonder whether it's better to have an under-funded company down the street or whether those people would have done a better job staying at, say, Intel." (in Electronics Weekly, February 27, 1985)

Training in the semiconductor industry

There are many forms of training available today including in-house instruction, training by consultants, college and junior college instruction and combinations that make use of more than one option. Large companies - by necessity - are the pathfinders in technical training today. Most major user and equipment firms have earmarked significant parts of their budgets to handle instructional tasks.

Equipment vendors with major commitment to training are exemplified by Varian Associates, headquartered in Palo Alto, Calif. Last year, Varian opened a multimillion dollar training center at its Extrion Div. in Gloucester, Mass. The center is designed to offer instruction for ion implanter operators, maintenance personnel and Varian service representatives.

Varian, which claims to be the world's largest maker of both serial and batch process ion implanters, trained more than 1,000 students from throughout the U.S., Europe and Asia during its first eight months of operation. "The center," according to Kenneth Cooper, training manager, "is one of the largest training facilities of its kind in the U.S. It includes four classrooms, two laboratory areas, a machine bay and administrative offices." Several Varian ion implanters are located in the facility and are dedicated to training uses.

A selection of two-week courses emphasizes advanced level trouble-shooting and repair of the firm's implanters and wafer handling systems. Other courses given at the center carry advanced course requirements for training of service and factory personnel. (Excerpted from an article in Semiconductor International, January 1985. Reprinted with permission from Semiconductor International Magazine, copyright 1985 by Cahners Publishing Co., Des Plaines, Il. USA.)

APPLICATIONS

Synthesizing chemicals by computer

... In theory, organic synthesis is straightforward. Organic chemists seek to convert about a dozen or so simple compounds, most derived from petroleum, into a myriad of final products using a veritable catalogue of chemical reactions. Just about any compound that chemists can imagine can be synthesized if supplies of starting material are available. However, the final product must be built up stepwise in a sequence of reactions, a process that can be lengthy and laborious. But the real problem is that scientists can envision a vast number of such reaction sequences, so choosing which is best is difficult. The secret of commercially successful, and intellectually satisfying, synthesis is to find the most economical and elegant reaction sequence. That means discerning the one that produces the maximum amount of the desired product in the fewest steps, and starting with the least expensive materials. Even then, finding how best to synthesize a certain compound is no guarantee of success. Often scientists must synthesize 10,000 substances, each the product of much time and effort, before coming up with a single pharmaceutical tailored for safe, effective medical use.

Can the process of creating useful new synthetics be simplified? The basic ingredient of the problem - the necessity of choosing from among a huge number of reactions and reaction sequences that might lead to the goal - points unerringly to computerization. What computers do best is to select the best options from among many alternatives much faster than humans can. In fact, researchers have been developing computer programs for synthesizing organic chemicals for a decade and a half. These rudimentary efforts are now beginning to jell into the prospect of fast, convenient routes to completely new chemical compounds. (American Scientist)

Computers to help blind chemists

Workers at East Carolina University in the US have devised a method of enabling blind scientists to identify chemical compounds from the noise they make. Robert Morrison, professor of theoretical chemistry, and David Lunney, professor of physical chemistry, have built a computer system which turns a scan from an infra red spectrometer into a series of musical notes. These are played back together to form an identifying chord. Signals from a spectrometer are relayed to a microcomputer. The machine converts the peaks of the scan into one of 96 notes in an eight octave chromatic scale. The length of time that a note is held corresponds to the intensity of the reading from the spectrometer. The notes are played back to the scientist through a synthesiser. So that a scientist can get a clearer picture of the shape of the scan, it is played back in three different ways. First, the synthesiser plays the high notes followed by the low notes, which correspond with the highest frequencies on the scan. Next this process is repeated with the shortest or least intense notes first followed by the longer ones. Finally, the notes are played together to give a chord or discord. It is this last stage which enables a scientist to identify the compound. The sound can be compare with chords already stored in the computer.

East Carolina's chemistry department has also developed a second micro-computer-based system to help blind chemists control and take readings from experiments. Signals from a wide range of instruments are fed into a small computer equipped with a voice synthesising board. Instrument readings are converted into a series of tones or spoken figures. The US Department of Education has commissioned East Carolina University to produce a commercial version of the system for production this year. The talking computer could be produced for between $5,000 and $8,000 says Morrison. "We developed it for blind undergraduates who wanted a career in science; the equipment could be used in engineering, physics and biology laboratories as well as in chemistry ones," says Morrison.

German researchers at the Stuttgart University's Institute of Informatics are working on a project to enable blind people to "see" information contained in videotex or viewdata pictures. Although text can be translated into braille through a small pad of moving pins which are felt by a blind person, graphics and colour are more difficult. Dr. Waltraud Schweikhardt at the Institute of Informatics has developed a method of transmitting this information to the blind through a series of thin cards on which a relief image is formed. A specially adapted printer first embosses the outline of the image on one card, followed by each of the colours on separate pieces of cardboard. Yellow, for example, is represented by the braille sign for Y and so on. The institute is now working on a system which employs a pad of moving pins similar to the one used for text. (This first appeared in New Scientist, London, 31 January 1985, the weekly review of science and technology.)

Microprocessors aid on-site analysis of coal

If the Coal Board or its customers want to monitor coal quality, samples are sent to laboratories for analysis. But with the development of microprocessors linked to analytic equipment scientist will be able to monitor coal quality on site in either the mine or the power station. One of the new instruments beams neutrons at coal. The beams stimulate sulphur in the coal to produce gamma rays of a particular frequency. A receiver tuned to this frequency detects the signal, and the microprocessor works out the concentration of sulphur from the intensity of the signal. Another instrument beams gamma rays through the waste and coal in coal-washing plants. The gamma rays are absorbed by solids, so the proportion of radiation that is absorbed indicates what the content of solids is. To measure the degree of non inorganic wastes, X-rays are shone from a third instrument, and the degree of absorption by aluminium in the waste is measured. Between them these two techniques show how much coal is thrown away in the washing process, and how much waste is left in the washed coal. A fourth instrument measures the quality of the final product. It uses neutron beams to stimulate iron, aluminium, silicon, sulphur and other elements to produce gamma rays. The proportion of the various elements present can be measured by analysing the frequency and intensity of the reflected signal. The instruments are being developed by the Nuclear Applications Centre in Harwell, Britain. BP is funding part of the work. (This first appeared in New Scientist, London, 28 March 1985, the weekly review of science and technology.)

Surgery by computer

Surgeons could soon be rehearsing their operations on three-dimensional, computer-graphic models. The surgeon will be able to manipulate a model of part of the body and view into it from all directions. At the same time, the surgeon could make experimental cuts on the model to find the ideal place for an incision. Once the surgeon makes an incision, the image on the screen splits in two. At the same time two further images appear, showing the surgeon what lies on either side of the cut; that is, perpendicular to the plane of the surface incised. Manipulation of the three-dimensional model is possible only because of a clever way of encoding and searching data. Solid models are made up from a number of shapes. The shapes contain data that describe tissue in the body, and the position of the shape in the model corresponds to the position of the tissue in the body. The method is fine for producing images of the surface of a 3D image. To "see" something inside the model means that these shapes must be disentangled from each other. This would be possible if the computer carried out mathematical operations to work out how one shape relates to every other shape. However, the process would take too long and be of no practical use.

Donald Meacher of Phoenix Data Systems in Albany, New York has developed a new method of encoding 3D images called Octree. The encoding method together with the software that controls the way data encoded by Octree is searched ensures a rapid response time. The three-dimensional image that is encoded is build up from a series of two-dimensional images, taken by techniques such as computer tomography. Tomography is a way of recording X-ray images of the body that show bones and tumours. If a solution dye that is visible to X-rays is injected into the blood stream, the images will also show blood vessels. Said Meacher: "To obtain an image of the brain, we need about 60, two-dimensional images taken by conventional tomography and stored on computer. These are assembled so that they constitute a complete three-dimensional picture of the brain." This information is then encoded by the Octree method. Said Meacher: "We start with a large cube, this contains the images of the patient's skull as well as the space surrounding the head. We subdivide this cube into a further eight cubes by making incisions half way along each of its three axes. In Meacher's method this process of subdivision is repeated on each cube that is generated. More and more, and smaller and smaller cubes are generated. Eventually, a point is reached along all of the subdividing paths when a cube is generated that contains no information. At that point the process stops. In other words, the initial cube is subdivided into smaller ones until one cube is reached which contains no information about say bone or tumour tissue.

To call up an image on screen, the surgeon decides whether it is bone or tumour tissue that the processor must search for data on. If it is bone, the computer search the cubes that contain information recorded at the density that corresponds to bone. It does so in a particular order. When the original cube was divided it spawned eight daughters. And each of these did likewise subdividing to smaller and smaller cubes. The daughters are numbered according to their position. First of all, the processor searches daughter number one, and continues to search daughter number one created by each subdivision until it reaches the smallest one. It repeats the process for daughter number two and so on. But as the search proceeds any information that would obscure an earlier piece of information is discarded. In this way an image is built up comparatively quickly of the distribution of the bone as seen from one direction. The surgeon can also move the cursor to a particular point and instruct the computer to list what is attached to that point. The potential applications for this technique are wide. For example, a surgeon could pinpoint rapidly a piece of fractured bone. It also enables surgeons to find the ideal cut for a particular operation. Once the incision is found, the computer can be instructed to store the exact position in its memory. (This first appeared in New Scientist, London, 21 February 1985, the weekly review of science and technology.)

Cures for cancer now on computer

The National Institutes of Health (NIH) in Washington have a new cancer information service called PDQ for "Physicians Data Query". The service offers a computerised data base of cancer treatments. The system is tailored to the physician with access to a computer and a modem, who is faced with a patient diagnosed with cancer and is wondering what the latest or best treatment is. The NIH's National Cancer Institute (NCI) designed the system, drawing on the masses of information on cancer treatment stored in computers at NIH's National Library of Medicine. "Cancer is more than a hundred diseases, each with its own set of problems," says Dr. Vincent DeVita the director of NCI. A non-specialist may come across a patient with testicular cancer, for example, only once in their career. Rather than slog through obscure journals at a medical library, the practitioner can search for help by calling PDQ from a computer terminal in the surgery or at a hospital. Besides describing state-of-the-art treatment, PDQ outlines over 1,000 studies underway on experimental cancer treatments. A physician may want to enroll his patient in some of these studies. The data base also contains a directory of 10,000 physicians who devote much of their practice to cancer, and 2,000 institutions with organised cancer programmes.

PDQ is now available to doctors in the US who subscribe to a computerised medical data base known as "Colleague", operated by BRS/Saunders in New York City. Physicians in Britain, France, Australia, South Africa and Japan can also access the data base through the National Library of Medicine's medical library data centres in those countries. BRS/Saunders will soon offer European subscribers a local phone number allowing them to hook into PDQ from home or office, without incurring overseas communications costs. A panel of 21 physicians, whose decisions are reviewed by a larger group of 51 cancer experts, will update the data base monthly. Most of the information will come from peer-reviewed journals, although PDQ also will contain preliminary results of current research.

The American Medical Association (AMA), the country's largest physicians lobby, doesn't like PDQ, because "expertise" might be conferred to physicians on the index just because they are members of a special medical organisation. Or, it says, legitimate experts might be left off the list, resulting in a loss of prestige or patients. The AMA has agreed to evaluate the system, however. Neither the AMA nor NCI would permit lay people to have access to the database. Their reasoning is that the information is too technical. "It's not a cookbook for patients to treat themselves," said a spokesman for NCI, "such information could be dangerous if misused by patients." Clearly, access to PDQ would give patients a panoramic view of cancer treatments - and their side effects - unfiltered by their attending physician.

So far, PDQ does not help physicians to diagnose cancer, nor is it interactive. Such an addition may be forthcoming however. At Stanford University, Dr. Ted Shortliffe, a computer scientist and assistant professor of medicine, has designed an expert system that helps physicians to prescribe therapy for individual cancer patients. Called ONCOCIN, the computer program digests data on a patient and provides advice immediately on a treatment for him. Martin Kahn, president of BRS/Saunders' Colleague system, says the company may add ONCOCIN and other medical expert systems to its data base once they have proven themselves to the satisfaction of the medical profession. Yet to be resolved, however, is the question of who will be held liable for computer-prescribed treatments that go wrong. (This first appeared in New Scientist, London, 14 February 1985, the weekly review of science and technology.)

Eye movement controls word processor

Some disabled people are so severely handicapped that the only parts of their body they can control properly are their eyes. A group at St. George's Hospital, Lincoln, has designed an eye-controlled switch that can operate a word processor, select telephone numbers and control domestic appliances. The switch is triggered by tiny changes in the electric potential of the eye that occur when it moves. There is a potential of about one millivolt between the surface of the eye and the retina. This potential changes by 20 microvolts with each degree of eye movement. By placing standard electrodes on either side of a handicapped person's eyes, researchers at St. George's pick up the eye's electricity to operate a switch. The switch is turned on when the eyes are moved to the right and turned off when the eyes flick to the left.

The team, led by Lincoln's director of medical physics, Peter Griffiths, has connected its eye switch to a BBC Micro and developed word processing software that responds to the switch. Handicapped children at a Lincoln school have been supplied with the system for their schoolwork. The BBC Micro displays a menu of letters and words from which the children can compose their written work. The team has developed similar software for operating a telephone and for switching appliances off and on.

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The Institution of Electrical Engineers has announced a 5,000 prize for the best application of electronic or electrical techniques for helping disabled people. The winner of the award will be announced in November 1985. (This first appeared in New Scientist, London, 13 December 1984, the weekly review of science and technology.)

Farm automation plows ahead

The world's first agricultural automation conference, Agrimation 1, was held on February 25-28 to address itself to the shape of agriculture to come, as well as to examine the kinds of automation equipment now available to farmers. "Significant gains in future productivity and food availability and quality will come from computer programming and development of sensors," says Sylvan H. Wittwer, one of the conference leaders and director emeritus of the agricultural experiment station at Michigan State University. According to Wittwer, "this will involve the entire food system - from production through harvesting, processing, packaging, and marketing." He sees the most important increases in agriculture as coming not from bringing more land under cultivation, but from growing additional crops during the year on the same land. "The major requirement will be for appropriate sensors of environmental variables and computer programming of growth-factor inputs," he says. In other words, it will require automation.

One of the oldest uses for automation in agriculture is in self-propelled combines. The automation components are supplied either by the combine manufacturer or, more commonly, by the automation manufacturers who sell to them. Since most of the automation equipment is electrohydraulic, the component suppliers tend to be firms with experience in electronics and hydraulics. According to John K. Schueller of Texas A. & M. University's department of agricultural engineering, in College Station, the standard automated item on self-propelled combines is a header-height control. "With the high potential losses associated with improper adjustment during soybean harvest, the availability of this control has become a necessity for all North American combine manufacturers," he says. The ultimate goal is to avoid damaging a growing crop by measuring how high above the ground a combine's blades are as it moves across a field. This is accomplished with ultrasonic or mechanical sensors that regulate the flow of hydraulic oil to and from the header lift cylinders through a feedback mechanism similar to the governor on an electric motor. The connection between the sensor and the actuator may be mechanical or electrical in this simple system, and no computing power is required to make it work.

A more complex use of combine automation involves automatic steering. However, many agricultural engineers are skeptical that it will soon reach the market in economically significant numbers. As Schueller points out, "Despite a large amount of research in the area, there is only one manufacturer that produces a steering controller." That system, which is used only on corn heads, employs two mechanical feelers to determine row-following error. An error signal causes a valve to correct the steering direction. Engineers at the University of Saskatchewan in Regina are reported to be working on applying modern vision systems to guide combines, but no combine manufacturer has yet indicated an interest in using them in its machines.

"About half the foodstuff of the earth is transplanted in some form or another before it is harvested," notes Wittwer. And he expects this percentage to increase as the techniques of microbiological manipulation - cloning and embryonic implantation - are applied to a wider range of both plant and animal tissue cultures. "The challenge is for automation of tissue-culture practices ... including computer-programmed production units," Wittwer says.

What are now needed, according to agricultural researchers, are sensors to detect favorable soil conditions for plant cultures and the progress of ovulation for artificially inseminating livestock. Similarly, the same vision systems that guide tractors and combines can be applied to tissue-culture transplantation when used to direct the motion of pick-and-place robots. When also outfitted with tactile sensors, such robots manipulate delicate tissue cultures more efficiently than a human could. When it can be sold cheaply enough, this sensory sophistication could be a boon to small farmers because it will permit them to raise specialized crops for limited markets, such as kiwi fruit for Silicon Valley, without a disproportionately large labor investment. (Electronics Week, 25 February 1985)

Chips integrate digital television

ITT of West Germany is now supplying integrated circuits for digital televisions to Japanese manufacturers. The circuits will enable the Japanese to build digital TV sets to compete with the model that ITT makes. The package of seven chips, which integrate the equivalent of 300,000 transistors, sells for £20. In digital TV sets, the analogue picture and sound signals are converted into digital pulses. These pulses can be processed like computer data before they are changed back to analogue signals at the picture tube and loudspeaker. Converting signals from digital to analogue and back again is expensive, but once the signals are in digital form, they are cheaper and easier to process. Digital TV sets are more expensive than their analogue counterparts, but ITT believes it can reduce the price of its own product - Digivision. The company says it will also offer new facilities which are technically possible only with digital TV.

The company worked for 10 years and spent $80 million to integrate the conversion circuits. Now the basic work is complete, engineers are designing extra features into the chips. One integrated circuit in the latest package handles all the different European teletext standards, and switches itself automatically to the appropriate standard according to the signal it receives from an aerial. Currently, TV set manufacturers make different circuitry for each country. Another chip in the package is aimed at the American and Japanese markets. It improves the quality of the 525-line TV picture which is the standard adopted by the US and Japan. European TV uses the 625-line PAL standard. Both standards put the colour (chroma) and black and white (luminance) information side by side in the transmitted channel, where they overlap to some extent. In the European PAL standard there is a 4 megahertz bandwidth available to carry the picture information, but the American and Japanese systems have only a 3-megahertz bandwidth. The result is that in Europe, colour TV pictures are clearer than in the US or Japan.

Because luminance gives the fine detail to a picture, engineers have tried to improve the 525-line picture by using comb filters. These extract a little extra detail from the area of overlap between chroma and luminance. But analogue filters are expensive and introduce fuzziness into the picture. The ITT chip is a comb filter which operates digitally, and does not introduce any fuzziness. However, there are problems with digital circuits in TV sets. For instance, the digital pulses may radiate to analogue circuits and cause interference unless the circuit layout is carefully designed. (This first appeared in New Scientist, London, 3 January 1985, the weekly review of science and technology.)

The speaking computer on French railways

Last week French Railways (SNCF) started an automatic information system in Tours, in which a computer synthesises speech from recorded syllables. When a train is late an operator keys in the message on a computer keyboard. From then on the process is entirely automatic. The computer dials the telephone numbers of signal boxes in sequence. The signalling staff pick up the telephone and the computer tells them about the problem. The computer synthesises the speech from between 600 and 1200 stored syllables.

The problem with the computer synthesis of speech is to make the end product intelligible, and to sound human. (This first appeared in New Scientist, London, the weekly review of science and technology.)

"Microprocessors in Geophysical Instruments"

Microprocessors are used in geophysical instruments employed in prospecting for deposits of mineral raw materials. Such processors decrease the size and weight of the instruments and their energy use. The first microprocessor instrument - the KT-5 capameter, which measures the magnetic properties of ores directly in the field - is now being manufactured in quantity by the Geofizyka National Enterprise in Brno. It has met with success on the domestic and the foreign market, since it is 10 times as sensitive as its closest foreign competitor, manufactured in Canada. Experience in the manufacture of the microprocessor capameter has made possible the rapid development of dozens of other geophysical instruments. Five of these are manufactured by Geofizyka, five by other firms around the country, and others will be used only within an enterprise. (Rude Pravo, Prague, 12 September 1984)

FACTORY AUTOMATION

Computers on the shop floor

Nowhere has the advent of computer technology met with such resistance as in its application on the factory floor. In some cases this fear is well founded: with any additional automation, job losses are liable to occur. However, this is not always the case, and in many instances, the successful installation can result in a more rewarding work environment for all concerned. But most projects fail dismally. Either the system being installed is badly designed and unsuited to the application, or the key people in the organisation are not kept adequately informed or fully involved in the exercise. To see the scope of possible computer applications in the manufacturing environment, and to appreciate their benefits, one should look first at the way information processing in general has evolved. Computers were first used widely in the 1960s and 1970s based on the batch processing mode of operation of mainframe computers. While this may have suited the more traditional accounting systems, it achieved very little success when applied to the more demanding requirements of production control. Batch processing essentially involves the collection over a period of time of transaction data which are then entered into a computer in "batches". These batches are then used to update master files on a central computer. Typically, this is located away from the end user.

So the only contact the user has with the system, apart from the data he/she sends to be keyed, is a proliferation of reports which the computer sends out following the update run. In most cases, processing the information takes quite a bit of time, and by the time reports are received, they may be so out of date as to be of little value.

Typically someone involved in the accounts area was more in tune with the computer system and could benefit significantly from it. The user from manufacturing, however, was far worse off. It's no use to a production controller to find out on Thursday that he should have rescheduled all his machine shop jobs the previous Monday.

The arrival in the late 1970s of the mini-computer was the next significant step forward. Systems like Digital Equipment's PDP-11 brought computer power to the user for the first time. It was no longer necessary to collect transaction information and send it away in batches for processing. Now details such as stock issues, job completion times and so on could be input directly via a terminal and the files affected would be updated immediately. The results were available at the touch of a button. This was a tremendous advance in terms of the capability of the hardware available. But the software system houses were not so quick to respond with suitable, well-designed packages for industrial applications. It was several years before true high quality systems began to emerge. Even to this day software packages which match all the standard required criteria are far and few between.

The arrival of the low-cost micro system may be considered as a further step in the process of bringing ever-increasing computer power to the user at ever-decreasing prices. However, it is generally agreed at this stage that the greatest single technical problem facing the developers of manufacturing systems is not hardware or software but the human interface. Even with the most stringent validation controls, it is impossible to guarantee the absolute validity of data input manually. Other human problems are late input of data or, in the worst case, failure to input data at all. The solution, however, lies in the ever-increasing use of sensor-based data acquisition systems. These front end the more traditional data processing applications and are linked directly to robotic and automated handling systems.

Sensor-based systems involve connecting the computer directly to the source of input. Normally digital or analogue, such sensors may be located in machinery or can consist of devices such as bar code readers, badge readers, automatic scales, measuring equipment and so on.

This type of technology can automatically pick the required data from its point of processing with 100% accuracy; and there is no time lag between the event and the recording. Sensor based systems are not new. They have been used in process industries since the mid 1960s. It is only in the last few years, however, that any real attempt to use them as the basis of an integrated management information system has been made.

So, given the state of the art in both hardware and software, what are the possible shopfloor applications, and what are the likely benefits? The answers depend very much on the type of industry involved. Rather than analysing each industrial sector individually, let's see how different areas of application can be best handled across the board.

- Inventory control, purchasing and sales order processing systems apply to all industries and are best suited to the standard manual input method, coupled with the increased use of bar coding and/or intelligent data collection devices.

- Bill of materials/product formulation control is an application that varies from one industry to another.

- Works order control/production information recording: in all industries the trend is towards getting as much data as possible automatically by means of sensor devices.

- Manufacturing resource planning: the planning of all manufacturing resources - manpower, machine, materials, and finance - is applicable to all types of industry but its importance depends on the complexity of the planning operation within the company itself.

Regardless of what application is being addressed, or what mode of processing is being used, it is essential that certain features and concepts are built into the basic design of the computer system. Apart from looking for the obvious features - for example, menu processing, integration, user interaction and ease of use - one should look at criteria such as listed below, particularly if a package is being evaluated:

- Is the package fully supported?

- Is the reporting structure flexible?

- Can reports be produced on the screen?

- What source language is used?

- Are good standards employed?

- Is the system well documented?

Circumstances have improved dramatically since the early days of mainframe/batch processing. On the surface - given the range of tools available for computerised manufacturing systems - it would appear that planning, design and implementation have never been easier. Unfortunately this is not so. The basic problems of poor understanding and ineffective internal liaison are still very much in evidence. Essentially these problems, when they occur, can only be overcome either by devoting more time and effort internally to education, planning and review, or by involving third party companies, with relevant skills and experience in the application areas to be addressed. Unless a company is prepared to take this type of action, it will run the risk of missing out entirely on the current trend of increased automation and growth in flexible manufacture systems. It must also be prepared to accept the inevitable consequences when competing companies become more efficient and less costly - and market share begins to drop. (Technology Ireland, January 1985)

Automated control in process industry

Automated control systems in the process industry are a relatively new arrival, with few suppliers selling into the market. Physically, the process industry provides a hostile and hazardous environment for any computer system with constantly changing temperatures, inflammable and potentially explosive situations. The continuous processes involved are often difficult to control. A measure of the late arrival of automated control systems is the fact that ICI installed its first system in a chemical plant only three years ago and it was considered a "leap in the dark". However, it marked a watershed for ICI and now all new plants and refurbishments entail installation of computerised control systems. When ICI built its new chloromethane plant on its Rocksavage site in Runcorn - the first to have an automated control system - it was taking a substantial commercial risk. The company had identified a large growth in the European market for chloromethane products and its success in this market rested on its ability to supply its customers' demands on time from day one of the plant's opening. The plant opened in November 1981 and represented an investment of some £40 million for ICI's Mond Division. The new automated system was new to everyone and the whole plant was dependent on it. In the words of Martin Bell, production manager, the company was "entering the unknown". The risk paid off - the plant is the world's largest single producer of chloromethane products. ...

At the time the company was selecting its control system there were only two companies to choose from: Foxboro and Taylor Instruments. ICI went for Foxboro's Videospec 2 system. Its main criteria was greater productivity - the whole plant can be operated with one man in the control room, compared to three with conventional instrument panels - and capital requirements. The Videospec system could be installed in one room, thus saving space, and its data retrieval and analysis capabilities were a resounding success. The Foxboro system cost some £120,000 including all the various interfaces.

Since ICI installed the Foxboro system, more suppliers have entered the market and the company has by no means become dependent on one supplier. Other plants have opted for Kent, Turnbull and Negretti controllers. In some, the actual number crunching is being done by BBC or Apple microcomputers. ...

Future computer development at the Rocksavage site as a whole is being considered by a special committee. It is looking at all computer needs and deciding on future policy. There are 15 operating units on the Rocksavage site - some are conventionally controlled, others, like the chloromethane plant are more advanced. In five to 10 years' time, Bell believes that each individual unit will have its own system, linking into a central computer. This will enable each unit not only to optimise its own operation, but to make decisions that will be commercially sound for the site as a whole. At present, while each site makes decisions to optimise its individual performance, commercial decisions affecting the whole site are a central management function. For now, however, it doesn't look as though computers will get total control of a chemical plant. (Computing The Magazine, 18 October 1984)

Comms put spanner in the process works

Distributed control systems are one of the most promising new techniques in the process industry, but a lack of real time communications standards means that the industry has been slow to reap the benefits. The world of general-purpose dp has, of course, been wise to the advantages of distributed computing for quite a while, and has also suffered from problems of standardisation. But in the process industry, the potential gains from spreading processing power around are even greater - and the problems of implementing it more acute. For some time now, the trend has been towards putting more intelligence into the programmable controllers used in process plants, and this has gone hand-in-hand with a shift in emphasis away from hardware towards software as the key factor in the system. The companies which make programmable controllers are starting to give them extra intelligence, in the form of predictive or self-modifying routines.

An example of the new generation of distributed system being developed for the process industry is Mod 300, the newest product from process control specialist Taylor Instruments. Mod 300 is a fully distributed control system that will work for continuous or batch processes, and it has no central processor at all. Instead, the system software is downloaded into a number of completely self-sufficient nodes. Each node holds part of the system's database and can operate independently should the system's communications break down. Taylor is not the first process control company to develop a distributed control system. Several manufacturers offer similar products. But the problem from the user's point of view is that all the systems use idiosyncratic communications protocols, so there is no question of buying in equipment from different manufacturers. The Honeywell, Foxboro and Taylor systems all use incompatible bus systems, so their kit won't communicate at all.

There are only a handful of companies involved in developing complete process control systems, partly because of the high research and development costs involved. Much of the development work is in the real time software to drive the system.

Supervising plants is one thing; controlling them is another. Systems like Mod 300 need to use high speed, high volume networks with enough capacity to handle real time communications. Standard telephone lines and local area networks can't come up to the level of performance needed.

For some time the standards committees have been looking at ways of tackling the problem of developing standards for real time communications; indeed, work has been in progress for longer than work on office automation standards. But office automation has raced ahead, while real time communications standards are still on the drawing board, partly because of the lack of a dominant manufacturer to set the pace. The two most promising candidates for the role of a process industry standard are HDLC, an Ethernet-like system, and Proway, which is based on IEEE 802 and uses token-passing. The Proway proposal was put forward by a US subcommittee of the International Electrotechnical Commission last year, and was greeted with enthusiasm by the process industry. But the future of Proway is in the hands of the chip manufacturers. Proway's wide adoption will depend on the availability of low cost communications chips, but the process industry market is only 1% or so of the office automation market and the incentive for the chip makers to cater for it is much smaller. The International Standards Organisation is hoping that by making Proway a subset of IEEE 802, it will be able to piggyback onto the office automation bandwagon. If so, the standards problems of the process industry may be over. As one of the leading companies in the field put it: "If the chip makers can come up with a product with the integrity and safety we need, at $5 a throw, then there'll be no choice - we'll all have to go that way." (Computing The Magazine, 18 October 1984)

Automated manufacturing

The potential for innovation in manufacturing has never been greater than it is today. The so-called advanced manufacturing technologies (AMT) offer major opportunities to makers of most engineered products to cut costs and improve quality and service to the customer. The key attribute of AMT is flexibility. Machinery has long been available to automate long, high-volume production runs such as those found in the car industry or process industries. The new flexible technologies, whether for designing, shaping, handling or assembling products, are also applicable to small-scale, small-batch production, and so hold out the promise of improving the competitiveness of thousands of small and medium-sized manufacturers.

As recently as a year ago, AMT was still considered by many experts to be a "missionary sell." In other words, it was so new that most potential users, particularly smaller manufacturers, had to be convinced that it was available and worked. That period is now clearly over. In the past year or so, a number of advanced systems have been installed, proving the practicality of AMT in a wide variety of applications, from sorting shoes to making wiring looms for complex machines. And many more are on the way. The boom predicted for the suppliers of equipment and software for the shop floor is now occurring, with some sectors, such as robotics and computer-aided design, growing at over 30 per cent a year. By 1990, the entire AMT industry is expected to have annual sales of more than $30bn which would be quite an achievement for an industry that is still very much in the embryo stage. Indeed, it is still difficult to predict the ultimate shape and structure of this industry. A year ago, it looked as if the giant electrical and electronic companies, such as IBM and General Electric of the U.S., were going to march in and take away the leadership of the industry from machinery makers.

But that has not happened so far. Instead, the main contractors on big AMT projects have tended to be the leading specialists in a particular sector. For example, almost all the major flexible manufacturing systems (FMS) built in the last couple of years have been made by the top machine tool builders, such as Cincinnati Milacron, Ingersoll International, and White of the U.S., Comau of Italy and Scharmann of West Germany. Similarly, the big contracts for materials handling systems have been won by companies such as BT of Sweden and Jungheinrich of West Germany.

However, there is no doubt that the importance of electronics will continue to increase, especially as attempts are made to achieve what is often called computer-integrated manufacturing (CIM), that is, linking various islands into integrated systems under the management of computers. And it is reasonable to assume that the makers of computers will play a larger role in the development of these systems.

Many observers have worried about potential competition from Japanese AMT suppliers, having witnessed the Japanese successes in recent years in selling robots, numerical controls and numerically-controlled machine tools in world markets. But with a couple of exceptions, the Japanese have not been very active in European and North American AMT markets, perhaps because of language and distance barriers to their providing the high degree of customised engineering required in AMT systems. Indeed, the main issues in AMT today are not so much technological as conceptual and managerial. For both suppliers and users, the most worrisome problems are the practical ones of designing sensible systems, choosing the right suppliers of equipment and preparing for the inevitable significant changes in their organisations.

For users, the key issues at first are those of costs and benefits, but these soon become less important than the human ones. An automated factory, or even a part of a factory that is automated, operates in a very different way from a conventional one, and different shop-floor organisation structures are needed. In some cases, automation can affect the organisation of an entire company.

Consider, for example, a hypothetical case of a manufacturer with a totally automated production system. From a simple electronic signal from a distant salesman that he has won an order, the central computer initiates production, supervises all the machining, handling, assembly and test functions and even generates orders for new materials and tools to replace those used. This degree of automation, which is beginning to appear in factories already, obviously eliminates a number of manual and skilled jobs. But it also plays havoc with the traditional roles of various supervisors and even directors. In effect, it is the lowly salesman who controls the production line. (Financial Times, 5 February 1985)

ROBOTICS

UK robot report makes depressing reading

British firms invested more than £50m in robotic equipment last year, but depressingly, British built robots only accounted for around 10 per cent of this figure. In its annual report the British Robot Association presents figures which suggest a rather depressed market for robots in the UK, and BRA chairman, Michael Skidmore from Cincinnati Milacron, predicts that there will be considerable market rationalization in the UK in 1985. Britain's robot population now stands at 2,623, an increase of 870 units on last year. British robots accounted for 225 sales, the largest figure from any geographical region, but most of these were low-cost models specifically suited to the plastics industry. BRA predicts that the UK will buy fewer robots in 1985 (800 is the prediction) as Britain's car industry, which accounts for between 30 and 40 per cent of robot sales, completes its robot acquisition programmes.

In the international robot league, Britain comes sixth in terms of robot population. Top of the league, and way in front of everyone else, is Japan with 64,600 robots. In earlier years, the BRA has been sceptical of Japanese estimates, but Tom Brock, BRA secretary, says he is satisfied that the Japanese estimate is accurate according to the BRA's accounting methods. The US has the second largest robot population in the world, with 13,000 units, followed by West Germany, with 6,600 units, Italy with 2,700 units and France and Britain with around 2,600 robots apiece.

The BRA says that robots are being used for new applications in British industry, as new automated production techniques allow the use of robots. Applications such as laser-cutting and water-jet cutting are growing fast as new technologies are utilized. Assembly work accounted for the largest single increase in robot population, with 96 installed in 1984, more than 93 per cent up on the 1983 figure. (Electronics Weekly, 20 February 1985)

Polish robots gather dust

Six hundred and five robots have so far been built in Poland, but only 360 are in operation, with 1985-1986 requests totalling merely 150 and plans for 700 more by the end of 1990 according to Promasz, the research and development institute for the foundry and machine industries which is in charge of the country's robotics programme. Two hundred and forty-five robots are gathering dust in warehouses because of the apathy and disinterest of manufacturing industry, despite its crying need for modernization and automation, claims the institute, pointing out that Poland is the pariah of robotics within the Eastern Bloc and in the USSR 40,000 robots are in use and 14,000 were made in 1984 alone.

One of the reasons is, according to Promasz, that many Polish producers make do with low technological standards, and reckon that the provision of ancillary equipment and of training service and maintenance staff would cost more than the robots themselves. Even large enterprises with a shortage of labour and a multitude of demanding physical tasks are reticent, apparently, while occasionally small firms without the technical and economic preconditions which would render the application of robots feasible request the issue of electronic robots and manipulators. ... (Electronics Weekly, 13 February 1985)

Robots get smart in Japan

Already the world leader in production-line robots, Japan seems the likely front-runner for the upcoming generation of intelligent mobile robots that will toil in environments too hazardous for humans. Close to getting into industry are experimental robots from two Tokyo firms, Hitachi Ltd. and Toshiba Corp. Their hardware cannot be considered true prototypes, but they nonetheless offer insights into what might be forthcoming in Japanese robot design. Hitachi's mobile robot crawls around under its own battery power, sometimes at its own discretion. When the terrain is not level, its crawlers adapt to climbing steps or ladders. Thus through the maps stored in its memory, plus vision over an angle of 162° (about equal to that of humans), the robot can maneuver around small obstacles. Using its arm, which has six degrees of movement, it can open doors or move objects. ...

For operation, the robot has a three-dimensional map in its memory for the area it is to traverse. Pattern processing is used to predict its position. Then an actual map of the immediate surroundings acquired by the vision system, including obstacles, is fed into a different segment of memory. The robot steers itself in a way that minimizes the difference between the predicted map and the actual map, all the while navigating to avoid impassible obstacles. It can open doors, however, as well as manipulate electrical switches, actuate valves, and perform other tasks.

While in operation, the robot recomputes its position and course once each second. Remote control from a base station is taken care of by a radio link that uses spread-spectrum technology to minimize interference by noise. The link also enables the base station to view the scene picked up by the robot's vision system. The data-transmission rate is 135 kb/s.

Toshiba is developing its intelligent robot for industry through a joint project with a team headed by Hiroyuki Yoshikawa of the Department of Precision Machinery Engineering at Tokyo University. The work was done under a contract with the Mechanical Social System Foundation, established by the Ministry of International Trade and Industry. ... (Electronics Week, 21 January 1985)

Robots come to their senses

Robots are useless unless they have a sense of what they're doing. Even a robot arm that can move with great precision can't be used as a manufacturing tool if it doesn't know where to find the objects to manipulate or how to position them in meaningful order. This was a recurrent theme at the workshop sponsored by the Society of Manufacturing Engineers that was held in Atlanta (USA) in late January. "The notion that machine vision is the latest add-on for robots is patently false," states Owen Herman, chief engineer for vision technology at Robot Systems Inc. "Only about 5% of robots currently in industry use vision. Limit switches and encoders have been around a long time and are doing fine, thank you." Conversely, he notes, only 5% of today's vision systems are used to control robots. The rest are used for inspection and quality control.

Many speakers at the workshop suggested that newcomers to the robotics industry often don't appreciate how much computer power is required for even rudimentary object recognition and its subsequent co-ordination with a robotic limb. A machine usually needs 20 megabytes of random-access memory to be able to see an object in three dimensions - that is, for it to store the visual parameters of a solid figure and remember what the figure looks like when it sees it a second time. If the object has been rotated through a different spatial orientation, the problem is exacerbated. Fortunately, less storage capacity is required for gray-scale and binary imaging. In this more simple task, solid objects are viewed in only two dimensions and one spatial orientation, thereby reducing the amount of visual memory needed to recognize the objects. The drawback is that objects cannot be placed at random in an industrial environment but must be oriented within a rigidly prescribed space for the machine to know what and where they are. Most vision systems on the market have this limitation, whether they are used as robotic sensors or to inspect products. The other limitation is cost.

In the workshop's hands-on portion, attendees showed a great deal of interest in the use of fiber optics in photoelectric sensing. This rugged technology is especially suited to robotic applications because the small sensing head can be mounted directly on the end effector, without signal interference from vibration or high temperature. In addition, the flexible cable can move with the robot arm and is relatively immune to damage from fluids or airborne particulates, both of which could make the use of a video camera impossible. ...

Using intelligent vision to guide a robot's end effector is an application that is still limited - but growing. In 1984, the $60 million market consisted mostly of such applications as inspection of critical part dimensions, position measurement (especially for checking the placement of holes in printed-circuit boards), seam tracking in industrial welding, and the detection of specific defects for which the vision system's computer had been programmed beforehand. ...

One new technology in tactile sensing involves capacitive cells made of a silicon diaphragm; the diaphragm moves against a glass substrate in response to an applied force.

Although sensitivities of 1 fF have been reported in the laboratory, many engineers responsible for integrating sensors and robots are wary of the cells' susceptibility to fluctuations in ambient temperature and electromagnetic interference. Robot Systems' Potter doesn't believe in the current economic feasibility of sensitive tactile equipment. "They are too affected by noise and require too many built-in corrections," he says. "Also, they have to give a digital interpretation of what it is they're touching. It's much easier for an operator to simply see an [analog] image on a video display." Though the same limitations have applied to another technology used in tactile sensing - piezoelectricity - a new development in piezo materials promises to mitigate them. Polyvinylidene fluoride (PVDF) films now being used in prototype sensors are said to offer several advantages over traditional piezoceramics such as lead zirconate titonate (PZT). PVDF can be subjected to much stronger electrical fields than PZT, as well as to a wider range of temperatures and more severe mechanical stress. It is also a more sensitive piezo transducer.

According to Potter, the best use for tactile sensors is not sensing as such but monitoring a robot's end effectors for force and moment build-up. More capable than simple strain gauges, they can be interfaced to a computer that resolves the forces into positioning vectors (possibly in integration with a vision system) and warns the operator if tolerances are exceeded. (Electronics Week, 18 February 1985)

Feeling poorly

Most industrial robots are blind and unfeeling. That, contrary to some popular opinion, does not make them perfect employees: they mistake nuts for bolts and crush things they are supposed to nudge. Much recent research has been aimed at giving robots the rudimentary ability to interpret information from touch sensors, so they can work out how hard they are touching objects, as well as the objects' shape and position. One of the most promising approaches so far has been to mimic human fingertips. At the Massachusetts Institute of Technology, Dr. John Purbrick and his colleagues have created a form of "artificial skin". It consists of tiny criss-crossed grids made from a special mixture of rubber that can conduct electricity. As a robot equipped with the skin presses against an object, each intersection sends an electrical impulse to a computer, which can then map out a two-dimensional plan of the thing it is touching. The advantage of making the skin out of rubber is that it can tell the robot how hard an object is being touched. If you increase the pressure, the rubber flattens out and more intersections send out their electrical impulses. But rubber has it disadvantages. It is hard to make rubber that conducts electricity evenly. Rubber also tends to deform under repeated pressure: eventually, the same amount of pressure begins to send out ever increasing impulses.

One solution might be to find a substitute for rubber. Dr. Bruce Robertson of the GEC's research centre in Britain is trying to do that by making an artificial skin that uses a fabric, coated with a conducting polymer, instead. But even if he succeeds, the skin would be able to "feel" in only two dimensions. A more difficult challenge is to teach a robot to think in three dimensions. Attempts to help robots build up a three-dimensional picture of an object by touching it have, until now, been relatively crude. One of the most common approaches is to make a sensor that consists of a grid of retractable needles; it creates a mould of an object by resting on it. But scientists at the University of Florida, led by Dr. Gale Nevill, claim to have pioneered a technique that is radically new. Dr. Nevill says his approach was inspired, like artificial skin, by the human fingertip. But he notes that blind people who read braille do so by moving their fingers across a surface, not by pressing down on it form above. So he has produced a ridged skin which moves across the object in order to recognize it.

Because the Florida team has applied for a patent it is not saying how its technique works. Other robotics buffs think it must use a polymer called polyvinylidene fluoride (PVDF). PVDF is piezoelectric, like quartz: changes in its shape produce electrical impulses. By moving across an object, a skin made from PVDF could create a pattern of vibrations to be monitored by a transducer. A computer would compare the results with a library of patterns stored in its memory. When the computer recognizes a pattern, it tells the robot to perform a pre-programmed task, such as picking the object up. What is novel about Florida's sensor is that it moves. A static piezoelectric sensor has been produced before, for example by Dr. Melvin Siegel and Mr. Gregory Toto at Carnegie-Mellon University in Pittsburgh. Their prototype has 16 sensor pads in a square array, each with its own signal amplifier and microprocessor. The Pittsburgh team, however, is paying as much attention to the computer processes that analyse the signal as to the mechanics of the sensor itself. The snag with piezoelectric sensors is that they spend a lot of time being silent; they give off short, intense bursts of data only when their pressure against an object changes. If the robot is to respond quickly enough, the signals must be fed through novel computer architectures that process the data in parallel. (The Economist, 9 March 1985)

Working with robots

Nypro Ltd., the country's largest trade injection moulder, produces moulded plastic parts for sectors such as telecommunications, computers and healthcare. A lot of this is exported to stringent standards. To survive, its level of technology has to be on a par with the most advanced in Europe. In a £0.5 million investment programme carried out over the past two years, it not only bought new injection moulding equipment, but comprehensively computerised its management information systems. And in November 1983, it bought its first robot. This machine, it reckons, paid for itself in a 6-9 month period. Now Nypro has 16 robots in its Bray plant, costing from around £6,500 to over £15,000 each (special grippers add to that cost) with an estimated average payback period of one year.

For Nypro, the introduction of robotics has meant improved, consistent quality and a greater degree of competitiveness. In some instances it has even been able to provide an additional finishing operation (carried out by a machine operator freed of some manual work by a robot) to a client free of charge - in effect cutting its price at no cost to itself.

First, the company did a lot of research on robots available in Europe. It looked at factors including ease of outlay, maintenance and installation; flexibility, reliability, adaptability to new and old machinery; space utilisation; technical back-up; and ease of operation. It came down "fairly heavily" in favour of a British made machine, from Pressflow Ltd. One characteristic that impressed was the robustness of the machine. This pointed towards a far-thinking design concept, and the components were of an extremely high specification. All this pointed towards high reliability. "This was the initial factor," says Tom Fitzgerald, "and were we ever proved right!"

The first robot was bought on a "no foal, no fee" basis. At the same time, Nypro bought an indexing conveyor from LVP Conveyors in Dublin. Since November 1983, that robot has run consistently. There was only one breakdown when a part had to be replaced. This lasted for 12 to 14 hours (it would have been dealt with in one if the part was in stock at the plant). The success of the first move led the company to continue. Now it has 16 robots and nine indexing conveyors. "A robot does a number of things. There are grave misconceptions. Everybody thinks they're going to eliminate jobs. Absolutely wrong," says Tom Fitzgerald. "In actual fact, the main benefit is that they improve quality performance."

In Nypro's plant, as in other injection moulding plants, raw material in granular form is fed into hoppers on the injection moulding machines. The material is melted under controlled conditions and injected into a steel mould. It sets quickly in the mould. The mould then opens, and the moulded part is removed. Before automation, an operator would lift the part out of the mould, and the cycle would then repeat. But unlike a machine, a human being is incapable of repeating a fairly simple operation like that at exactly the same pace and at exactly the same speed for a long period. This has ramifications for quality control. Changes in pace affect the timing of the cycle - and the properties of plastic lead to variations in product, which in turn lead to rejected product. ...

The action of a robot could be subdivided into a number of functions. The first robot had to perform five tasks:

- Remove two cosmetically critical mouldings from the tool (mould).
- Remove the runner (an extraneous piece of plastic on the product, formed by the moulding process, and designed so as to be removed easily without damage to the finished part).
- Place the component on to a conveyor.
- Place the runner into a box, where it would be earmarked for recycling as raw material.
- Index the conveyor.

At this stage, Nypro gave the robot manufacturer sample parts and tooling dimensions. The manufacturer then interfaced the machine and the robot (this is critical since a serious miscalculation could result in a robot arm damaging a tool worth thousands of pounds) and supplied the gripper units. Since then Nypro has become self-sufficient. "... Our confidence and knowledge of the robots grew quickly," says Neil Dewar. "We became less and less dependent on our robot supplier, undertaking by degrees the interfacing and the installation of the robots and also the development of the gripper units." ...

The injection moulding shop at Nypro has 26 machines from 15 tonne to 650 tonne locking force. The robots, then can service weights from 15 tonne to 1,000 tonne. ... (Technology Ireland, January 1985)

Helping firms use robots for arc welding

Arc welding is highly adaptable to robotics. Manually welding is labour intensive and monotonous: quantity and productivity very much depend on operator skill. Robot arc welding is now a well established technique. It offers significant improvements in productivity: typically between 200% and 300%. While a manual welder has a typical "arc-on" time of up to 30%, a robot will have the arc on up to 80% of the time. Quality is usually improved and scrap reduced markedly.

The robot and 500 kg fully programmable manipulator form an industrial tool used by many companies abroad and regarded as one of the market leaders in arc welding cells. The laser seam finder adds further sophistication. It is capable of locating inaccurate seams between parts. And an air plasma unit is capable of highly accurate plate cutting in three dimensions when mounted on the robot.

A working team has been set up with members from the Manufacturing and Metallurgy Departments of IIRS and the Mechanical Engineering Dept. of UCD. The team aims to carry out feasibility studies in robotic welding for Irish firms. A company with a significant workload in welding, and considering a robot or wishing to have the technique tested, can avail of the service which offers a low cost method of testing the process for industrial products. A feasibility study will include such factors as the suitability of a company's products for welding by robot, the actual welding sequence, difficulties arising due to component fit-up and lack of accuracy, improved cycle time and product redesign for robot welding and jigging.

The emphasis will be on the practicalities of welding by robot. These will be considered from a production engineering and metallurgical stance. (Technology Ireland, February 1985)

COUNTRY REPORTS

China

The Government of the People's Republic of China has agreed to a proposal made by computer scientist Shu-Park Chan, professor at the Santa Clara university in California, to establish the China Experimental University in the new Shenzhen Special Economic Zone near Hong Kong. Five hundred acres of land and $100 million to build a campus will be provided by the Government. Professor Chan is now trying to raise $100,000 from American companies for a small staff. That staff in turn will attempt to raise $5 million in two years and $15 million over six years for salaries and high-tech equipment, such as computers.

The professor's campaign is paying off with companies that are eyeing the Chinese market. Those that contribute to the university qualify for extra tax incentives and concessions if they build plants in the Shenzhen zone. But the professor is not content to seek support only from California high-tech companies. He is talking to top executives at major corporations, including General Electric, International Business Machines, and American Telephone & Telegraph. He asked AT&T to endow two chairs at the new school and to build a communications laboratory.

Chan himself is ready to commit up to six years of his life to make the university a success. He hopes to recruit other middle-aged professors from a variety of countries who will work for low wages and then hire a younger cadre of high-salaried scientists and engineers "who will have forefront knowledge." Initially, the university would award only master's degrees in five science and engineering fields and in hotel management, a sorely needed talent in a China eager to modernize. Within 15 years, although it still might not be a Stanford University, the experimental school could grow into a full-fledged university, granting bachelor's master's, and doctorate degrees in the sciences and humanities. (Businessweek, 31 December 1984)

East Europe's computers

... Democratic Republic of Germany boasts the largest and most advanced computer industry in eastern Europe. Its U-D microprocessors, though less powerful than the latest Intels in the west, drive thousands of Comecon ES mainframe computers and SM mini-computers -

copies of IBM 360s AND Digital Equipment PDPs. Since 1980 the Democratic Republic of Germany's output of integrated circuits and semiconductors, made mainly at the Robotron complex in Dresden, has more than doubled. The country also leads Comecon's dash to automate industry, having installed 35,000 robots (all domestically designed and built), against Russia's 25,000.

Czechoslovakia depends heavily on western technology. It makes some microcomputers and peripheral equipment under licensing agreements at the ZPA plant in Cakovice. Quality of production there has been poor. In November, Czechoslovakia took the unprecedented step of complaining to the Gatt that the Cocom* embargo on some of its planned purchases was a non-tariff barrier to trade, against Gatt rules. It complained that microcomputers from several countries, industrial robots from Britain and optical electronics from Japan were being blocked. Though the complaint is unlikely to open the trade door wide, it might influence some western governments to be more sympathetic towards Czechoslovakia in individual licensing decisions.

Poland also depends on imports of western technology. In 1972-1978, it imported 30% of the $690m-worth of western computer equipment that was bought by eastern Europe. The MERA-ELWRO computer works in Wroclaw once housed the most dynamic computer industry in eastern Europe. Many of Poland's best computer scientists have emigrated. Computers are now so scarce that programmers cannot be trained properly.

Bulgaria's computer industry has rapidly developed. Bulgaria is the biggest net exporter of electronics and the main producer of magnetic disks in Comecon. The disk drives, electronics and electronic robots made at the Beroe plant in Stara Zagora are widely used in computer-aided manufacture throughout the factories of East Europe.

In Rumania, even old-fashioned mainframe computers are rare. According to official statistics, 1,062 computer terminals were in use in 1980 and 4,000 will be installed by 1990. Rumania ducked out of successive Comecon co-operation agreements, preferring to build up its own small computer industry almost entirely under western licences or by joint ventures with western companies like Control Data. As it has run out of the hard currency needed to pay for such licences, Rumania's production of computers, almost all of which takes place at the Central Informatics Institute in Bucharest, has recently fallen.

Hungary writes some of Europe's best software and is also a leading Comecon supplier of hardware. Videoton, Hungary's largest computer-maker, diversified into a wide range of high-quality peripherals in the late 1970s under licence from American, Swedish and French firms. Today Videoton sells around 85% of its output to foreign buyers. Szamalk, Hungary's biggest systems house with annual sales of 1.5 billion forints ($30m), sold western countries $1.5m-worth of IBM- and DEC-compatible software last year. Not far behind Szamalk was SZKI Laboratories, which claimed a 1984 turnover of 1 billion forints. Its logic programming language, M-Prolog, was selected by Japan for use in its fifth-generation project for computers with artificial intelligence. (The Economist, 19 January 1985)

Esprit project is coming of age

The European Commission last week congratulated itself and European industry on moving the £900 million, long-term, collaborative information technology (IT) project, Esprit, into its mature phase. The commission believes that even if its own support were to collapse tomorrow, European IT companies would continue the collaborations that formally got off the ground last week. The aim of the Esprit project is to create the conditions where European industry could leapfrog US and Japanese competition in the future. A major emphasis is on collaboration; all the projects must have at least two industrial partners, each from a separate European country.

At the same time, the commission is beginning to give impetus to its second major programme, in telecommunications following formal approval last December. That programme is currently at the stage that Esprit was at about four years ago, when industry leaders and politicians were actively formulating their plans. One element of the telecommunications programme is the Race project, which could, by 1986/87, blossom into a collaborative research programme with funding in the order of £500 million over five years.

In January, five months later than expected, the European Commission formally announced details of the 104 successful collaborative IT projects. It will subsidise these by about £150 million (180 million ECUs) for the first part of the full programme. The industrial participants will stump up another £150 million for their share of the projects, most of which are to run for three years in the first instance.

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* Co-ordinating Committee for Multilateral Export Controls.

The Esprit programme focuses its research in five main areas: advanced microelectronics, software technology, advanced information processing, office systems and computer integrated manufacturing. Although each project must have a minimum of two industrial partners, the average size of a consortium is, in practice, about five. The largest, which includes both IBM and American Telephone and Telegraph (AT&T) has 16 participants from seven countries. Given the aim of Esprit, to leapfrog US and Japanese IT technology, it is paradoxical that several US controlled companies are taking part in Esprit. These are IBM, Digital Equipment Corporation (DEC), ITT, AT&T and Bell Telephone Manufacturing. ITT also owns most of the German company, Standard Electric Lorenz, which has won a place on one project, as well as around 25% of STC. Moreover, the Battelle Institute of Frankfurt, which is to take part in two projects, was founded in Germany by its giant US parent. ...

In the final analysis, says the commission, the multinational companies simply have to be trusted to play by the rules. "It is up to them to live up to their contractual undertakings," says Michel Carpentier, director general of the European Commission's IT Task Force and in overall charge of Esprit and the bulk of the commission's other IT projects. He adds that less than 2% of the Esprit budget of 180 million ECUs is going to multinational companies.

The commission acknowledges that several good projects had to be turned down. One area that did not get good proposals was software technology, and the commission was below target in that area.

The sum available for the next round of contracts is larger than last year's 180 million ECU's. This year the commission is offering subsidies to the value of 220 million ECUs (£180 million) and IT companies have until March 25 to apply.

This year Esprit programme is to emphasise the potential of projects for implementation and exploitation, rather than pure technical merit. Director Cadiou says: "We found in the Esprit Technical Week (a conference organised for Esprit participants last year) that the happiest consortia were those with a more focused approach and with more concrete results - it is more difficult to work on more abstract things".

There have been significant results from the work so far, says Cadiou. From the 30 short-term pilot projects, which got underway in 1983 and mostly went on to become full Esprit projects, there have been three main advances. A consortium that included Plessey and GEC has filed Esprit's first patent - for an advanced interconnect on a chip. Another consortium, headed by US-based Bell Telephone Manufacturing, has built the first demonstrator chip - for digital signal processing. And a consortium led by Istel has established design rules to enable people building computer integrated manufacturing systems to communicate with each other. The Esprit programme is now into its mature phase and carving a trajectory towards the fifth generation.

The commission is happy that the Esprit programme, generated by the former European vice-president of industry, Viscount Etienne Davignon, has brought European IT companies closer together. That is what it hopes will be achieved for its nascent telecommunications initiative, also generated by Davignon. Following informal talks with PTTs and ministers since November 1983, the European Commission has drawn up an outline action plan to create and stimulate the European telecommunications market; to expand collaboration on development of new services and networks; to start up an industrial R&D programme in telecommunications; and to help modernise networks in poorer European countries. Last July the commission, in collaboration with industry and PTTs, started to work out an R&D programme called Research in Advanced Communication in Europe (Race), which got the green light from the European Council last December. *

The aim should be to have broadband networks throughout Europe between 1995 and 2000, to be achieved in an orderly way from the present situation where there are nine separate sets of manufacturers switching equipment. "There are no standards for teletex, videotex or radio telephony," Carpentier explains. "To achieve this will involve a lot of investment in research and organisation and Race is part of that process." Carpentier says that 15 million ECUs (£10 million) is in the 1985 budget for Race and that it could expand in 1986. He says: "1986 may see proposals for more ambitious proposals," adding that Race could develop by "an order of magnitude" into a 500 million ECUs project over five years.

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* See also "Standardization and Legislation", page 58.

However, he points out that Race is one of four kinds of project. "The first type is small - such as videoconferencing projects - which force people to get together. The second is more ambitious: to see how it would be possible to have a skeleton high rate network oriented to business communications by 1990 using different means of transmission - co-axial and optical cables, and satellites." The third type of project would focus on radiotelephony - "on the second generation digital and high frequency area". The fourth is Race. "Race must be more market-oriented and more targeted than Esprit. Its aim is to prepare the ground for the community, industry and carriers to prepare for the networks of 1995-2000, which will be broadband services with integrated services still to be defined." (Computer Weekly, 31 January 1985)

Ethiopian phone job for Italcom

Italcom, the joint export company established between Italtel (Iri-Stet Group), GTE and Telettra, will supply Ethiopia with transmission systems to connect large areas of the country excluded, at present, from the national telephone network. The supply, worth a total of over Lira 13,000m consists, among other things, of radio relay and rural radio-telephone systems, which require no cables and provide both a service and a telephone set identical to normal ones. Such transmission systems are extremely useful in large, scarcely-populated areas where the installation of traditional telephone lines would be difficult and expensive. Technical assistance and education and training of local personnel will also be supplied, in agreement with ETA, the Ethiopian telecommunications authority. The supply will be financed by the Department for the co-operation and development of the Italian Ministry of Foreign Affairs. (Electronics Weekly, 27 February 1985)

Micronas semiconductor plant planned for Finland

Next fall the manufacture of semiconductors will begin in Finland. Micronas Oy in Helsinki is responsible for this investment. The new factory, which will go into operation next fall, will have such a large capacity that in addition to covering the needs of the domestic market, it will export half of its production corresponding to about a couple of million semiconductors. The new factory involves an investment of about 75 million kronor. During the latter part of the 70's there was a great deal of investigation of the need of and the prerequisites for design and manufacture of semiconductors in Finland. This led to a decision by Aspo, Nokia and Salora in 1979 to come together and create a company for production of semiconductors. On 22 September 1980 Micronas Oy was formed. Some of Finland's largest industrial firms with large interests in electronics plus the American firm Micro Power Systems in Silicon Valley, California, stand behind Micronas Oy, which has a stock capitalization of FIM 18 million. (Modern Elektronik, in Swedish, 14 September 1984)

Federal Republic of Germany

The electronics industry has assumed supreme importance in Bavaria, the largest German state in terms of area, where 230,000 people are employed in this one sector. Traditionally an agricultural region, Bavaria has none of the problems which heavy industry - coal mining, steel and shipbuilding - has brought the north of the country. In the years of industrial development since the last war Bavaria has been able to concentrate on the newer light industries. Today almost half of the worldwide demand for silicon - the basic material used in electronic components - is met by Bavaria. Of Germany's 600 software firms, 40 percent are based in the "blue-white state", as it is known by virtue of its traditional colours. In recent years the microelectronics industry alone has accounted for 10,000 new jobs, and a further 20,000 will be created by 1989. The state capital Munich, dubbed the Mecca of the computer world, a second Silicon Valley, has long established itself as a desirable location for foreign electronics firms, the more so since other future-oriented facilities have begun to spring up in and around the city: the Fraunhofer Institute, various Max Planck Institutes and the European and German Patents Offices. Munich has another asset. It is the site of Siemens, the superpower in the electronics world. With a workforce of 313,000 Siemens is the Federal Republic of Germany's largest employer in the private sector and boasts one of the world's steepest industrial growth rates. Over half of Siemens' 45,000 million Mark turnover is now accounted for by products which have been on the market for less than five years. Siemens' intensive research programme employs a scientific staff of 30,000 - physicists, chemists and experts in electronics and engineering. The declared research goal is to make the company a front-runner on the world's microelectronics market. The research and development budget for the next five years totals some 30,000 million Marks.

An ultramodern research complex has been built in the Munich suburb of Neuperlach. Its sole purpose is to employ intelligence and the logical pursuit of technical progress to set the pace for the electronic technology of the future. Within the 350,000 square metres of this think-tank, whose avantgarde architecture reflects its special function, a personnel of 7,000 is busy designing the miniature shape of things to come. The megabit chip must be the most complex artifact in mankind's history to date: a tiny, wafer-thin rectangle of silicon the size of a fingernail. Whoever succeeds in mass-producing such chips completely without defects will take over the lead in the international microelectronics field. Several of the world's most powerful corporations, both in the U.S.A. and in Japan, are in the race. Siemens is on the home straight. ...

A few of Siemens' competitors have succeeeded in producing this superchip under laboratory conditions, but nowhere else has the inconceivable degree of precision required for the mass-production of the miracle chip been achieved. The staff of the research complex in Neuperlach (known familiarly in Munich as "Datasibirsk") are already rehearsing the manufacturing of the megabit chip. A special factory is being built in Regensburg, at a cost of 400 million Marks, and is due to open in 1987. (Skala No.4, 1985)

Micro-Electronics Council to be set up in India

A decision to set up a 15-member National Micro-Electronics Council (NMC), which will act as the central body to formulate, implement and regulate the short and long-term national strategies in this sector has been taken. A recommendation to this effect was made by a task force three years ago and the Electronics Commission has accepted it recently. Coming in the wake of the controversy over the American technology that has been contracted for the national silicon facility in Baroda, formation of this council would seem as an emergency step to resolve the issue. The report of the task force envisages a programme, with an outlay of Rs. 400 crores, to develop a national capability of fabricating one million components on a microchip based on 1-micron technology from the level of 33,000 components on a chip based on 5-micron technology over a decade. The technology that is available in the country through the national semi-conductor complex, Chandigarh, is based on 5-micron semi-custom design technology, bought from American microelectronics incorporated. This existing technology suffices to generate some coder-decoder and micro-processor circuit designs in the large-scale integrated area.

The council, which will have full executive and financial powers, will periodically review and update R and D, production and applications in the field of micro-electronics. It will take measures to bring about maximum standardisation to meet the national requirement of microelectronic systems. Measures to ensure that specific user requirements, particularly in critical and strategic areas will be formulated. A comprehensive plan to generate in the shortest possible time and to utilise properly the scientific and technical manpower will be drawn up by the council. It will formulate fiscal, import and industrial licensing policies. (The Hindu, 16 February 1985)

Indian Computers

Computer output in India is expected to quintuple, from 2,000 to 10,000 machines, in 1985, as a result of the government's new computer policy, which eliminates controls on capacity and plant location while reducing the duties on imported components. The new policy is designed to give manufacturers which build computers and peripheral equipment from scratch, using imported components, an advantage over companies that assemble imported kits. Duties on kits will remain high. The government also proposes to import up to 2,000 personal computers through the Electronics Trade and Technology Corporation, for use by professionals, at very low rates of duty. Similarly, the Computer Maintenance Corporation will be asked to market software from international suppliers.

India: Computers go rural in a big way

The ground is being prepared for entry of computers into the rural areas. To begin with, the management information system for rural development programmes is being computerised and the day is not far off when computers will be used for optimal use of farm inputs and increasing agricultural productivity.

An idea of the emerging scenario in rural areas was given at a two-day conference on "Computer for Advancement of Rural Society (CARS)" organised by the Computer Society of India (CSI) as part of its annual convention.

The Agriculture and Rural Development Minister, Mr. Buta Singh, who inaugurated the conference on CARS, said the computerisation of management information system for rural development programmes had already been taken up on an experimental basis in a few districts. The experiment in Karwar, for instance, had yielded positive results, including better management and effective field inspections.

The Minister said there was no question of computers replacing labour in the present context. He felt that computerisation at the district level would create employment opportunities for skilled personnel. Moreover, for computerisation of vast data available at the village, block and district levels, the compilation and data preparation would provide employment for the educated unemployed. Referring to the tremendous possibilities which computer technology had opened up for agricultural development, Mr. Buta Singh said problem areas in agriculture could now be identified for speedy implementation of programmes aimed at increasing agricultural productivity. It would also be possible now to concentrate on low productivity regions having potential for agricultural growth to reduce inter-regional disparities in agricultural development. Computer facilities would also enable optimal planning for agricultural adjustments in the light of the country's requirement of foodgrains and raw materials of agricultural origin. Mr. Buta Singh, however, cautioned that rural society was an uncharted area and extreme caution would have to be practised at the initial stages to replace the routine pattern of implementation, reporting and management control so that there was minimum dislocation of the existing system. Dr. Utpal Bennerjee, consultant, in a welcome address, pointed out that eight thrust areas for use of computers in rural society had been identified: microlevel planning, food and agriculture, education, health, communication, industry, banking and environment.

According to CSI spokesmen, the price of computers was expected to come down to Rs. 50,000 and at that level it would pay for itself tenfold when used in a village with a gross output of Rs. 50,000 because it would result in a big increase in output. The CSI president, Dr. O. P. Mehra, noted that the number of computers in use had risen from 1,000 in 1975 to 3,000 in 1984 and was projected to increase to 100,000 by the end of the Seventh Plan. He welcomed the new policy of the Government to remove constraints on production of computers but felt that incentives by way of sharp reduction in import duties for all components, reduction in sales tax and other levies, provision for increased depreciation allowance etc., were required to encourage wider use of computers. (The Hindu, 11 March 1985)

Ireland: £180m. plant shows the wafer forward

The netting of Advanced Micro Devices by the IDA is a major technical boost to Ireland's electronics industry. For unlike the vast majority of electronics plants here, Advanced Micro Devices (AMD) will be doing far more than assembly. The new plant is to fabricate 6" silicon wafers for integrated circuits using advanced VLSI technology. The £180 million plant is just the second fabrication plant in Ireland, complementing Analog Devices' Limerick operation. The Irish made wafers will be shipped to low cost locations such as Singapore and Malaysia in the Far East for the simpler operations of assembly and testing, before being shipped back to Europe and other locations for sale.

Attracting a wafer fabrication facility has certain strategic implications. "As more and more electronic functions are incorporated into chips, the design of electronic products is becoming more dependent on the design of the chips themselves," said Industry Minister, John Bruton.

Over 500 steps will be involved in the fabrication process. The AMD plant represents an investment of £180 million. In its first phase, AMD will be employing 530 people. A second phase is scheduled to provide another 480 jobs. Of these, 450 jobs will be for graduates in industrial engineering, electronics, physics and chemistry, according to John Bruton. Already an IDA/Department of Industry study in conjunction with the Departments of Education and Labour is in progress to ensure that the skill requirements for the project can be met from within Ireland. (Technology Ireland, February 1985)

Ivory Coast computer specialists

With a view to serving the development needs of all of Africa, computer science specialists have founded a professional association based in Abidjan.

Spain hopes show will boost R&D

Tecnova 85, the first national industrial and technological innovation exhibition and conference was held in Madrid, March 5-9. It was mounted by the government's directorate general of industrial innovation to show the business and industrial world, as well as the general public, the importance for Spain of new thinking in industry and research.

The need for the public exposition of these topics was underlined by the director general of industrial innovation, Para Ornia, who pointed out that "Our deficit in technology transfer is more than Pta80,000m and the average Spanish firm spends on R&D less than five per cent of its total investment". Ornia explained that his department, part of the Ministry of Industry, was acting within a network that included the autonomous regional governments and many research organisations with the object, among other things, of setting up CAD/CAM research and advice centres and taking part in international projects. Fiscal and financial help was available for companies undertaking R&D he added. (Electronics Weekly, 13 February 1985)

Computers have come to stay in Sri Lanka

"Many of the mighty dams and irrigation projects this government has undertaken would have been very difficult to build without the assistance of computer technology", Mr. Gamini Dissanayake, Minister of Lands, Land Development and Mahaweli Development said. The minister speaking at the 5th National Computer Seminar on the "Impact of Computers on Sri Lankan Society" said professional people appreciated computers more than others. The minister said the subject of computers is one that is relevant to everyone today. Twenty years ago, computers were spoken of only in relation to universities or large multinational companies. However, the rapid advancement of computer technology (what has now come to be known as the "computer revolution") has made fundamental changes to the way in which people work, even in a developing country like Sri Lanka.

Part of the reason for the proliferation of computers has been the benefits of productivity associated with their use. However, the major contributor to their widespread use has been their ever reducing cost. Each year, while the costs of almost everything else increases, computer costs go down.

Not everybody has accepted computers as their friends. As the use of computers becomes more and more widespread, so does the suspicion among many working people develop that they may become unemployed because computers are replacing them at their workplaces. This fear has been amplified by recent developments in robotics, where robots controlled by computers can now handle most tasks done, for example, by motor car manufactures.

In the office too, the impact of computers has been very significant and much more widespread. In Sri Lanka today most government and private offices are computerised. Electricity, water and telephone bills are managed by computer. Computers are now an essential part of any large administrative system and have come to be commonly accepted.

The alleged adverse impact of computerisation on employment has been seen to be a myth. Since the liberalisation of imports by this government in 1977, computers, until then hardly known in Sri Lanka, have sprung up everywhere. In fact, about a hundred new computers are installed in Sri Lanka each year. Yet, you hardly ever hear of anyone losing their job because of a computer. On the contrary, many additional jobs have been created.

Centres for computer education have mushroomed everywhere, and the public is showing a great interest in educating itself in this sphere. Many of the larger schools have now included the teaching of computer science and languages in the curriculum for senior students.

The government too has spared no pains to encourage this trend. The Computer and Information Technology Council (CINTEC) was established by the President to form guidelines and define national policy in this area. At the same time, as a special incentive, the rate of customs duty applicable to computer equipment has been drastically reduced. The computerisation of many government departments, banks and corporations has greatly increased their productivity and helped them to give better services and be more efficient. In many cases rather than displace the existing staff by computer specialists, the staff of each department have been trained to operate the computer system themselves. This not only helps them to retain their jobs, but also makes them more motivated and efficient. Of course, many people may feel threatened by the introduction of computers. The inroads made by computers into fields hitherto occupied by professionals have been far reaching. (Daily News, [Sri Lanka] 14 March 1985)

UK Software study

The UK software engineering industry is due for a revamp. ACARD, the government's advisory council on applied R&D, has started an urgent study on how software engineering can be improved from both the user and producer point of view. ACARD feels that there is too much fear and ignorance at higher management levels about how software can help their operations, and that many managers responsible for equipment in manufacturing industry do not understand what software actually is or does. The council is also looking at the possibility of having a BSI stamp of approval for software, and at ways of helping consumers assess the quality of the products they buy.

The study is claimed to be complementary to the Alvey initiative which looks more towards software engineering techniques and technical management of the products. On a wider scale, the working group responsible for the study will look at the health of the UK software industry in the world market. Key issues here will be the effect of international trade restrictions on software standards, rather than acting as spectators of IBM/ISO type conflicts. (Electronics Weekly, 6 February 1985)

UK: Alvey promises £20m to interface

The Alvey Programme will commit about £20 million this year to projects aimed at improving the man-machine interface. Of this, £6 million will be for ease-of-use applications. Director of the man-machine interface scheme, Chris Barrow, says he expects to announce between 20 and 40 initiatives by the summer, involving mainly consortia of industrial firms and academic institutes. There will also be a small number of pure research ventures. This investment represents most of the money the programme is likely to spend on man-machine interfaces during its five-year term, excluding the Plessey-led demonstrator plan to build a speech-driven word processor. Industrial participants will have to match the Alvey contribution pound for pound, but academic work will be 100% funded by Alvey.

Barrow says he is pleased to have received 26 submissions on the ease-of-use question, an area that until now industry has shunned. Around half of these are likely to win approval and together will take the biggest share of the remaining budget of about £6 million. Six image-processing ventures have been approved and a further five out of 24 applications are under consideration. About £5 million will be devoted to this topic. Larger firms are concentrating on defence applications and remote sensing, while smaller firms are looking at techniques for medicine and quality control in production. Six speech projects are being launched, split between speech recognition and speech synthesis. About £4.5 million will go to these, with most of the work being done in universities. Ten suggestions were turned down. Results of this research could help the Plessey demonstrator. Only four entries were received for work on visual displays. Barrow says this is not surprising, as the research is extremely capital intensive. It is possible all four will get the go-ahead, costing a further £4.5 million. (Computer Weekly, 14 March 1985)

What is happening to UK's Alvey Programme

Two years after its launch, the Alvey programme is running some nine months behind schedule, more because of wrangles over money than bureaucracy. Early on in the programme, its director, Brian Oakley, warned that Alvey contracts were being held up because the consortia involved could not agree among themselves. This problem has since got worse rather than better. Of the 331 approved projects, which represent about 80 per cent of total funds, only a handful have got the final go-ahead. A mere £40 million of Alvey's total budget of £350 million has so far been spent. In its attempt to speed up research into new types of chips (one of the four main thrusts of the Alvey programme) the directorate has been forced to let projects begin without final agreement, on the understanding that payments will be backdated. Academic partners in the Alvey consortia, who lack the cash to recruit staff or buy equipment, are particularly badly hit by the slow progress. Their funding comes through grants from the Science and Engineering Research Council (SERC), on the say-so of Alvey. However, the SERC system of annual grants means that while industrial firms are free to start whenever they are ready, their academic counterparts are not. SERC's budget under the Alvey scheme for 1985-86 has still to be settled.

Originally the Alvey committee, under the chairmanship of John Alvey, chief engineer at British Telecom, identified four main thrusts for research. These were intelligent knowledge-base systems (based on traditional AI research), very large-scale integration chips, software engineering (concerned with improving and automating programming methods) and the man-machine interface (anything connected with the business of "talking" to computers). Because the Alvey directorate had difficulty cramming everything under these four headings separate support for computer-aided design and manufacture and wafer-scale integration were added.

Together, all of these separate strands are what the computers of the future, or at any rate the British versions of them, will be woven from. So far, the loom has proved a little difficult to assemble. Work on knowledge systems has begun quickest. This is largely because of AI work already done at Edinburgh University and Imperial College, and because it is a newer field. At Edinburgh, the Artificial Intelligence Department is working on two pre-Alvey projects, one for making sense of sonar signals and the other on the problem of getting a computer to guess what its user is going to do next. (This first appeared in New Scientist, London, 21 March 1985, the weekly review of science and technology.)

US plans four university centres for supercomputers

The US government is to spend $200 million over the next five years on supercomputers for universities. The National Advanced Scientific Computing Centres will be the Reagan administration's latest tactic in the race with Japan and Europe to build and use the next generation of large computers. Each centre will draw scientists to share time on some of the world's largest and fastest machines, according to the National Science Foundation (NSF), which will run the programme. Besides providing more scientists with maximum computer power for basic research, the NSF hopes that the centres will produce better computers as well. The four centres will be at the University of California at San Diego, the University of Illinois at Urbana-Champagne, Cornell University in Ithaca, and the John Von Neumann Center, near Princeton University in New Jersey.

Computer manufacturers, the host universities and state governments will share the cost with the NSF. The country's leading manufacturer of supercomputers, Cray, will provide an XMP computer for San Diego that will be connected, via a high-speed network, to 18 universities around the country. A Cray machine will also be the centrepiece at the University of Illinois, whose own supercomputing faculty is now engaged in designing hardware and software for supercomputers. IBM and Floating Point Systems, of Oregon, will supply the centre at Cornell, which will be under the direction of the Nobel laureate Dr. Kenneth Wilson. Control Data Corporation and ETA Systems are providing the machine at Princeton, which will cater for a consortium of 12 universities. Only a handful of supercomputers, which cost upwards of $10 million each, are sold each year. Most are used by the Pentagon and its weapons laboratories, by intelligence-gathering agencies, and the few universities that can afford one. IBM is new to the supercomputer market, and its link with Cornell is bound to change the business. Cornell's Wilson says that one of his goals is to develop a new generation of parallel-processing computers. These can outstrip today's best machines by abandoning serial, or step-by-step computing, for arrays of processors that divide and perform large tasks simultaneously. IBM is investing $30 million in the centre. Meanwhile, the Exxon Corporation, American Telephone and Telegraph and Lockheed Corporation will participate in the centre at Princeton.

Marriages between industry and universities are not new to engineering departments. But the allure of academia to industry has heightened as biotechnology and computing have become big business. The Reagan administration has encouraged the romance, although some critics have warned that joint endeavours will divert research from the basic to commercial products. Spokesmen for some of the universities insist that the centres, built in part at taxpayers' expense, will not put profits before knowledge. Nonetheless, many of the projects now planned cannot help but benefit the companies involved. At the University of Illinois, studies already planned include the redesign of chemical processing plants, faster semiconductors, and, possibly, new designs for aircraft and automobiles. Also on the agenda, however, are models for predicting contamination of groundwater, simulating the global atmosphere and the dynamics of the movement of sea ice. (This first appeared in New Scientist, London, the weekly review of science and technology.)

USSR: microelectronics development

In his research into Soviet microelectronics, Paul Snell, of Birmingham University's Centre of Russian and East European Studies, reveals that Soviet computer and chip customers apparently are content with supplies, progress in the introduction of microelectronics is assumed healthy since savings from their introduction to 1990 are put at 5,000 million roubles (approx £5m) by the State Committee for Science and Technology.

Snell's list identifies at least three distinct series of Soviet micro-chip with some obvious gaps, he suggests, where devices exist but of which little is known - and it includes examples of every conceivable semiconductor technology employed in the West. There is the chance that such devices might soon be exported as low-cost, lower-performance substitutes for Western microchips.

In the West, Snell argues the micro-electronics industry basically relies on its ingenuity in packing more circuits onto a semiconductor wafer - with VLSI - and in also producing new materials which together give faster and more powerful chips. This also has the advantage of being more reliable and using up less power and space. But in the East, he continues, there is now a marked reliance - at least in commercial production - on less sophisticated bit-slices devices as the basic building blocks. These have the advantage of being micro-programmable, for a set function, and that, if a microchip fails, often just a portion needs to be replaced. The development of this indigenous technical base had been "step-by-step" - with its ultimate application lagging - until the turn of the decade, then the Soviet microelectronic industry took off on the curve of expansion and rapid growth experienced in the late 70s here in the West.

There is some important internal integrated logic technology in the K582/3/4 devices, which have basic word lengths of 4 or 8-bit but which assume greater power by being able to combine as basic "building blocks", in so-called "bit-sliced" devices that can be 8, 16 or even 32-bit in their method of operation. Snell believes that in employing bit-sliced devices the Russian microelectronics industry is charting a different - and, he argues, a far more conservative and risk-averting - technological course from the American industry, upon which the majority of its earlier devices were undoubtedly based.

Snell's list of Soviet micro-chips also includes the fastest micro-chips for giant super-computers, mainframes and super-minicomputers, like the Elbrus (ES) and Small Machine (SM): fabricated in Emitter Coupled Logic (ECL), in the K1800 family (the K1804 to be precise), and also made in the very fast Schottky type Transistor-to-Transistor Logic (TTL) devices, in the K1802 and K1804 (the latter said to be a copy of the AMD chip). All these have potential military applications. Snell concludes that the Soviets might be as near as a couple of years away from Western developments in many electronic devices. Yet, more importantly, they lag just behind across the water-front of basic technologies, in everything from readily available commercial microcomputer products, state-of-the-art 16 and 32-bit machines, VAX super-minicomputers, new materials (like ultra-fast, but expensive Gallium Arenide chip work, high-level microelectronic production facilites, CAD/CAM, robotics and high-performance military hardware including the very latest techniques in VLSI and parallel processing micro-engines now on the horizon. ... (Electronics Weekly, 27 February 1985)

COMPUTER EDUCATION

Why computers have taken on a vital role in classrooms

In 1982, the UK government sponsored a campaign to promote information technology as a means of solving some of the problems associated with the generation, storage, handling and dissemination of information. Promoting the widespread use of computers and sophisticated electronic communication systems was a central issue in this campaign. Education is also primarily concerned with the generation, storage and dissemination of information and knowledge. So it would seem quite natural to assume that computer (and information technology generally) will play an important role within the various teaching and learning processes of an educational system. This is indeed so. The computer is finding an increasing number of applications as an educational resource at all levels of instruction ranging from primary teaching through to advanced university degree courses and a wide variety of industrial training applications. Nowadays, CAL (computer-aided learning) and CBT (computer-based training) are two popular acronyms often used to describe activity within this area. Originally, only very large computers (or mainframes) had the processing speed to support interactive CAL and CBT applications. But today minicomputers and micros are also extensively used. Much of the development work that is currently taking place is intended to support microcomputer based CAL.

The range of instructional techniques for which the computer is used includes drill and practice; inquiry-based learning; intelligent tutoring; dialogue generation; problem solving; expert system usage; gaming; and simulation. These basic techniques may be employed to implement a wide variety of teaching and learning strategies.

The future directions that development in CAL will take will be influenced by the current advances within information technology generally. Most prominent among these are computer networks, video technology and artificial intelligence techniques.

The important developments within computer networking originate from two sources: research into local area networks (LANs) and the experience being gained with satellite transmission systems (to enable global communication). Together, these are likely to provide a communication infrastructure well suited to the development of sophisticated open learning systems.

One of the major objectives of this type of system is to make information and knowledge available to a user community independent of the geographical location of those users. This may be achieved through the use of electronic books and journals. access to these being provided by both national and international videotex systems. The potential importance of video technology stems from the ease with which this medium can be used to capture and store details of events that are of interest to us. Video tape and video disc will play a major role in the design of future instructional systems - under the guise of interactive video. Such systems attempt to combine the image storage (and presentational) features of video with the logical processing capabilities of the computer. Because of its robustness, speed of access, and high quality of presentation, disc-based systems are likely to become increasingly popular.

Artificial intelligence techniques will provide us with two significant developments: advanced methodologies for modelling students, their behaviour, and, student-teacher interaction; and the application of expert system technology for the creation of knowledge bases that can subsequently be used to drive computer-based teaching machines through the use of highly intelligent student-computer interfaces. Each of these developments is important: first, when we attempt to use computers as a teaching resource we are, in effect, trying to replace some of the functionality of the human teacher by an intelligent machine; and without adequate models of conventional teaching systems, learning and cognitive processes we will not have the understanding necessary to construct useful systems. Second, as human endeavour continues to generate more and more information, our ability to cope with this becomes substantially more difficult. Within education computers have a particularly important role to play. At present we are only scratching the surface of what might be achieved. (Electronics Weekly)

Computers in education

The schools' computer network launched recently enables schools to exchange details of sports fixtures, children to pass personal messages to kids in other schools and, more sinisterly, provides teaching programs devised by industry and commerce. It is an opportune time, therefore, to rehearse some arguments about the dangers of computers in schools. Dangers that many teachers and educationalists and countless parents are concerned about, but fear to express, at a time when any questioning of the efficiency of new technology produces indignant shouts of "luddite" from the high priests of hi-tech. So what are these concerns and dangers? The most widely recognised concern is over the dehumanising effect of machines in the classroom. In allowing a teaching machine to take over a large part of the teacher's functions, the pupil loses out on a relationship with another human being, however fraught with problems that may be. And those problems, after all, are part of education. Learning is not simply being crammed with facts or manipulating information, it is also concerned with understanding attitudes, expressions, emphasis. No machine, no matter how interactive, can replace the interchange of body language that occurs in a classroom, nor can it provide the emotional contacts, negative and positive, that take place between people. Of course, it is argued that the teacher is freed by the machine to provide more human help, but the child sitting at the keyboard of a computer is not in fact participating in the sharing process that is a vital part of education (training people in particular and technical skills is quite another matter).

If children relate less well to their teacher in the computerised school, what about their relationships with classmates? There is some evidence that children cooperate more with each other when a computer is around, but this is deceptive. The children actually cooperate with each other in order to relate to the machine. Evidence now shows that computers are even more harmful than TV in affecting the ability of children to make human relationships. They are drawn into a depersonalised fantasy world and find, on re-emerging into the real world around them, that it is much harder to play with other kids. This dehumanising role of the computer stems from the form of thinking embodied in the machine. The computer imposes a form of instrumental thinking on to its user. However flexible and 'friendly' the software appears, the machine is essentially mechanistic and totally quantitative. It stems from a particular sort of adult mind, and imposes a uniformity of thought on the children it is meant to serve. In practice, the children serve the machine, adapt to its ways. The machine leads the children to believe that there is a right answer to all questions, that there is some notion of "perfection" contained in the machine. Any faults lie in the fallibility of the humans who serve this silicon master, and the world it presents to the forming mind is seen to be somehow more real than the real world around us. That is, the computer spins fantasy. The reality, fortunately, does not yet live up to the expectations engendered by the computer and media people. In practice the computer teaches what someone wants the youngsters to learn. And this leads to the question of accountability. The teacher in front of a class is accountable; the programmer is anonymous, and cannot be challenged. The computer also limits education to the single experience of pressing keys in response to images on a VDU, atrophying other human senses. Programs enable children to "weigh" objects on the screen, or "pour water" from a screen generated jug into various images of cups, thereby depriving the children of the sense of touch and a feel for balance. They can put together recipes without the use of the senses of taste and smell. They sit at the keyboard and direct the machine to do things for them, rather than doing them themselves. This is not education but its inverse, merely teaching children how to get their machines to substitute for real world living. The fantasy life of the computer program becomes a generation's form of reality.

Finally, it is argued that computers merely provide a set of tools through which children may express their creativity. The word processor enables them to write freely, released from the "burden" of using hand, eye, mind and pen as they get the machine to manipulate text. The graphics package enables them to draw or paint without the mess of actual materials, and gives them the facility to manipulate images on a screen in ways inconceivable with paper, scissors and glue. These tools actually replace the "burden" with techniques, so that writing and drawing become technical exercises rather than learned craft skills. This tool is said to give the child the chance to produce the perfect text or image, but such a notion of perfection is as much a part of instrumental thinking as the machine that breeds it. There is no such thing as the perfect letter or picture, the truth is that perfection can be found in the work of all children, expressing themselves as children. There is no set of quantified objectives for perfection, and such a notion is yet another way of denying children their childhood. In practice, the computer provides a crude tool indeed. Apart from on the most sophisticated machines (far beyond the budget of any school), computer graphics are crude, limited in scope, unaesthetic, full of zigzag diagonals, clumsy and often downright ugly. Rather than providing a tool for children's creativity, the computer lowers standards, adjusts children to a poor aesthetic sense and, rather than enabling them to create, it limits them, and in creating the illusion of "creating" for them, reduces their skills, feelings, range of expression and so on. A pencil is a far more refined tool than any computer system I have seen.

I'm not griping only about poor computer programs, although most that are available are dismal or worse. But the very use of the machine itself is detrimental to education. The better we understand that and come to terms with it the sooner those hidden concerns of parents and teachers will be dissolved while the children themselves are no longer enticed into accepting an inferior vision of the world. (Michael Shallis, Staff Tutor, University of Oxford, in New Scientist, 31 January 1985)

Micros in Indian Schools

When schools reopened in India in July 1984, some 9,000 students in 250 schools in the country were introduced to a new kind of teacher - the computer. The introduction of computers into schools is high on the Indian Government's priority list. A deal has already been struck with Acorn to supply 900 computers and associated software and the UK firm is reported to have netted some 3 crore rupees (one crore is 10 million) for the order. The policy, however, raises a dilemma for a developing country such as India. When the computers start bleeping in a handful of schools, only 36 out of 100 Indians will be able to read and write and 40 out of 100 children will have access to middle-level schools. Some argue, therefore, that the introduction of computers can only serve to reinforce the building up of a highly-educated elite and a lower rank of technical workforce, while leaving the population at large in a state of ignorance.

The introduction of computers into Indian schools is part of the seventh five-year plan which begins in April next year. The brainchild of the Department of Electronics (DOE) and the education ministry, the Computer Literacy and Studies in Schools (Class) programme is expected to grow rapidly. Though no specific proposal has yet been made for the seventh plan, an estimated 250,000 mostly government funded schools will be offering computing as a part of regular curricula by 1990. The total cost of the programme is projected to be around Rs. 300 crore. This major policy decision, however, has been taken without any open debate. The plan to start with only 250 schools has been officially described as an experiment the result of which is supposed to decide the future of the programme. It is expected that over half the schools in the country will be equipped with computers in the coming five years.

But not everyone is completely clear as to what computer literacy in Indian schools is intended to achieve. It is too amorphous and ill-defined in its aims either to impart practical skills or to encourage the student's mental growth. For computer-assisted learning (CAL) to make any impact on the quality of education, a lot will depend on how imaginatively it is used. In the absence of a large enough number of teachers with the right abilities to make CAL work, it is in danger of becoming just another drill and practice, pre-programmed text learning. Any flexibility and vividness that a computer is capable of can be lost when it is transplanted on to a traditional framework of teaching.

US experience is instructive in this area. Despite all its resources, research up until 1982 suggests that "only a few have acquired algorithmic problem-solving skills, many lack awareness of the role and value of a computer", according to Professor Joseph Weizenbaum. Computer educated children "are like people who have somehow become eloquent in some foreign language but who, when they attempt to write something in that language, find that they have literally nothing of their own to say." ... (Computing The Magazine, 11 October 1984)

Computers in Academe (USA)

The 780 first-year students entering Harvard Business School this semester need more than text books and sharp wits to help them through their arduous course-work. For the first time, school authorities expect them to use IBM personal computers - purchasable at a discount through the school - as part of their preparation for classes.

Last June, Digital Equipment Corp, and the University of Houston announced a joint plan to establish the nation's largest network of computers on any college campus. With a $35 million grant from Digital, the university will start work on a network that will eventually link as many as 20,000 computers in the school's four campuses and the homes of its students, 91 per cent of whom commute to class.

Early this year, before it launched its Macintosh personal computer, the Apple Corporation formed what it calls the Macintosh Consortium. The group will allow students at more than 20 universities to buy their own Macintoshes at bargain-basement price tags of $1,000 - about 60 per cent below the normal retail price. Dartmouth College, Drexel University, and the University of Michigan have already agreed to purchase about 6,000 of the machines over the next three years. Researchers at universities in the group will develop educational software for the Macintosh.

About 500 students at M.I.T. are acting as pioneers this semester in Project Athena. They are taking the first courses offered through the $70 million experimental project. Named for the Greek goddess of wisdom, Athena aims to make computers and computing facilities available to every individual on the campus. As a unique feature, it is using hardware from both IBM and Digital on the same network, and undertaking a major research effort to make the two companies' products compatible. (Technology Review (MIT), October 1984)

STANDARDIZATION AND LEGISLATION

EC strives for telecom standards

In a last-ditch attempt to create a homogeneous European market for telecommunications equipment and services, the Commission of the European Communities in early February agreed in principle to set up a research and development program aimed at standardizing the next generation of broadband networks. The program, designated RACE (for Research on Advanced Communication in Europe) could propel the European telecommunications market out of its dead end. Despite repeated efforts to create a competitive environment, Europe remains a group of heterogenous and protected national markets. And none is large enough to provide native suppliers with a decent return on the substantial investments required. Close on the heels of Esprit's debut, the EC's effort to promote cooperation in data-processing research, RACE is intended to have a narrower focus. While Esprit supports computer and related research in the broadest sense, RACE, in contrast, is geared to produce a product called the Integrated Broadband Communication Network (IBCN).

Should RACE be successful, such networks would be end-to-end compatible in all EC-member countries. Although no budget has as yet been worked up for RACE, some Eurocrats figure the program will match - or even surpass - the $300 million earmarked for Esprit ... (Electronics Week, 18 February 1985)

Users unite to push for IT standards

The biggest UK blue-chip companies have combined to use their computer purchasing muscle to force manufacturers to conform to international standards. British Petroleum, ICI and British Aerospace are some of the founding members of the Information Technology Users' Standards Association (Itusa). It also has the support of the Department of Trade and Industry (DTI) as well as the National Computing Centre (NCC). Ray Walker, an independent consultant and the association's first secretary general said: "While our members are only British companies, we plan to link up with similar groups in Europe. We will use the purchasing power of our members to get manufacturers to comply to standards. When manufacturers try and set up *de facto* standards which exclude certain types of equipment we will try and stop them."

The association recognises manufacturers wanting to protect their commercial position but has come to the view that it was time the user's commercial position was also protected. The companies who have joined the group have millions of pounds at their disposal to spend on computers for both data processing as well as manufacturing applications. These companies are each paying £1,000 a year to belong to Itusa. In an effort to also attract medium and small users, lower subscriptions will be charged to them ... (Computing, 1 October 1984)

BSI slams Europe over IT standards

A row has broken out between the British Standards Institute (BSI) and the European standards body, CEN, over the adoption of standards in public procurement. And a group of 12 US information technology companies, including IBM, is so concerned about European collaboration on standards for public procurement policies that it called a meeting in Paris early in December 1984 with 12 European companies to discuss the matter. Although the four-day meeting was shrouded in secrecy and its organisers are playing down its importance, it is believed that this US concern was the real reason for the meeting.

The problem originates from a call by the group of 12 European companies known as the Standards Promotions and Application Group which announced its commitment to Open Systems Interconnection standards early in 1984, to CEN, asking it to produce a European policy for the adoption of standards in public procurement ... (Computing, 10 January 1985)

European computer makers pick Unix for applications work

In an apparent attempt to arrive at a common operating system for their hardware, six European computer makers have banded together to develop applications software using AT&T Bell Laboratories' Unix operating system. The six - Bull, Ing. C. Olivetti & Cie., Nixdorf Computer AG, Siemens AG, International Computers Limited plc, and N.V. Philips - now have proprietary (and noncompatible) operating systems for their hardware. The gang of six say they want to develop a common application-software environment, which they describe as a set of tools - such as languages, compilers, and software for work stations and data-base management - that can define the interface upon which software houses can base their work. The definition of that application-software environment will be published throughout 1985. The firms say the resulting operating system will be widely available to all users, soft-ware vendors, and other manufacturers and will not be proprietary. No decision has yet been made on which of the many forms of Unix the six will choose. AT&T owns 25% of Olivetti, however, and the two firms have a London subsidiary to promote Unix. (Electronics Week, 25 February 1985)

US seeks robot standards

The Robot Institute of America (RIA) has embarked on the slow haul to develop standards for the robotics industry. The industry has so far gone without nationally imposed standards. There is no corresponding initiative in the UK. An official for the British Robot Association said that "we have tended to leave it to the industry to sort out its own". The RIA has already produced a draft standard on robotic safety and is now working with the American National Standards Institute (Ansi) to get the standard adopted nationally. This standard will cover the installation, maintenance, construction and use of robots. Jim Prange, the RIA manager of standards, said that most accidents happen during maintenance and training. The major concern in robotics safety is to keep humans out of reach of a robot when it is working.

The standard will also formalise the installation of emergency stop devices such as light barriers and pressure sensitive mats which automatically switch off a robot when crossed.

Prange said that the RIA would be developing a series of standards but that safety had the highest priority. He hopes that the safety standard will be adopted by the middle of 1985. ... (Computing, 8 November 1984)

Japanese to adopt OSI as a standard

The Open Systems Interconnection (OSI) draft networking standard has received its third major boost in as many weeks, this time from the Japanese Government. The Japanese Industrial Standard (JIS) committee announced last week that it will formally adopt OSI as a Japanese Industrial Standard, enabling computers to communicate with each other using standardised protocols. The decision means that from three months time the Ministry of International Trade and Industry (Miti) will formally adopt the standard and OSI could soon be mandatory for procurement purposes.

Three weeks ago the UK industry minister, Norman Tebbit, said that in future licences for value added networks would only be granted if the applicant could assure that OSI protocols would be offered and supported within a reasonable timescale. A week later the Government's Central Computer and Telecommunication Agency, which is involved in £100 million worth of dp purchasing each year, also backed the OSI standard. It said that in future the vast majority of government contracts would stipulate the use of OSI standards where required. In June this year OSI received crucial backing from Fujitsu, which issued a statement of intent to support OSI in conjunction with ICL and AT & T of the US. All three urged governments to avoid using IBM's SNA networking standard in government projects. Miti also recommended that Japanese computer makers take steps to develop conversion tools between IBM standards and OSI. (Computing, 1 November 1984)

Chips get copyright

Motorola and Harris are the first companies to register chip design under a new US law that gives copyright protection for up to 10 years. The new Semiconductor Chip Protection Act is the first new intellectual property law passed by Congress in over 100 years. But only chips that have been introduced after July 1, 1983, can qualify for protection under the new law, which can impose fines of up to $250,000 on convicted violators. Thomas Dunlop, Intel's general counsel and secretary, said that the new protection from chip piracy "encourages the development of chips that were previously considered economically marginal." Intel registered a new 256K CMOS EPROM, the 27C 256. A spokeswoman for Intel said that more chips are waiting to be registered under the new law. She said: "There are about another 20 chips that were introduced after the July 1983 deadline that we wish also to register. To gain protection, a company must submit to the US Copyright Office, documents that describe in detail the layout of the circuits. (Electronics Weekly, 16 January 1985)

Japan copyright urged

The international data processing community has moved to force the Japanese to agree to provide copyright protection for software. Software vendors throughout the world have voiced concern over Japan's controversial position which only offers 15 years of protection under a patents system. The European Computer Services Association (ECSA) is claiming a major breakthrough in its campaign for copyright protection with the recent recruitment of the US and Australia despite strong opposition from Japan. Last week the Australian Software Houses Association decided to support ECSA. This follows a similar move from the important US Association of Data Processing Service Organisations (Adapso) earlier this month. Canada and New Zealand have already become members of the 15 country-strong Ecsa group.

The Computer Services Association (CSA) believes this international united front will force Japan to reconsider its attitude. The point was stressed at a meeting between representatives of Japan's Ministry of International Trade and Industry and the CSA last week.

Tony Lewis, membership manager of the CSA, said the Japanese proposals were not acceptable because patents require advance declaration of developments and because 15 years is not considered sufficiently long. Legislation has been introduced to the US senate to stop the holder of software from renting, leasing or lending to others for commercial advantage. Jerome Dreyer, president of Adapso, said software piracy is "sapping significant revenues from the developers of computer software" and stunting investment in development. (Computing, 1 November 1984)

Copyright law catches up with computer software

Britain's MPs debate a proposal to include computer software under existing copyright legislation. A Private Members Bill would make copying a criminal offence liable to fines and, in some cases, a jail sentence. The bill has all-party support and, with luck, could become law by June. The legislation is backed by two pressure groups from the computer industry: the Federation Against Software Theft (FAST), which represents mainstream computer firms, and the Guild of Software Houses (GOSH), composed of firms which specialise in software for home computers. The organisations estimate that illicit copying of programs in Britain costs them more than £150 million a year. "It's monstrous as far as owners are concerned that they cannot get the full financial rewards from the programs they produce", says Donald MacLean, chairman of FAST and a director of Thorn EMI. MacLean has been pressing the government to bring in an amendment to the 1956 Copyright Act to include computer software. Although computer programs are assumed to be covered by the existing act, there is no mention of software in it and there has never been a legal ruling on the matter. ...

The present bill has been drafted with the help of experts from the Department of Trade and Industry. It covers programs stored on disk, tape, chip or similar device. There is some doubt, according to MacLean, about whether existing protection extends to programs temporarily stored in random-access memory (RAM) chips. RAM chips are used as a computer's main memory and hold work in progress only while a computer is switched on. Information held in them is lost once the chips' power supply is turned off.

One difference between computer software and other works protected by the Copyright Act is that those who buy programs need to have at least one copy of each program in reserve in case their original program is "corrupted" or damaged. Under the new law, consumers will have to rely on their suppliers to allow them to make back-up copies. The number of copies that are allowed by each copyright owner will either be printed in the documents that come with the programs or will be a matter for negotiation.

It is unlikely that the arrival of explicit copyright protection for software will end efforts made by computer firms to lock up their software with so-called technical protection. In recent years a variety of methods including encryption, extra chips, scratches on disks and modified systems software, have been developed to stop software from being copied. (This first appeared in New Scientist, London, 21 February 1985, the weekly review of science and technology.)

World in a muddle over laws on software piracy

An international meeting of lawyers broke up recently, unable to decide how to protect computer programs from piracy. The problem is whether copyright law, which protects the written word, will prevent the illegal copying and use of valuable programs, from video games to expert systems. The meeting, held in Geneva, was called by UNESCO and the World Intellectual Property Organization, the UN's patent office. In the few countries where disputes over computer programs have come to court, copyright law has proved hard to uphold. Australia passed a law in 1984 protecting programs by copyright.

Several delegations in Geneva argued that copyright law should not be aplicable to computer software. Greece pointed out that an author does not have to register a work for copyright to apply. Hence, there is no way of knowing whether, in programming an idea for which few alternatives are available, a programmer has infringed a copyright. On the other hand, an official register might give away secrets about valuable programs. Copyright law protects a work from being tampered with or adapted, even when rights to its use have been bought. But, in translating a program from one computer's operating system to another, where does translation stop, and adaptation begin? "You can't simply ignore the technical aspect in information technology, which copyright does," said one Greek delegate. Similar conflicts have emerged elsewhere. In France and Italy, the right of an author to prevent any alteration of a work is enshrined in law. In France, this has created legal confusion as civil courts have upheld copyright for programs, while criminal courts have held against it. The Federal Republic of Germany is introducing laws to copyright computer programs. But the programs must be "personal intellectual creations", more than a simple algorithm, expressable in different ways, and they must exhibit "qualities of selection and arrangement". The potential legal confusion implicit in such a definition could be a boon for the German legal profession. Amendments to copyright legislation to encompass the special features of computer programs are enacted or in progress in Denmark, Finland, Hungary, India, Norway, Spain, Sweden, Japan, the Philippines and Britain. But, say copyright's opponents, the complications are so great that countries might as well have set up special legislation to protect programs alone.

Brazil led the call among developing countries in Geneva against the unquestioning acceptance of program copyright. One concern is that, under copyright law, an author reserves the right not to publish a certain program in a particular country. Countries worried about gaining access to the technology of the developed nations want compulsory licensing of programs to prevent this. The Brazilians say that copyright law does not protect a user's rights. If a show flops, the producer cannot sue the playwright. But if a computer program does not do what it says it will do, a user should be able to sue the program's owner. But the real concern of some developing countries revolves round protection of their own fledgling computer industries. Brazil bans foreign companies from selling microcomputers if a similar machine is already produced by a Brazilian company. International copyright law would not permit any such protection for software produced in Brazil. (This first appeared in New Scientist, London, March 1985, the weekly review of science and technology.)

Data protection

America's Intel this week announced its heyed-access, erasable, programmable, read-only memory, or keprom for short. It is a cheap ($45 in bulk), wholly automatic electronic safe which can be slotted into the place of a standard memory chip. But lurking on it, beside the ordinary eprom memory, is a sophisticated electronic lock. Intel will supply the keprom to designers who then programme it to hold whatever they want protected. This might include actual data; but it would be more likely to contain those lines of the computer's operating system which are used to call up the valuable data files (bank balances, airline reservations, commercial secrets or whatever). It can even hold programmes; games designers use eproms, rather than floppy discs, to drive arcade games. Once the keprom has been programmed, whatever is in it can only be accessed by the right user.

Keproms work in pairs. One is placed inside the mainframe, the other inside the terminal. (The mainframe one can be modified to provide different access to different users with different keys.) When access is required, part of the electronic lock on one of the keproms generates a 32 (binary)-digit pseudo-random number, which is then encrypted. To encrypt, one needs a key; Intel's is 64 binary bits long, which means that a hacker testing 800 keys a second would need more than 45 billion years to try every one. The encrypted random number is passed to the other keprom, together with the en clair random number. This keprom encrypts the random number it has been given and checks to see if it gets the same answer as its counterpart did. If it does, then the whole process is repeated in reverse (so that the first keprom can be sure that the second wasn't "lying"). Only if this double handshake (which takes just one quarter of a millionth of a second) goes through perfectly will the lock on the eprom open. The trick is, of course, that the two chips contain the same key; but since the key itself is never passed along any network, a hacker, short of getting hold of a terminal and scrutinising its keprom with an electron microscope, has no way of finding out what it is. Moreover, the chip is so wired that the contents of the eprom part of it can never be electronically accessed except through the lock. (The Economist, 23 February 1985)

SOCIO-ECONOMIC IMPLICATIONS

It could change rules on shareholding

Changes brought about by information technology mean stock market investors may no longer have to hold physical evidence of their shareholdings, according to a White Paper on investor protection from UK Secretary of State for Trade and Industry Norman Tebbit. The revolutionary move is a direct consequence of the spread of information technology, says the White Paper. The financial markets are increasingly facilitated by information technology with the result that there may no longer be a need for securities to be held in the physical form of a certificate.

Tebbit says the government therefore proposes to amend existing legislation to permit the holding and trading of uncertified securities. The White Paper also makes it clear that the biggest shakeup in 50 years in the City has been considerably influenced by the growth in IT. "Modern technology is transforming both the way in which business is conducted and the opportunities for the financial services industry," it says. (Computer Weekly, 7 February 1985)

Jobs set to rise in UK electronics

Over 10,000 jobs will be created in the UK electronics industry within the next 12 months, with Scotland offering the best quality of labour. The conclusions from the National Manpower Survey of the British Electronics Industry, by the research division of the Electronics Location File are the result of a year's work covering 905 electronics companies, around 25% of the industry.

Tann vom Hove, managing editor of the survey, said that eight out of every 10 of these 10,500 jobs will be in small and medium-sized companies while the main beneficiaries of the net increase in employment will be in the South East, West Midlands, North West and Scotland. The net increase in jobs is a gain of 3% on the industry's current level of employment with a high proportion in companies with fewer than 500 employees. The survey says: "Companies with no more than 100 employees, while employing less than 20% of the electronics industry workforce, will contribute to the net gain in jobs by one third." Top of the survey's list with a net jobs gain of 4,160 is the South East, followed by the West Midlands with 1,455, the North West with 1,255 and Scotland with 1,150. Vom Hove said that the geographical pattern of electronics activity will change, as competition for space and skilled labour in the South East forces electronics companies to expand in other parts of the UK. (Computing, 1 November 1984)

Newspaper unions face tough battle to build IT policy

The National Graphical Association (NGA) is forcing itself to come to terms with the most important issue in its members' careers. At the NGA conference the union will consider a policy document, The Way Forward and Prospects for Progress which attempts to lay down a framework for future technology agreements in the industry. The NGA had successfully fought a rearguard action against what must be inevitable. Mechanical typesetting will one day no longer exist and up to two thirds of the unions' members will have no jobs. The Times, the Mirror Group, The Guardian and soon the Daily and Sunday Telegraphs will use computerised phototypesetting. The Times is close to going one step further and installing computer terminals on every journalist's desk.

The massive job losses expected in the newspaper industry would be expected to produce an industrial battle. The first conflict came in 1978 when The Times closed for 14 months over introducing the first stage of computerisation. A trouble-free transition to more advanced technology would be a surprise, to say the least.

A second front for newspaper owners opened up recently as a result of a pilot new technology agreement at the Portsmouth News. Journalists would be less affected but have objected to members of the NGA taking over editorial jobs.

The reason for heavy job losses owes more to the complications of mechanical typesetting. Journalists at a newspaper not using computers, for example The Sun, type stories on paper. This is passed to sub-editors who tidy up and if necessary rewrite the stories and add typesetting instructions. Next door the story is handed to a typesetter who starts the process of assembling lines of loose type into rows the exact length of a column. This is such a highly skilled job it takes a seven-year training to learn the operation of these "linotype" machines.

In a modern US newspaper, the San José Mercury for example, the difference could not be more pronounced. Journalists sit with terminals on their desks on which they type stories. The stories are transmitted to editorial executives and sub-editors electronically. Sub-editors edit stories on a screen and insert typesetting instructions as sometimes complicated control codes. Pages can be made up on graphics terminals. Because the stories are typed in once this has become known as "single keystroking".

The Portsmouth News scheme was agreed by the NGA and the Newspaper Society, which represents the publishers of most provincial newspapers. It allowed the gradual introduction of single keystroking with continuous high level talks sorting out problems as they emerged. The resulting agreement would form the basis of both local model and national agreements between the NGA and the Newspaper Society which was scheduled for January 1985. ... (Computing the Newspaper)

Seeds and Microchips

For the small farmers of developing countries, the computer as the primary tool of agricultural efficiency is a distant prospect. But the microchip is already making its impact in the grain fields and rice paddies, boosting yields dramatically by calculating how growers can optimise crop strategies. In China's Hunan province, rice farmers have increased yields by at least 50,000 tonnes on 260,000 hectares of land. Information on optimum times for planting, fertilising, weeding and harvesting is obtained from the local computer centre. All the peasant farmer has to do is supply information about specific conditions on his land. The computer provides a production plan laid out in simple charts. In Venezuela, peasant farmers linked to a pilot computer project are reporting wheat and maize yields up by 25%. Terminals in each village are hooked up to the programme in a central computer in the city. Despite the success stories, major technical, financial and educational problems must be solved before computers can play a significant role in Third World agriculture. In the short term, an increasing volume of work will be turned over to computers in government farm surveys, food policy planning and regional agricultural services.

A versatile package of interrelated computer programmes for farming is the SCAPA system (Systems for Computer-Aided Agricultural Planning and Action). Produced by the UK's International Computers Limited, it is being used in two areas of Malaysia. Based on data collected from local farms, printouts are available to guide farmers step-by-step to grow rubber more efficiently in 16 different combinations with other crops. The programme also gives progress reports and other services, including information on farm sales and listing of inputs.

The computer is also being deployed in cattle management. An example is the dairy programme, run by the department of agriculture and horticulture of the University of Reading, UK. Farmers are given personal advice on how best to look after their cattle operation. In one case, better doctoring of cattle feed saved a farmer with 500 cows US $4,200 a month.

Large scale agricultural development projects in Third World countries will depend increasingly on computers to handle payrolls, budgets, inventories, and to plan, manage and evaluate projects. A pioneering effort in this field is the Ayangba agricultural development project in Benue State, Nigeria. Ayangba, one of several government-run projects for rural communities, covers everything from farming to road-building. Based on surveys, computer programmes are written to calculate field sizes, crop yields and patterns, labour inputs and five-year cost tables for the project. While these early forays into a comparatively new area appear to be proving their worth, large scale implementation in the Third World faces major obstacles of limited choice a severe shortage of local technicians and programmers inadequate data gathering and programming. However, optimists forecast that the computer's agricultural role will grow as the hardware gets cheaper and more powerful databanks multiply and the advantages of computer farming boost demand. (South, 1984)

New Technology Is Called a Failure In Serving Third World Education

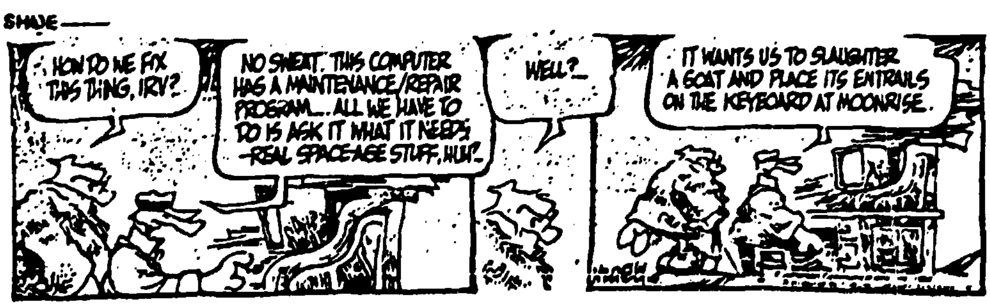
Advances in communications and information technology have been of little help to developing countries trying to educate their children and illiterate adults and train their unemployed, educators and journalists said at a seminar held in Ajijic, Mexico. Their frustration was reflected last week in a meeting sponsored by the Ajijic Institute of International Education and the International Council for Educational Development. It brought together education and news media representatives from seven Latin American countries, Britain, France and the United States.

Dr. Juan Carlos Lavignolle, an educator and columnist for the Argentine newspaper La Prensa, defined as a basic problem the tendency to focus on the instruments of transmission, and to gloss over the fact that there is nothing of value to transmit. In communication as in education, the high-tech hardware, such as computers and satellites, is starved by the lack of software, or content, he said. Conferees also reported that expensive and elaborately produced educational television programs in developing countries reach less than 1 per cent of the potential audience.

Claudio de Moura Castro, a Brazilian university professor, called for greater reliance on "low-tech" solutions, such as books, radio and the blackboard. Brazil, he said, has an elaborate computerized data bank, "but nobody uses it". Why look to costly high-technology transmission of information, he asked, when the job could be done more easily and more cheaply through the copying machine and the mails? Roberto Rondon Morāles, a physician on the faculty of the University of the Andes in Venezuela, estimated that perhaps 40 per cent of all the technology bought is inappropriate to local needs and is never used. Educational technology in the Third World, said Oscar Soria, a Mexican academician who is a director of the Ajijic Institute, has gone through a period of progress, but disappointment has followed as hoped-for miracles failed to materialize. Much technology "went into decay," he said. "Successes have been islands in an ocean of failure," he said. Specifically, "there are no global solutions to illiteracy." He thought developing countries may have come to "the end of the importation of foreign solutions and that time and patience are needed to create local solutions."

Dealing with educational problems in Latin America is complicated by intense national feelings, particularly about any suspicion of North American or West European imperialism. "Sesame Street," the U.S. television program for preschool children, is an example. Although acknowledged as one of the best-researched televised teaching aids, it was rejected by Mexico as incompatible with Mexican values. So Mexico developed its own version to avoid charges of North American imperialism. Subsequently, the Mexican version was rejected by other Latin American countries as Mexican imperialism.

The word "dependency," said Mr. Soria, "needs to be decontaminated." It is in the industrial countries that much essential information is produced, he said, and "denying this is insanity." In social science and educational research, there is often in the Third World "a mismatch between researchers and practitioners," said Alain Bienayme, professor of economics at the University of Paris. Social science research, he said, is often perceived by those in power as dangerous. At the same time, researchers complain that those in power do a poor job of carrying out the programs recommended by researchers. (International Herald Tribune, 13 March 1985)



(Source: MIRCINET Newsletter)

GOVERNMENT POLICIES

Current situation of Microelectronics in Brazil: an overview *

In 1981, the Special Secretariat of Informatics (SEI) of the National Security Council was assigned to co-ordinate the government activities in the Brazilian microelectronics area. In that same year, SEI had resumed studies previously developed on the matter and, together with other government agencies, private companies, universities and research groups at work on the area, defined the guidelines for its actions, which have become effective thenceforth. At present (June, 1984), the National Congress of Brazil is carrying out a study on the possibilities of improving and enlarging the scope of these actions. These actions are rooted in governmental policies established in the middle of this century and whose objective was chiefly to increase the scientific, technological and industrial development of the country. Among other outcomes, these policies have brought about improvement and expansion both on research activities and fosterage of human resources within universities and government-owned Research and Development Centres (R&D), and incentives to developments in technological and entrepreneurial activities of domestic industrial undertakings.

In the beginning of the eighties, when these actions started to take effect, the situation of microelectronics in Brazil was as follows:

- The expected value of the domestic market for semiconductor components was US$130 million per year.

- That market basically consisted of discrete components and linear integrated circuits used on consumer electronic equipment for domestic consumption. There was a great demand for a wide range of different types of components. Valuable segments of the market were captive to foreign subsidiary companies that controlled part of the production of the above-mentioned consumer electronic equipment.

- That market was supplied by imports and by the production of fifteen companies with manufacturing activities. Amidst the above-mentioned companies, fourteen were foreign corporations subsidiaries established since the mid-sixties, and one was a domestic private company which was established in 1974 to operate on wafer processing and which went bankrupt in 1980. Among the foreign companies, two of them performed wafer processing (one produced power components and the other discrete components and rather simple integrated circuits) besides having mounting and testing lines. The remaining twelve companies performed only mounting and testing activities. Furthermore, another foreign company allotted its whole linear IC's assembly activity exclusively to exports. Except for that company, the remainder were set up basically to supply the domestic market and their export performances were small. The amount of exports of all those companies totalled US$40 million per year.

- From the University standpoint, the Federal Government, through its agencies and public companies, had supported and fostered laboratories and research and development groups devoted to microelectronics since the late sixties. Specially noteworthy were the Microelectronics Laboratory of the University of Sao Paulo (USP), the Devices Research Laboratory (working on composed semiconductors) and the Electronics and Devices Laboratory, both at the University of Campinas (UNICAMP), not to mention other research and development groups at work in many federal universities, such as the Federal University of Rio de Janeiro, Federal University of Rio Grande do Sul, Federal University of Pernambuco and Federal University of Minas Gerais. However, the growing financial difficulties faced by the country since 1981 had forced the Federal Government to drop its investments in those activities approximately to the equivalent of US$2.5 million per year.

- Despite their surging demand, design and manufacture capability for both "custom" and "semi-custom" integrated circuits were inexistent.

Within this context, the chief objective of the measures being carried out by SEI is to develop a suitable scientific, technological and industrial domestic infrastructure so as to enable the country to design, develop and produce strategic components in order to meet

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the needs of those national industrial segments whose evolution is dependent on microelectronics. To that effect, the Federal Government is introducing a set of incentives to domestic private undertakings whose goal should be to master the complete cycle of production of strategic components, such as digital integrated circuits, considered of vital importance to the full development of the Brazilian electronic industry. It is apparent that the implementation of this complete cycle of production is liable to require rather much time and hard work to be attained and will also most certainly require interactions with other countries. The Federal Government will closely follow the evolution of these enterprises in order to grant and keep up incentives previously accorded and to ascertain the achievement of technological capability goals. Amidst these governmental incentives stands out the Microelectronics Institute of the Technological Centre for Informatics (CTI), that was set up in 1983 in Campinas (a city approximately 60 miles away from Sao Paulo), nearby the Research and Development Centre of TELEBRAS* (CPqD) and UNICAMP. The chief objective of the Microelectronics Institute is to promote and co-operate in the development of the Brazilian microelectronic area by encouraging and conducting research and development programs along with universities, other R&D Centres and industries. Thus, the Microelectronics Institute is responsible for co-ordinating a nationwide program of research activities and human resources qualification within the university realm through committees formed by representatives of the academic, R&D, professional, industrial and business community. According to this model, universities are expected to develop works on advanced fields of technology and science in order to enhance scientific and technological mastery at international level. It is also expected that universities should provide sufficiently skilled training to their students so as to enable them to promote technological innovations in their future professional areas. Outcomes of works developed in universities must undergo a process of development and improvement either in the Microelectronics Institute, other governmental research centres and/or industries, whenever they prove to be suitable to any of those institutions. The Federal Government expects that this model may even contribute to the progress of the state of the art at international level, thus giving rise to cross-licensings and intense exchange of information on technological processes, software programmings etc., with universities and concerns from abroad. Within this context, some Brazilian corporations have decided to invest in the microelectronic area during the last years, certainly motivated by the vital importance of achieving technological mastery and adequate capability to design "custom" and "semi-custom" integrated circuits. They may also have been encouraged by the prospects of governmental incentives and by a qualitative and quantitative increase of the domestic market. The expected overall domestic production of semi-conductor components is approximately US$100 million, including approximately US$40 million for exports. However, this production requires imports of chips, silicon wafers, chemical lead-frames etc., that total almost US$35 million. The relatively small growth of the domestic market when compared to its performance in 1980 and the rather high idle capacity of assembly lines facilities already set up in the country, are consequences of the recession that Brazil has been forced to face since 1981. Concluding, it can be said that the measures being undertaken by the Brazilian Government express the nation's rising awareness of the importance of attaining suitable microelectronic technological capability so as to engender the development of industrial sectors whose operations count on microelectronics. However, it is important to point out that the country's economic difficulties, the short time establishment of those governmental measures, plus the fact that a significant part of the projected incentives has not yet become effective, render it difficult to draw further conclusions about the effectiveness on the outcome being attained through those measures.

RECENT PUBLICATIONS

<u>UNIDO publications</u>

UNIDO/IS.526 — Survey of government policies in informatics prepared by the UNIDO secretariat

UNIDO/IS.529 — The UNIDO Programme on Microelectronics: an analytical perspective prepared by the UNIDO secretariat

UNIDO/IS.531 — Technology Monitoring in the Information Technology Sector in Argentina prepared by Sean Eamon Lalor

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* TELEBRAS (Telecomunicacoes Brasileiras S.A.) is the government-owned holding company for Brazilian telecommunication operating companies.

Documentation prepared for the Regional Meeting for the Initiation of a Regional Network for Microelectronics in the ECLAC Region (REMLAC):

ID/WG.440/1	The Use of Public Purchasing as a Tool to Develop Technological Competence in Microelectronics prepared by E. Lalor
ID/WG.440/2	Telecommunications and Information Technology in Latin America: Prospects and Possibilities for Managing the Technology Gap prepared by M. Hobday
ID/WG.440/3	Proposed Structure of the Regional Network for Microelectronics in the ECLAC Region prepared by the UNIDO secretariat
ID/WG.440/4	Some Considerations on the Content and Modalities of a Programme of Work for REMLAC prepared by the UNIDO secretariat
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ID/WG.440/6	Report on the UNIDO Mission Preparatory to the Establishment of a Regional System for Microelectronics in Latin America (REMLAC) prepared by G. Fernández de la Garza and M. Octavio
ID/WG.440/7	Government Policy for the Data-Processing Industries in Argentina, Brazil and Mexico prepared by H. Nochteff

<u>UN Centre for Science and Technology for Development</u>

<u>Advance Technology Alert System (ATAS)</u>

<u>The ATAS Bulletin</u>

The ATAS Bulletin is a semi-annual publication and is part of an effort by the United Nations to link research institutions in developed and developing countries and to provide concise and integrated information on the potential positive and negative implications of specific technologies for the development of developing countries. It provides concise information on specific new and emerging technologies. It is designed to alert policy-makers and planners in the third world to the potential development implications of these technologies.

The bulletin has a standard format, which includes:

- An overview of a specific new technology
- A review of major on-going activities involving this technology in the developing countries
- An assessment of the potential benefits of the technology to developing countries
- An analysis of potential negative impacts
- An analysis of the factors involved in capacity building in the specific technology, with a focus on human resources, investment requirements, and science and technology infrastructure considerations, and including policy planning implications with regard to the promotion and application of the new technology in the context of a national development strategy.
- News on ATAS-related substantive and institutional matters.

A pre-publication version of ATAS Bulletin II "Microelectronics - The Implication of Automation for Developing Countries" was discussed at an editorial workshop held in Rome in March. The final version is expected soon. ATAS III "Software Technology" is under preparation.

Economic Commission for Europe

Sales No. E.84.II.E.33	Production and Use of Industrial Robots
Eng.Aut/SEM.3/4	Report on the Seminar on Flexible Manufacturing Systems - Design and Applications, Sofia (Bulgaria), 24-28 September 1984
Forthcoming in second half of 1985	Recent trends in flexible manufacturing

The Semiconductor Industry

The following is an excerpt from a much broader and extensively researched article by Dimitri Ypsilanti, Information, Computers and Communications Policy Division, OECD's Directorate for Science Technology and Industry.

Three distinct phases of international technology transfer in the semiconductor industry can be identified:

- The domination of the industry by American firms which were involved in direct investment overseas and some licensing agreements.

- The emergence of Japanese competition and the increasing drive by European firms to obtain technology.

- The increasing internationalisation of the industry through direct investment and international cross-licensing between firms at a similar technological level. (In earlier years the pattern had been for firms with a weak technological base to receive licenses from technologically advanced firms.)

Because of the extensive direct investment on the part of U.S. firms in Western Europe during the 1960s, a significant share of European semiconductor production (50 per cent in 1983), especially integrated circuits, are produced by U.S.-owned installations. During the late 1960s, there was also a surge in direct investment in assembly operations by U.S. firms in developing countries, notably South-east Asia; this investment, which has slowed considerably since the mid-1970s, was in the main a response to the need to reduce costs so as to meet the competition. A wave of direct investment by European companies in the U.S. began in the mid-to-late-1970s and reached a peak in 1977 as they bought up existing semiconductor companies. Subsequently, there have been very few such acquisitions, though there have been major investment and expansion programmes in the companies acquired. Since the latter part of the 1970s, Japanese semiconductor firms have adopted a strategy of investing directly in the United States and, more recently, in Europe. Three assembly facilities for integrated circuits were set up in the United States between 1978 and 1981 (NEC, Hitachi and Fujitsu). Mitsubishi followed in 1983 while Toshiba has acquired a manufacturing facility. In Europe during 1980-82, Japanese producers set up four manufacturing or assembly plants: Hitachi and Toshiba in Germany, Fujitsu in Ireland, and NEC in the United Kingdom.

While a large proportion of the joint ventures of the late 1970s and early 80s were between U.S. companies, there was also interweaving between American, Japanese and European firms, partly to gain access to markets but mainly to develop new products. A common form of inter-firm technology transfer has been through "second sourcing", which allows one firm to make an exact copy of another firm's product. Second sourcing is useful, especially for small firms whose innovations may be more acceptable if manufactured by large companies. It also allows firms to keep up with the rapidly changing technology without incurring larger R and D expenditures and can be used to set standards by broadening markets for a particular product. European firms have concluded such agreements with U.S. manufacturers so as to keep up with recent technological developments and to offer their customers a range of tested and tried products. One of the newer forms of inter-firm technological agreement is the customer-supplier relationship in which a consumer of electronic components offers to buy them exclusively from a single company, obtaining in return the right to produce that firm's products; such agreements are often necessary in order to share the high product-development costs of "systems-dimension" components. The increased use of customer-supplier agreements in recent years reflects the realisation on the part of larger firms that the independence of innovative firms should be maintained; this factor is particularly important in the U.S. where firms producing integrated circuits are not usually vertically integrated and contrasts with earlier practice when smaller firms involved in takeovers were integrated into the purchasing firm's structure.

Few intra-European technological co-operation agreements exist in the semiconductor industry. Because of the relative technological backwardness of Europe in semiconductors, it has seemed more logical to acquire technology through agreements with leaders in the sector, that is, mainly with U.S. firms. The important question is whether the agreements between European firms and their U.S. or Japanese partners will allow European firms to remain or become serious competitors, given the rapid rate of innovation in the industry. Such agreements are often a stopgap. European industry still has a relatively weak record in exploiting promising innovations, particularly in standard products, and in co-operating to increase the effectiveness of research. The EEC's ESPRIT programme and recent agreements such as those between Philips and Siemens will undoubtedly help to change European attitudes in this regard. Both of these are financed in part by government. In spite of the increasing co-operation among semiconductor-producing firms in the OECD area, there is keen competition in the field - even between firms which co-operate. It is disquieting however that in many cases agreements between firms have proven necessary at the international level to overcome obstacles to direct trade or to reduce trade frictions. This reflects a certain weakness in the international trading system. ... (The OECD Observer, January 1985)

A Data Base that Keeps up with the Computer Industry

Strategist Inc. is taking the pulse of the computer industry. The Visalia (Calif.) market research and consulting company has developed a data base to track, index, and analyze a broad array of trade-press articles that reflect vendor and user attitudes, concerns, and plans. Using the content-analysis methodology popularized by John Naisbitt in his best-seller Megatrends, Strategist will issue semiannual reports on industry trends and make its 5,000-article data base available on disks for IBM PC-compatible personal computers. (Business Week, 24 December 1984)

Microelectronics in Industry: An international Comparison (Britain, Germany, France)

The report provides objective facts and figures based on surveys covering more than 3,300 factories in the above three countries. It shows that Britain is slightly behind Germany in the percentage of factories using microelectronics in their production processes and, probably more important, further behind in the percentage with applications in the products themselves; but ahead of France in both. Compared with Germany, Britain makes less use of CNC machine tools and robots, appears to have fewer professional engineers with microelectronics expertise and sends fewer people on training courses. However, Britain appears to be relatively strong in some areas, such as the electrical engineering and food industries, and in the use of semi-custom chips. Altogether about 5,000 factories in Germany, about 13% of all those employing 20 or more people are using microelectronics in their products. This is more than double the proportion in France (about 6%). Britain (with about 10%) is roughly mid-way between. The proportions with applications in processes are higher - 47 per cent in Germany, 43 per cent in Britain and 35 per cent in France.

(This report is available from Policy Studies Institute, 1/2 Castle Lane, London, SW1E 6DR at the price of £10. It was published in January 1985.)