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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Distributed free to a targeted audience in developing countries

Compiled by Ms. D. Rhind, Technology Development and Promotion Division, Department for Industrial Promotion, Consultations and Technology, UNIDO, P.O. Box 300, A-1400 Vienna, Austria.

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

I. NEWS AND EVENTS

New information revolution

Will new technology make possible another information revolution? Small circuits, fewer components per circuit and larger silicon wafers have propelled the revolution of the past two decades. Circuits will continue to shrink. But selecting the technology to achieve this shrinkage may be critical. Transistors with gate lengths only 0.1 microns long have been successfully tested, but mass production has not been achieved, since they must be made with electron beam lithography. Designers say that today's powerful 4 Mbit chips will soon be replaced by 256 Mbit chips, with work on 1,000 Mbit chips to be under development by 1999. Minimum line width now produced is 0.35 microns, limited by a numerical aperture number of 0.6 for laser light of 250 nm. Focus drilling and phase shifting masks might allow production of features as small as 0.15 microns. It is not clear, however, if optical lithography is the way to go. Some engineers say that X-ray lithography holds more promise. And electron beams could be used to produce specialized chips. X-ray techniques will depend on the mask and the X-ray source used. The high cost of synchrotron radiation sources will be a deterrent to developing X-ray lithography. (Extracted from *New Scientist*, 18 April 1992)

Intelligent manufacturing

A little-noted but potentially huge milestone in the history of research collaboration between the United States, Europe and Japan was reached when government officials, industrialists and academics gathered on 24 February in Toronto to launch a two-year pilot study on intelligent manufacturing systems (IMS). This is the first major collaborative programme of commercial significance involving the world's three main scientific blocks.

The IMS project has had a difficult and prolonged birth, proposed two years ago by the Japanese Ministry of International Trade and Industry (MITI). IMS is intended to apply cutting-edge information technology to industrial manufacturing. It was designed as a counterpart to the International Human Frontier Science Programme, a MITI initiative that is now jointly supported by the G-7 nations and the European Communities and that supports basic research in molecular biology and neuroscience. Both programmes are Japanese attempts to put money into collaborative research and to counter criticism by Western countries that Japan's economic success has been achieved by "riding piggy-back" on the research expertise of Europe and the United States.

MITI envisaged having $1,000 million to spend over 10 years. Japan was to provide 60 per cent of this money, with the rest divided between the United States and the European Communities (EC). Most of the work would have been carried out in a single new research centre, set up in the EC or the United States, although the programme would have been administered from Tokyo.

But now the proposed international fund, the central administration and the research centre have all gone. Instead officials were expected to choose three pilot collaborative research projects to be conducted in the home laboratories of the researchers involved. The nations taking part (the EC, United States and Japan have now been joined by Australia, Canada and the countries of the European Free Trade Association) will finance the work carried out on their own territory. (Source: *Nature*, Vol. 355, 27 February 1992)

Low-cost calls between Europe and the USA

Staggered by the phenomenal telephone bills incurred by his Europe-based salespeople, an American businessman has set up a new scheme to sidestep Europe's PTTs. European telephone charges can be twice those levied in the USA.

Howard Jonas, publishing entrepreneur and part-time inventor, who started the scheme when his US-based directory publishing company was expanded into Europe, has now started to market his telecommunications service to a wider public. International Discount Telecommunications Corporation (IDT) rate, based in New York, has now been selling its cut-rate service since autumn 1991.

How it works: a user in Europe who wants to make a call to the USA first dials the company's New York switchboard, which then calls the user back and connects him or her to the domestic telephone lines. The user can then make his or her call on a US telephone line, in effect reversing the charges, so that the user's company pays only the far lower American rate.

Originally, the switchboard service was worked by human operators, but a computer system has now been developed that can perform the same task. One helpful spin-off is that the computer system also improves sound clarity.

The IDT service, which now has an impressive lineup of international clients, is said to be perfectly legal, but Europe's PTTs are, it is reported, not amused. (Information source: *International Herald Tribune*, 16 January 1992)

Integrated Services Digital Network (ISDN)

Integrated Services Digital Network (ISDN) is an end-to-end digital network, which is widely seen as the successor to the public switched telephone system.

Voice and image transmission quality is enhanced with the use of ISDN, and the time it takes to send a fax or a computer file can be reduced by anywhere up to 85 per cent. On the minus side, use of ISDN costs at least twice as much as that of normal telecoms lines.

Special equipment is also needed to use ISDN - either complete systems, such as purpose-built private exchanges, or adaptors to connect existing PCs and data terminals.

Whatever the costs, ISDN looks likely to be the system of the future for telecoms transmission, as more and more countries bring it into service. For availability in EC countries, refer to *Information World Review* (ISSN 0950-9879), May 1992.

Bring wireless to the masses

Until recently, wireless data communications were the preserve of vast corporations with the mega-dollars needed to build their own network. Increasingly, however, the option of using radio to transmit data is becoming accessible to much smaller fish in the corporate sea, as companies rush to bring wireless data communications networks to the masses.

Two new systems, Ardis and Ram, are already up and running in the USA. These networks are relaying electronic mail messages to travelling executives, and exchanging information with field-service technicians, insurance-claims adjusters, and other workers on the move. Both systems use the packet-switching technology used by telephone-based data networks. Packet switching encapsulates data in "envelopes", ensuring that their information arrives intact.

The mobile data business is a major part of an even bigger market for all kinds of wireless data communications, including office computer networks that use airwaves instead of wires. A number of communications companies are modifying existing networks for wireless data.

Cellular carriers are pursuing a variety of technologies to boost data traffic over their voice systems. Specialized mobile radio networks that have been used to dispatch fleets of taxis are now being fitted for data communications.

Paging services are also getting in on the act; one US company has recently set up a national service delivering text and data to pagers. The race is far from over, but one thing is clear; wireless data services are here to stay. (Information source: *Business Week*, 9 March 1992)

Numbers for the 21st century

EC initiatives in the pipeline on telecommunications numbering may mean that the day when countries of the European Community share a common country code may not be far off.

Numbers are a key element of a telecommunications service, and in particular for the introduction of new and competitive services. The numbering plan of a country's telecommunications service must be capacious and flexible enough not to constrain the system's continued development and expansion.

The EC (European Community) is designing a common Community numbering policy for the 21st century. While changes to existing national numbering plans are likely to be achievable only slowly, and there is little prospect of major change before the end of the decade, the European Commission has already taken action to harmonize some individual access codes in use within the Community. A common European emergency number (112) is, for example, required to be introduced by the end of 1992.

Another European Commission initiative deals with the introduction of a harmonized international access code (00), and further measures are planned. An expert study on the introduction of a European area code has recently produced its report, which proposes a Community-wide "country code", to be used as a supplement to existing national country codes.

The report summarizes the benefits to the Community of a European area code, identified the most appropriate choice of code, and considers the major implementation aspects. Copies of the report can be obtained from: Jürgen Rosenbaum, CEG/DGXIII E5 Rue de la Loi 200, B-1049 Brussels, Belgium (TP+32 2/236 90 28; Fax+32 2/236 90 37). (Information source: *XIII Magazine*, Issue Number 1/92)

CD/ROM workshop in Ghana

Within the framework of the Sub-Saharan African Journal Distribution Programme, the American Association for the Advancement of Science (AAAS) is to hold a CD-ROM Workshop in Accra, Ghana in November 1992.

The workshop will have two components: a one-day session for academic and scientific decision-makers, which will look at what CD-ROM can do for the end-user, CD-ROM technology and costs and funding; and two days for librarians and information professionals who already have CD-ROM capability within their home institution. Topics to be covered will include: technological troubleshooting, funding strategies and marketing CD-ROM to researchers and academics.

A variety of CD-ROM products will be demonstrated during the course - some well-known titles such as MEDLINE, POPLINE and AGRICOLA as well as some less familiar full-text databases.

For further information, contact: AAAS, 1333 H Street, NW, Washington, DC 20005, USA. (Information source: *WHO Liaison*, March 1992)

Global alliance to speed image transmission

IBM and Time Warner are understood to be negotiating a global alliance to link the computer maker's technology with Time Warner's TV systems and its library of films and TV material.

A venture between the world's largest computer maker and its biggest media company could accelerate the merger of home entertainment, computers and communications, leading to new features.

An engineer at the University of Rochester, New York, has developed e method of speeding up the transmission of images by stripping down the amount of information that needs to be sent over telephone lines. The system allows photographs, charts and other material to be faxed four to five times faster. (Source: *AMT*, June 1992)

Recycling process

A new process for recycling glass from cathode ray tubes (CRTs) has been announced in the US. This process, developed by Digital, Envirocycle and Corning, eliminates the need to bury television sets and computer videos display terminals in increasingly expensive hazardous waste landfill sites. The recycling process requires a material to be recycled, a process that extracts the primary material and recycles residual materials and a source to utilize the primary material, which in this case is the CRT glass. Digital supplied the material, Envirocycle the process and Corning the crushed glass end product. (Source: *AMT*, March 1992)

Working at home

The UK Department of Trade and Industry began a year-long investigation of teleworking - working at home or in a remote office with a computer early in July. The study will first assess the current state of teleworking in Britain. Then, between September 1992 and March 1993, it will investigate three organizations which use teleworking in depth.

Management consultants Brameur, of Aldershot in Hampshire, are running the study. Eric Todd of Brameur says teleworking is already used by disabled people and people in remote communities. Brameur will recommend to the DTI the action it should take on funding and technical assistance, legal issues and standards. (This first appeared in *New Scientist*, London, 11 July 1992, the weekly review of science and technology.)

Europeans collaborate on submicron CMOS technology

The two largest European semiconductor manufacturers, Philips Semiconductor of Eindhoven, The Netherlands, and the Franco-Italian SGS-Thomson Microelectronics have signed an agreement to collaborate on the development of advanced submicron CMOS logic processes. Their first work on a 0.5 μm CMOS logic process using 8 in. wafers is to be completed by the end of 1993.

All of the work will be carried out at the Joint R&D centre of SGS-Thomson and CNET (the French telecommunications authority) in Crolles near Grenoble, France. This centre is currently under construction, but should be operational by the middle of this year. The companies have also agreed that Philips will use the SGS-Thomson pilot production plant in Crolles for the production of prototypes and any devices developed using joint processes.

Nevertheless, this collaboration falls far short of the fusing together of the three largest European semiconductor producers that seemed a strong possibility a year ago. (Reprinted with permission from *Semiconductor International Magazine*, April 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, Illinois, USA)

ED directive on VDU

The EC directive on VDU use comes into effect at the end of this year and is set to cost industry up to £295 million to implement, according to estimates.

The legislation will affect all full-time users of display screen equipment - almost 7 million workstations will require considerable changes to working conditions for even the most enlightened employers. The days when a VDU was just dumped on a hastily cleared space amid the same lighting and payout as that used for typewriter use are over at last.

By December 1992, employers will have to comply immediately with EC directive requirements for all new workstations. For existing workstations, they will have to have assessed what changes are necessary, but will have four years to implement these alterations.

The Health and Safety Commission has published a consultative document with its proposals for regulations and guidance on work with display screen equipment. It is now awaiting responses from relevant parties such as employers and trade unions.

Unions have already expressed misgivings over the proposals which they deem to be too weak. They are unhappy the directive only applies to habitual users and want the employers' duty to give free eye tests extended to all users.

Reuters has taken steps to correct its work environment, changing keyboards and so on. But are other employers taking heed? They face a similar scenario to that in Australia where 50,000 government employees are suing their employers.

More than 55 per cent of employers have not yet developed any policy on VDU use, according to a survey by the personnel managers' magazine *Personnel Today*. The private sector is lagging furthest behind - only 40 per cent have firm guidelines satisfying EC requirements, compared with 57 per cent of public-sector employers.

Of private-sector employers, transport and communications firms are the most likely to have set up adequate policies and employers in manufacturing and finance the least likely.

Ergonomics consultancy MCU claims the EC directive will minimize the effects of the bottom 20 per cent of poor work practice.

But although there are about 100 points to cover in each assessment, Alastair Davidson, managing director of MCU, says most employers are far more daunted than necessary.

MCU is currently updating its employers' manual, "VDUs, Ergonomics and the EC Directive". This outlines in detail exactly what employers should be doing and where they stand. It says that while the cost of implementing the directive will be considerable, the improved productivity should offset these costs.

Estimates say implementation will cost up to £40 million a year. More than half of this will be spent on the assessment, risk reduction and minimum compliance of each workstation. A further third is associated with providing users with an employer-paid eye test. All in all, the cost represents about £42 per workstation - less than 1 per cent of the cost of equipping a new workstation.

In many cases employees will have to wait four years before they reap the benefits of the EC legislation. In the meantime improving posture can help to minimize stress.

But the pressure is on for employers to act. Both the EC legal requirements and the mounting lawsuits combine to enhance employees' rights. The UK is likely to follow in the footsteps of the US and Australia where the courts have backlogs of cases.

EC directive requirements

- Employers must analyse all workstations and take action to remedy any risks.
- All operators must be trained in adjusting workstations.
- Employees have a right to regular screen breaks or changes in routine.
- Employees must have eye tests before starting work on VDUs and at regular intervals.
- Display screens must satisfy six sets of criteria such as stability of image, swivel and tilt, height adjustment and reflections.
- Keyboards must satisfy five criteria such as legibility of keys and adjustability of keyboard.
- Work desks must be adjustable and not reflect too much light.
- Chairs must satisfy four criteria such as adjustability.
- Each operator must have sufficient working space.
- Workstations must not produce too much heat, noise or radiation.
- An adequate level of humidity must be maintained.

(Source: *Computing*, 30 April 1992)

Intel set to develop TeraFLOP in Europe

Europe is to play a major role in Intel's bid to develop supercomputers capable of performing a trillion floating point operations per second, or TeraFLOPS.

At the Supercomputing Europe '92 conference in Paris, Intel announced that it was to establish a European Supercomputer Development Centre in Munich.

The new centre will be staffed largely by locally recruited Europeans and will concentrate on software development, including operating-systems, environments and application tools. Intel's aim is to produce a TeraFLOPS machine by the middle of the decade.

The company recently received a promise of $21 million over five years from the US Defence Advanced Research Projects Agency (DARPA) to help in its development of TeraFLOP machines.

Intel is also cooperating with the Open Software Foundation, which has a development centre in Grenoble, France, to develop an OSF-type operating environment for its TeraFLOPS machines. These will be

built around massively parallel arrays of its i1860 microprocessor. (Source: *Electronics Weekly*, 19 February 1992)

The man from UNCTAD

Computer programming is not something most people associate with the United Nations Conference on Trade and Development (UNCTAD). But these days even UNCTAD has adopted the rhetoric of enterprise, markets and "good management". Better yet, the UN agency is showing an unsuspected flair for innovation in putting computer power at the service of governments in poor countries. At its headquarters in Geneva a tenth of UNCTAD's 430 staff are now working on software development and related activities.

Their biggest project involves customs computerization, a system now installed by over 50 countries to cut costs, speed transactions, reduce corruption and provide trade data. Other UNCTAD software packages cover debt management (the latest version written in collaboration with the World Bank), trade barriers, shipping and commodities. MICAS will enable users to get data on the production and consumption of most common commodities anywhere in the world, down to the level of individual firms. Governments normally get UNCTAD's computer systems free as part of aid projects financed by the UN or World Bank.

These systems clearly have commercial value. Automating customs procedures can more than pay for itself by boosting tariff revenue. Proper debt management can save millions. But UNCTAD officials claim to have a competitive edge over any single software company: big economies of scale (the same basic system can be installed in all countries), easy access to international databases, use of UN standards like EDIFACT (a paperless trading system) and, importantly, provision of continuing technical back-up and service. Western donor governments seem to have been won over. America and Britain, initially sceptical, are now backing the work with cash and people. Perhaps UNCTAD's greatest innovation is not software at all, but entrepreneurial bureaucrats. (Source: *The Economist*, 4 July 1992)

Trade on better terms

Exporting to developing countries can sometimes seem more trouble than its is worth, especially for smaller firms. Goods mouldering in customs warehouses for weeks on end, baffling paperwork, high and arbitrary duties, levies and surcharges, etc. are enough to deter even the most enterprising. World-wide, the United Nations estimates that such transaction costs may amount to 10 per cent of total merchandise trade, now worth over $3.5 trillion a year.

THE UN Conference on Trade and Development (UNCTAD) says these costs could be cut by $75 billion through more efficient trade procedures, including customs computerization. Many industrialized countries now have sophisticated computer systems for their customs, permitting virtually paperless trading - but these are far beyond the resources of most developing countries and the newly freed economies of Eastern Europe. So UNCTAD has developed a cheap and simple computerized system, coupled to standard customs procedures. It has already been adopted by over 50 developing countries.

In Mauritania a first investment of around $1 million generated extra customs revenues of $4 million, allowing the Government to cut tariffs without losing income. In Mauritius customs declarations are now dealt with in about 30 minutes, instead of 48 hours, and most goods are cleared within one or two days, instead of five to 20.

UNCTAD hopes to go further, linking developing countries into an integrated system that would not only provide a clearing house for up-to-date and accurate trade data, but would also extend eventually to the exchange of detailed market information that could be obtained by companies hoping to tap markets in both rich and poor countries.

A pilot "trade point" along these lines, complete with computerized customs-clearance, was installed in Colombia, when UNCTAD had a conference there last month. It cut companies' transaction costs by around 40 per cent for an investment of only $20,000. Poland, Belarus and several African and Asian countries have asked UNCTAD to help them set up similar facilities. Whatever the results of the Uruguay Round of trade talks, says UNCTAD, cheaper trading should give the world economy a boost. (Source: *The Economist*, 21 March 1992)

Piracy costs Europe £500 million a year

The Business Software Alliance, which represents major PC software suppliers including Microsoft and Lotus, revealed this week that software piracy cost European governments more than $1 billion (£560 million) in lost VAT revenues during 1990.

In the UK, where the BSA estimates 67 per cent of PC software in use is illegal, the VAT revenue loss in 1990 was $160 million. Germany and Austria jointly lost over $210 million, and France forfeited $186 million in revenue, the BSA claimed.

The BSA has decided to tackle the crisis by making European governments the target of a public awareness campaign to be launched in September.

The scheme, called Software: A National Asset, will encourage government bodies to raise the public profile of national and international laws relating to software copyright.

BSA representatives will begin the initiative with visits to government officials in EC countries later this year.

The officials will be urged to put their own houses in order by drawing attention to copyright laws in departments, ministries and government agencies.

Existing European copyright legislation differs from country to country, but next year standard EC laws apply. (Source: *Computing* 4 June 1992)

Users still fail the paper test

Businesses have too much paper and too little information, according to a survey released by management consultant Touche Ross.

The study reveals a lack of information management - the effective production, storage, retrieval and distribution of paper or disc-based information.

Despite the report's prediction of a dramatic growth in the use of electronic data and office systems - nearly 70 per cent of companies say they will be using them by the end of the decade compared with less than 20 per cent now - there will be no decrease in paper.

The report puts this down to a distrust of technology which means companies keep paper copies of computer-generated records.

Nearly 70 per cent of organizations questioned think that the amount of paper generated in a year is too much. In one company each member of the 2,000 staff uses 25 kg of paper. The main problem for firms is finding space to store these records.

The survey also reveals that despite this glut of paper, 60 per cent of respondents say that they are not getting the right information to do their jobs properly.

Touche Ross blames the poor management of documents on the lack of standards or procedures for dealing with the paper.

As a result almost 70 per cent of the respondents report duplication of work because of lost records, and 39 per cent of firms think they can be taken to court over missing records.

The report predicts that paper-based working will be used in offices until the end of the decade at least.

But some companies, mainly those with BS5750 quality management accreditation, have proved they can make effective use of technology, and save time, by using computers.

Yet, according to the study, few companies are investing in technologies such as multimedia and voice recognition. (Source: *Computer Weekly*, 11 June 1992)

II. NEW DEVELOPMENTS

Silicone screens put a new face on computers

American researchers have developed a synthetic rubber sheet which, if pressed, conducts electricity. The rubber is suffused with tiny metal balls which link up to form conducting paths. The transparent sheet could be used for computers controlled by touching or writing on a screen.

Existing touch screens and pen computers use very thin layers of conducting material, such as a metal or metal oxide. These are coated on the surface of a plate of glass or plastic. Such transparent conductors are essential for liquid crystal displays. But these types of coatings do not conduct well and do not provide a conducting path through the glass or plastic.

Sungho Jin and his colleagues at AT&T Bell Laboratories in New Jersey mixed tiny balls into an unhardened clear silicone elastomer - a synthetic rubber. The balls are made of nickel and covered with about 0.1 micrometres of gold or silver. They make up less than 2 per cent of the volume and are about 20 micrometres across - thinner than a human hair. (This first appeared in *New Scientist*, London, 21 March 1992, the weekly review of science and technology.)

New transistor developed

Matsushita has developed a transistor with a gate electrode length of 0.2 micron. The device is made using a large angle tilt implanted drain (LATID) to form a self-aligned lightly doped drain. This is based on the formation of a p-type impurity layer along the surface of the source and drain regions using self-aligned pocket implantation techniques.

This additional layer helps prevent short channel effects, such as drops in threshold voltage, that accompany device miniaturization.

Threshold voltage levels can be maintained with gate lengths of 0.2 micron. Parasitic capacity is reduced by 30 to 50 per cent, allowing a 20 per cent improvement of device speed to 40 ps/gate.

Matsushita's latest advance, an application of its proprietary LATID technology to the quarter-micron area, is a step towards realization of high-performance

256 Mbit DRAMS. (Extracted from *Electronic Times*, 6 February 1992)

Ceramic transistors lower resistance

Researchers in Japan and the United States have succeeded in making the two most common forms of transistor used in electronics from high-temperature superconducting ceramics rather than semiconductors. But although the devices offer lower internal resistance than silicon transistors, there are many problems involved in using the new ceramics.

A device made by Sanyo Electric modulates current passing through a superconducting layer of barium potassium bismuth oxide, analogous to the base layer of a bipolar transistor. Venky Venkatesan and his colleague Xiaoxing Xi at the University of Maryland have made a superconducting equivalent of the field-effect transistor.

Sanyo claims a theoretical speed 10 times higher than present semiconductors transistors, and electrical losses 100 times as low. However, the material it calls a "high-temperature" superconductor is cooled to 28 kelvin - far below the critical temperatures of other ceramic superconductors.

The American researchers passed current through a thin film of yttrium barium copper oxide. Applying an electric field to the third terminal of the device, a gold electrode, changed the resistance of the superconducting layer by up to a factor of 30, so modulating the voltage.

Venkatesan thinks that 1,000 to 10,000 is possible. He concedes that the superconductor cannot match the high speeds of silicon electronics, but says the superconductors offer much lower internal resistance in the "on" state, an important concern in power switching. (This first appeared in *New Scientist*, London, 4 April 1992, the weekly review of science and technology.)

53-GHz silicon transistor

Experts at the Daimler-Benz Research Laboratories in Ulm, Germany, have developed a silicon-based transistor that can handle frequencies up to 53 GHz. A similar speed performance for a silicon transistor has been achieved so far only at IBM Corporation's Thomas J. Watson Research Laboratories in Yorktown Heights, NY.

This record has been obtained with a hetero-bipolar transistor (HBT), a technology that not only is faster than conventional silicon technologies but also outdoes them in other aspects: current amplification is higher, and both noise and power consumption are lower.

The heart of the new transistor is a 50-nm silicon-germanium base layer. A high boron doping level makes for a high charge-carrier density and hence for a low resistance, the prerequisite for fast switching. With HBTs opening the high frequency ranges to silicon technology, high-frequency devices and conventional silicon circuits can be integrated on the same chip.

Unlike conventional silicon transistors, HBTs consist of layers of different semiconducting material. To obtain that structure, germanium is usually added to the silicon. Even though germanium atoms are somewhat bigger than silicon's and would not fit into the silicon crystal lattice, the researchers managed to make the different layers monocrystalline by using molecular-beam epitaxy to grow extremely thin layers on top of each other. So all transistor layers are made in one process step at low process temperatures - typically 550° C. (Source: *Electronics*, April 1992)

IBM claims world's smallest transistor

IBM researchers claim to have made the world's smallest transistor. The tiny device, described as being 20 times smaller than the smallest transistor built so far, could be used to produce memory chips with 4 Gbits capacity. According to IBM it may be possible to reduce the transistor size by a further factor of two. The transistor has feature sizes of 0.1-microns and is a MOSFET device. IBM used electron-beam nanolithography to produce the device but says that a different technique would have to be developed for volume production. (Source: *Electronics Weekly*, 3 June 1992)

Semiconductor compounds biologically synthesized

At the Advanced Engineering Centre for Biochemical Engineering at University College London, researchers have biologically synthesized semiconductor compounds. Curiously enough, the compounds produced have photoluminescent properties.

Plants and simple organisms adapt to hostile environments. For example, grasses can be bred to be resistant to metals. The grass captures and binds metals in its roots, protecting the plant by preventing metals from entering the rest of it.

The mechanism of metal tolerance works for metal compounds. In UCL's work, researchers added cadmium sulphate to a metal tolerant yeast culture. During the binding process the cadmium ions were formed into crystals by a peptide created by the yeast as a response to cadmium. The metal/peptide complexes then bound in sulphide ions.

The cadmium sulphide crystallites created by the peptide have nanometric dimensions, giving them quantum properties, rather than the semiconductor properties of bulk material. The researchers demonstrated these quantum properties by illuminating

the crystallites with UV light. The resulting luminescence was not a property of bulk material.

UCL's work promises a new method for making quantum semiconductor devices. By modifying the binding peptide, crystallites of different shapes, sizes and properties may be possible. The technique may also work for other metal compounds. (Extracted from *Electronic Times*, 6 February 1992)

Ciliary motion

In future, tiny plastic hairs on a silicon chip could move light objects around in the same way that minute hairs rhythmically sweep away mucus in lungs.

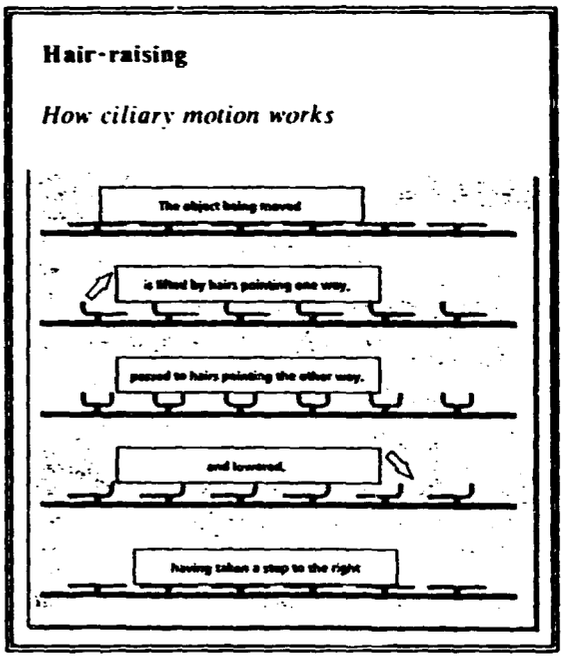
Using the same standard techniques with which silicon chips are made, Hiroyuki Fujita and colleagues at Tokyo University's Institute of Industrial Science have made arrays of tiny hairs, each about half a millimetre long, on a piece of silicon. Each hair is made of two different types of plastic, with a minute wire sandwiched between them. To begin with, the hairs lie flat; after being cured at a high temperature, they curl up. Then, when a current is run through the wire, making it warm, the two types of plastic expand, but to a different degree; the hair uncurls until it is almost flat again.

As objects shrink, their volume gets smaller more quickly than their surface area does. Since the rate of cooling depends on the surface area, but the amount of heat stored depends on the volume, microhairs cool much more efficiently than the large parts of a normal machine would. So they can be made to curl and uncurl more than ten times a second.

It is easy to produce arrays of thousands of hairs wired up in such a way that the heating can be computer-controlled. The simplest such arrays, like Dr. Fujita's, have the hairs arranged in rows, with successive hairs in each row pointing in opposite directions. By heating the two types of hair in the right sequence, it is possible to move an object along the direction of the hairs.

Though the individual hairs are minute, they can do a good deal of work when acting in unison. Dr. Fujita's prototype can support aluminium foil. More robust versions now being developed should be able to move a silicon wafer. By interweaving rows of hairs at right angles to each other, it will be possible to control the exact position of an object anywhere on the hairy surface. One obvious application would be to make a surface that automatically moves a chip into exactly the place it has to be in, in order for automatic tests to be done.

In large arrays with millions of hairs, trying to send messages to each individual hair would be a logistical nightmare. So the hairs will have to be given some



autonomy. Since the hairs are already on a silicon chip, it is quite simple to give each one some computing power. Then, as long as each hair can communicate with its nearest neighbours, the surface can work out what needs to be done all on its own. (Source: *The Economist*, 18 April 1992)

Inmos to improve outlook for PC users

Higher resolution graphics will soon be available to the majority of PC users, thanks to a new chip developed by Inmos.

Its G191 device will allow users of AT-based machines, who accounted for 67 per cent of PCs sold in 1991, to display XGA images on their screens.

The device is a variant of the G190 serializer palette device designed for MCA computers, but the new chip has a digital to analog converter which runs at 80 MHz instead of 50 MHz. (Source: *Electronics Weekly*, 1 April 1992)

1.5 Mbit/s copper pair cable transfer

High speed data at 1.5 Mbit/s has been successfully transmitted over copper pair telephone cable by Canadian telecommunications supplier Tellabs using technology developed by Bell Canada. The company believes it has demonstrated that new services such as video need not rely on the introduction of fibre-to-the-home, which operators find cost restrictive. (Source: *Electronics Weekly*, 4 March 1992)

Fastest semiconductor switch developed

A group in the Department of Electronics and Electrical Engineering of the University of Glasgow,

Glasgow, Scotland, has developed what it claims is the world's fastest semiconductor switch. This all-optical switch is operated by extremely short pulses of laser light that are so intense that they alter the optical properties of the semiconductor in a non-linear directional coupler. Alteration of the intensity of the pulse results in the light pulse emerging from a different part of the semiconductor structure.

The device was tested at the Center for Research in Lasers and Electro-Optics in the University of Florida with 10 ps pulses. The switching was shown to be instantaneous on this time scale, but the Glasgow group expects that this switch will operate in times of the order of 10 fs. (Reprinted with permission from *Semiconductor International Magazine*, February 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, Illinois, USA)

A simpler superconductor?

Scientists at Kyoto University report a strontium-calcium-copper oxide superconductor with a transition temperature of 110 K. While such a temperature is still below the 127 K achieved with thallium-containing compounds, the superconductor could have advantages because of its relatively simple structure, consisting of layers of strontium and calcium atoms interspersed with planes of copper oxide. (Source: *Chemical Week*, 6 May 1992)

Supercomputer sought for structural biology

A group of US academic researchers, government officials, and industry representatives are working together to seek funding for a new supercomputer that could dramatically advance the field of structural biology. Structural biology, as they define it, includes protein folding, biomolecular structure determination and simulation, molecular recognition, and drug design.

At a recent high-performance computing workshop at Florida State University, Tallahassee, the group met to discuss the idea of generating a "grand challenge" grant proposal for a massively parallel supercomputer with a sustained processing speed in the range of 1 teraFLOPS - 1 trillion (10^{12}) floating-point operations per second.

The grand challenge concept is part of the presidential initiative in high-performance computing and communications, an interagency research and development effort designed to promote US leadership in advanced computing and networking. A big part of the initiative is establishment of the National Research & Education Network, a computer network with 1 gigabit (10^9 bits per second) transmission speed. The initiative also provides support for grand challenges, science and engineering problems in which significant progress is believed possible were better hardware and software to be made available.

TeraFLOPS performance is well beyond the capabilities of today's supercomputers, which process data at sustained rates in the low gigaFLOPS (10^9 FLOPS) range. Supercomputer maker Cray Research, says it plans to build a massively parallel computer with sustained performance of 1 teraFLOPS by 1997. (Extracted from: *Chemical & Engineering News*, 2 March 1992)

A non-volatile RAM fast as DRAM

A non-volatile competitor to existing memory technologies is starting to make waves in the research community. Using silicon carbide instead of silicon, the technology, developed under contract with the US Government's Strategic Defense Initiative programme, is the first to offer read/write speeds comparable to those of dynamic random-access memories and a cell small enough for very-large-scale integration. The devices, dubbed NVRAMs, can even boast of some advantages over silicon when it comes to manufacturing processes.

Since the energy bandgap of silicon carbide is 2.5 times that of silicon, thermally generated leakage currents are thousands of times smaller. Memory should be stable for hundreds of years, according to Cree Research Inc. of Durham, North Carolina, which with Purdue University in West Lafayette, Indiana, is conducting the NVRAM research. So far, a bipolar charge-storage capacitor has been fabricated to prove the concept; a full-blown device should be working within a year, say the researchers.

NVRAMs can retain the same charge as a DRAM in a cell 25 per cent the size, and since the charge is held in the cell, 1-Mbit NVRAMs do not require the tunnelling technology that must be used in high-density DRAMs. Silicon carbide is compatible with existing silicon fabrication technology and does not have the "wear-out" problem that plagues ferroelectric RAMs or flash memory. Also, since refreshing DRAM soaks up as much as 80 per cent of the power consumption in notebook computers, NVRAMs hold the promise of being able to operate with much smaller batteries.

Despite their promise, NVRAMs are at the beginning of the research curve and even a 64-Kbit commercial product is five to seven years away, say scientists at Cree Research. (Source: *Electronics*, April 1992)

Optical control device for HDTL

The Research Development Corp. of Japan has developed an optical control device for possible uses in high-definition television and broadband digital telephone system production. The high-performance optical isolator uses a yttrium-iron-garnet alloy and is one hundredth the size of prior devices. Its function is to prevent the reversing of laser light produced by a semiconductor laser back into the laser. Its

short-wavelength operation will make it suitable for use in a number of high precision optical instrument applications. (Extracted from *Asian Wall Street Journal*, 18 May 1992)

High temperature superconductors

Thin films of copper-oxide materials made one atom layer at a time could have record high transition temperatures to superconductors, according to Tomoji Kawai of Osaka University, Japan. Laser molecular beam epitaxy is used to produce the films, which can be made any number of layers of copper oxide molecules thick. Sandwiching calcium or strontium atoms between the layers, allowing more oxygen atoms in, improves the electrical conductivity. The films are superconducting up to 120 K, and could even be superconducting as high as 180 K, although this has not been verified. (Extracted from *Science News*, 16 May 1992)

Melting moment makes a microfilm reusable

A new microfilm that is erasable, needs no photographic processing, and can store digital data as well as pictures and text should be available within about 18 months. Liquid crystals, similar to those in laptop computer screens and digital watches, form the basis of the film. All that is needed to write on it is a tiny solid-state laser, like the ones in CD players.

The laser can write lines as fine as 5 micrometres and is computer controlled so that the film can record digital data, which can then be read back into a computer. Conventional microfilm can be written on by laser but is sensitive to daylight and needs wet chemical processing.

The new microfilm is based on a liquid crystal that has a much higher melting point than those used in orthodox displays. It is a solid at room temperature, and has two solid forms: above a certain temperature, known as the "clearing" temperature, the rod-shaped molecules of the crystal lie in random directions, and the crystal appears clear. Below this temperature the molecules form small "domains" within which they line up with each other. This form appears milky.

There is enough contrast between the clear and opaque forms for the liquid crystals to store images and text.

The two universities and three companies which collaborated on the project developed two types of liquid crystal with higher melting points by joining together their rod-shaped molecules into longer chains. Their clearing temperatures are between 100 and 240° C, suitable for heating by a solid-state laser. The crystals must have a high clearing temperature so that the film is not erased accidentally - 100° C is enough for most applications, such as storing important documents.

A whole film can be erased and reused by heating on a hotplate. Guus Möhlmann of Akzo Electronic Products, based in Arnhem in the Netherlands, which is running the project, says the crystal can withstand being erased about a thousand times.

The microfilm is made by depositing 3 to 7 micrometres of the solid liquid crystal on a sheet of PET. A dye, developed in the colour chemistry department at the University of Leeds, is added which absorbs photons of laser light and converts the energy into heat. (This first appeared in *New Scientist*, London, 20 June 1992, the weekly review of science and technology.)

Improved crystal solar PV cell

Solar photovoltaic cells, which convert sunlight to electricity, could provide an unlimited supply of non-polluting energy.

Sharp, the Japanese electronics manufacturer, has developed an improved single crystal solar PV cell with a conversion efficiency of 22 per cent, the first high-efficiency device of its type capable of being mass-produced.

The new solar cell results from improvements to the reflective back surface of the cell. They improve the reflectivity of the surface to 90 per cent and reduce the loss of electrons generated when sunlight is absorbed by the silicon substrate. (Extracted from *Financial Times*, 15 May 1992)

Optically active chemical from bacteria to make artificial retina

An optically active chemical from bacteria has been used by researchers at Fuji Photo Film Co. Ltd., in Kanagawa, Japan, to build an artificial retina. The researchers have demonstrated a 64-pixel image sensor using a photoactive layer of bacteriorhodopsin. The chip responds only to changes in light intensity, an image preprocessing function also found in the retina. Bacteriorhodopsin is a pigmentation protein found in certain bacteria that has attracted research interest because it is similar to photoactive components of the retina. The Fuji researchers deposited a film of bacteriorhodopsin over an 8 x 8 array of indium-tin-oxide electrodes wired to an array of LEDs. Images of letters were focused on the film, and the researchers found a differential response similar to the motion-detection ability of the eye. That function is an essential feature of the eye, allowing it to extract movement as well as detect essential image components, such as lines and edges. (Extracted from *Electronic World News*, 20 April 1992)

Device made from superconducting thin film

Neocera and Los Alamos National Laboratory have jointly made a resonating microwave device out of a

-383° F superconducting thin film that conducts electromagnetic energy with 30 times less resistance than copper. The material is a ceramic compound containing yttrium, barium, copper and oxygen. It is expected to be used in satellite communications. Identical film will be tested aboard a satellite later in 1992. (Extracted from *Design News*, 20 April 1992)

New developments in batteries

Yuasa Battery has developed a solid-state battery, which could be commercialized within one year. The battery could be made less than 1 mm thick, and in any shape to fit various sorts of devices. Rob Neat of AEA Technology (Harwell, UK) says solid-state lithium batteries should be able to generate 150-200 W-hrs/kg, versus 35-40 W-hrs/kg for lead acid or nickel cadmium batteries. The new class of batteries has solid polymer electrolytes. The polymer is sandwiched between an electrode of lithium and an electrode of a vanadium oxide compound. The polymer electrolyte is made of polyethylene oxide cross-linked to a type of polyether. The battery can operate even at 0.1° C. Stainless steel foil is used as the current collectors. In cooperation with Hydro-Quebec (Canada), Yuasa has developed a battery less than 1 mm thick. The battery can produce 4 milli-amps at 3 V. It can drive a small motor for 10 hours.

Dowty Batteries (Abingdon) has developed a similar battery, which it has demonstrated for powering lights on miners' helmets.

Matsushita Battery Industrial (Japan) has developed the first nickel hydride battery in the world, according to the company. The new battery would allow an electric car to run 2.8 times farther than it could with a conventional lead acid storage battery. Sales of the battery are expected to start in the mid-1990s. (Extracted from *New Scientist*, 25 March 1992 and *New York Times News*, 8 May 1992)

Contactless keyboard

Engineers at Digifrance sarl, in Paris, have developed a highly sensitive contactless keyboard that can be operated through glass up to 10 mm thick. A high-frequency generator feeds a 1-MHz signal through each of the "keys", and when a finger is placed near the key, a change in capacitance modifies the amplitude of the signal. The increased sensitivity is achieved by comparison with a reference signal through a differential amplifier, which can be varied to modify the sensitivity. A decoding matrix determines which key has been touched, and the signal is converted to a TTL-level output. (Extracted from *Electronic World News*, 20 April 1992)

New method of circuit depositing on Teflon

A method for depositing copper circuit lines directly on polytetrafluoroethylene substrates (Teflon) has been developed by researchers at Sandia National Laboratories and the University of New Mexico (Albuquerque, NM). The mixture of copper conductors on Teflon is perfect for numerous electronic requirements. While early applications appear to be in producing printed circuit boards where copper strips attach to various microelectronic devices, the method may also be used in the microelectronics themselves. (Extracted from *Material Engineering*, April 1992)

15-micron microconnector

Japanese connector maker Nitto Denko has developed a microconnector for highly integrated chips with a pin-pitch of 15-micron. The microconnector, called Zaxis, uses rivet-head shaped metal bumps protruding on both sides of a porous polyimide film. This film can be sandwiched between chip and board and compressed to form the connection. The bumps have a minimum pitch of 15-micron and a minimum diameter of 10-micron, making for very dense interconnection. It will allow the maximum number of pins on a chip to be increased theoretically. (Source: *Electronics Weekly*, 3 June 1992)

Memory cell stable under 3 V

Mitsubishi Electric has developed a new type of memory cell that can operate stably at voltages less than 3 V and will enable 16 Mbit SRAMs to be built.

The cell requires a 0.35-micron CMOS process with two layers of polysilicon and two layers of aluminium wiring. It measures 2.9 x 2.7-microns, and remains stable with a large ratio of access transistor to driver transistor current.

Conventional linear driver transistors were made in ring form to increase the current flow while maintaining the same cell area. The alignment accuracy is not vital in this cell structure and allows the technique to be transferred to mass production.

Leakage current at the storage node will be decreased due to the shorter length of the field oxide film terminal. (Source: *Electronics Weekly*, 3 June 1992)

Toshiba develops sharper LCD

Toshiba has developed a new type of colour LCD screen which it claims is much faster than current colour screens and rivals the speed of TV type colour displays. The screens are built with what it calls Level Adjusted Operation and can change screen images in about 17 ms compared with current colour LCD screens that take as long as 60 ms. The screens also produce a sharper image. The new colour LCDs are still in the prototype stage and according to Toshiba it may be three years before they appear in commercial products such as computer display and high definition TV systems. (Source: *Electronics Weekly*, 3 June 1992)

Polyimide breakthrough

Researchers at the Georgia Institute of Technology have developed a new technique for producing polyimides that increases the reliability of the final product. Polyimides are good vapour barriers and resistant to high temperatures, but current methods of production involve heating polyamic acid after it has been applied to the desired location. This process releases water vapour which may result in pinholes that reduce the effectiveness of coating. The new technique uses Diels-Adler polymerization to combine two newly developed precursor materials in a process that produces no water during curing. (Source: *Electronics Weekly*, 3 June 1992)

Single-chip microprocessor

IBM, Apple and Motorola are to spend $1 billion in getting single-chip versions of the IBM RS/6000 microprocessor, to be known as PowerChip, onto the market over the next three years. Late 1993 or early 1994 is the closest date set for volume availability of PowerChips for low-cost PCs. More sophisticated versions of the PowerChip for portables, desktops and high-end PCs are due in late 1994, early 1995 and late 1995. PowerChip versions of Apple's Macintosh computers would run significantly faster than Macintoshes using Motorola's 68000 series of microprocessors, said Apple. (Source: *Electronics Weekly*, 11 March 1992)

IBM makes super RISC machines

IBM, the world's largest computer maker, is to build parallel supercomputers based on its RS/6000 RISC microprocessors that are currently used in its desktop workstations and servers. To date, IBM's offerings in the supercomputing arena have been mainframe computers tweaked to include vector processing nodes, machines based on Intel's i860 processors that perform visual post-processing of data generated by other means, and clusters of RS/6000 boxes connected together. IBM has set up a new research centre in Kingston, New York called the Highly Parallel Supercomputing Systems Laboratory (HPSSL) to develop the parallel supercomputers. The new centre will develop machines with several processors working in parallel in standalone systems. The systems will be built around a multiple instruction multiple data design, and will include a distributed memory architecture with message passing for processor coordination. (Source: *Electronics Weekly*, 19 February 1992)

Red light doubles density

Toshiba has used a short wavelength laser to build an optical recording system which it claims has twice the data density of conventional techniques. The red-light laser diode is made from indium gallium arsenide phosphide (InGaAlP) and can produce more than 30 mW at a wavelength of 690 nm. This short wavelength produces a smaller beam size, allowing the system to record data with a pitch of 1.25 µm. The company demonstrated the technology at the optical data storage topical meeting in San José in February. The shorter wavelength laser is used with a fast laser power control unit which monitors and corrects fluctuations in the laser's power. Toshiba expects to be able to market systems able to store 150 Mbyte/square inch based on its new technology. (Source: *Electronics Weekly*, 19 February 1992)

New interconnect process

A process for making pure copper interconnects for ULSIs has been developed, and the technology evaluated by workers at Tohoku University (Sendai, Japan), according to Tadahiro Ohmi and Dazuo Tsubouchi of the university. As device sizes are decreased and increased levels of integration density and speed are required in ULSIs, it is necessary to develop a low-resistivity, electromigration resistant metallization process for geometries under 0.5-micron. Aluminium alloys are presently much used for interconnects, but have the disadvantage of poor reliability related to electromigration. The Tohoku researchers believe copper is a good alternative, with superior electromigration properties and low bulk resistivity of 1.72-micro-ohm-cm, much lower than aluminium alloys. A process was developed for formation of high quality copper thin films, making use of a rf-dc mode, bias sputtering system. The system included a 100-MHz rf power supply and 2 DC power supplies with connection to target and to wafer holder. The system allowed control of a number of process parameters, and copper films around 1-micron in thickness were grown on silicon dioxide substrate. The films were thermally annealed at 450° C for 30 minutes, and found to develop large grains as the crystallographic orientation of the films was transformed. Grains up to 100-microns were grown after annealing. Investigations indicated the formation of ideal metal/silicon interfaces, with the resulting copper interconnects expected to have lifetimes 3-5 orders of magnitude greater than those using aluminium alloys. The copper interconnects are also said to have much larger current driving capability. The workers used scanning micro-RHEED microscopy for *in situ* observation of electromigration. Article includes figures and 22 references. (Extracted from *Solid State*, April 1992)

New EEPROM cell

Mitsubishi has developed an EEPROM cell smaller than the cells in a typical 4 MBit DRAM in the same process technology, 0.8 micron CMOS.

The firm's LSI laboratories in Osaka used a stacked, split-gate structure to include the select and store transistors required for an EEPROM cell in a

10 square micron area using 0.8 micron CMOS. Using the technology, researchers have built a 1 Mbit memory.

In the design, the control electrode is stacked above the floating gate as in a conventional EEPROM. However, the floating gate is stepped to partially overlap the gate of the select transistor.

Split gates have been used in non-volatile memories before, but for EEPROM it is usual to use two separate transistors with a corresponding overhead in die area. Mitsubishi has achieved the area reduction by making the region for Fowler-Nordheim tunnelling of electrons on to the gates extremely narrow.

Mitsubishi claims it was able to limit the tunnel region to a width of 0.1 micron by using a three-layer resist and proprietary 0.8 micron processing technologies.

Mitsubishi stopped commercial EEPROM manufacture at the 8 k x 8 bit size. It is unlikely to revive its EEPROM programme. (Extracted from *Electronic Times*, 6 February 1992)

Experimental computer learns by mistake

Bell Communications Research has created an experimental computer that can learn by example. The computer is made of neural network chips, interconnected circuits based on the workings of the human brain. The machine may one day evolve into a learning computer that can handle high data rate applications such as complex network monitoring and speech recognition. A neural network computer "learns" by following examples, picking up "knowledge" and then "understanding". (Extracted from *Telephony*, 4 May 1992)

Wafer drying technique is the cleanest yet developed

Scientists at the Philips Research Laboratories, Eindhoven, the Netherlands, have developed an ultra-clean method for drying silicon wafers, glass plates, etc. They claim it is of particular interest for IC production to meet the increasing demands for cleanliness as dimensions decrease.

A wafer that is withdrawn from a water bath after rinsing is covered by a water film about 10 µm thick. Conventional drying methods, such as spin drying, reduce thin film thickness to about 1 µm, but small contaminating particles are usually deposited on the surface, while stress-induced damage to fine surface structures may also occur.

The Philips technique is based on the Marangoni effect in which a flow along a liquid surface is induced by local variations in surface tension due to a gradient in either the temperature or the concentration along the surface.

Philips claims that the water film on a wafer can be reduced in this way to a thickness of only a few nm and that the product emerges from the water bath essentially clean and dry. Marangoni drying does not result in any environmental pollution, consumes hardly any energy and, if an organic compound with a low vapour pressure is used, does not require expensive safety measures. However, the most important advantage is that the flow of water macros the surface results in what Philips claims is "the highest yet attainable level of cleanliness in drying". (Reprinted with permission from *Semiconductor International Magazine*, February 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, Illinois, USA)

Transforming the prospects for robot vision

Developers of robotic systems have long grappled with the problem of giving their machines reliable vision. A team of European engineers has come up with a solution which relies entirely on optics, rather than electronics, and so is fast and reliable. The system could help production-line robots recognize objects, or weapons systems to identify hostile aircraft.

Most vision systems are electronic; they use a video camera to produce an image of the scene which is then digitized and analysed by computer. This analysis can be slow and inaccurate. The prototype optical system matches a test object, such as a round bottle, against a set of reference objects, such as a collection of different-shaped bottles. It then identifies which of the reference objects the test object most closely resembles.

The system was developed by the French company, Thomson-CSF in collaboration with the company Krupp and the University of Erlangen in Germany, and the Riso National Laboratory in Denmark. It is part of an ESPRIT project, funded by the European Community.

The system, called a joint transform correlator, is as fast as the video cameras that present the original objects and pick up the result, so it can spot changing objects instantaneously. At the moment, however, it has a serious drawback. Although it will identify objects anywhere in its field of view, it will not work if the test object is larger than the reference objects or is at a different angle. Researchers at Riso are working on a device that can optically process and record the difference in size and orientation. When integrated with the existing correlator, researchers believe this system could be used for more complicated tasks than are currently possible.

Researchers at Thomson-CSF are also looking at ways of increasing the number of reference objects that can be available for comparison at any one time. The reference objects could be varied, both within a single frame and over time, to try different sizes and orientations, the correct fit being determined by which

object gives the brightest spot. (This first appeared in *New Scientist*, London, 22 February 1992, the weekly review of science and technology.)

Scientists use lasers to show images in eyes

Researchers at the Human Interface Technology Laboratory at the University of Washington in Seattle are developing technology that uses lasers to scan computer images directly onto the retina of the eye.

The display system uses fine low-intensity laser beams directed through the pupil of the eye to scan computer generated images directly on the retina in much the same way as images are presently scanned on cathode ray tubes.

So far, simple line images such as an X-ray have been successfully scanned in monochrome using red lasers.

Colour will only be possible when blue lasers are available, which can be combined with red and green to give a full colour spectrum.

Scientists at the university are confident the technology will eventually provide very low-cost lightweight devices that can be fitted to a pair of spectacles.

Applications would include virtual reality systems and "head-up displays" for airline and fighter pilots.

Meanwhile, computer graphics researchers are developing techniques to generate subtle and complex graphics images using procedures that mimic Darwinian evolution.

At US supercomputer manufacturer Thinking Machines, researchers are evolving equations to describe computer graphics textures, shapes and movements. Initially a population of simple equations is established.

Environmental conditions are then set to determine which equations will survive intact into the next generation. (Source: *Computer Weekly*, 13 February 1992)

Robot eye follows surgeon's every move

Inflamed gall bladders, brain tumours and arthritic hips could all soon be operated on with the help of robots, if a company launched this week fulfils its promise. Armstrong Projects is Britain's first firm to specialize in the design and production of medical robots. Although not the first such company in the world its founder, Patrick Finlay, says it certainly has the widest range of medical automatons under development.

Robots are expected to replace humans in operating theatres for tasks that need greater precision and stability than the human hand and eye can manage. For example, Armstrong is building a robot to help surgeons perform common abdominal surgery, such as gall bladder removal.

Laparoscopy, in which a camera is pushed through a small hole in the abdominal wall, allows a doctor to operate "by television", with instruments inserted through a second puncture hole. The small size of the incisions reduces the trauma for patients and speeds up recovery. But a junior doctor must point the laparoscope so that the surgeon can operate - a procedure that can take hours. The junior doctor, in Finlay's words, is an "expensive form of retort stand".

His solution is Laparobot, which manoeuvres the camera in response to movements of the surgeon's head. Four tiny transmitters worn by the surgeon on a headband send radio signals to a base unit. If the doctor turns his head, raises or lowers it, or leans in, Laparobot pans, tilts or zooms the camera.

For the first version, which is about to be built for clinical trials, the surgeon will still watch a television screen, but Finlay expects later models to include a head-up display similar to those used by military pilots.

Finlay rejects the notion that robots will one day operate on people unsupervised. He plans to introduce automation step-by-step, increasing the machine's complexity and autonomy.

So Neurobot, which will assist in operations on the brain and the spine, will grow through three stages, each one for use in theatre. In its third and final guise, the device will propose the best angle of entry through the skull and guide a probe into the brain, for example to take a sample from a tumour, using information from a 3-D CT (computer tomography) scan of the patient's brain. But the first, passive, stage is already in use. The surgeon merely holds the robot's mechanical arm, to which the probe is fixed, above the patient's head. As he guides the probe by hand into the hole through the skull, the probe's tip shows up on the CT scan. Stage two will be "semi-active", says Finlay. Under its own power, the machine positions a tube attached to the mechanical arm outside of the head, down which the surgeon will insert the probe.

Armstrong has its roots in the International Advanced Robotics Programme, set up by the OECD, the club of leading industrialized countries. (This first appeared in *New Scientist*, London, 4 July 1992, the weekly review of science and technology.)

Computer chemistry - the shape of things to come

Chemists in Germany have made the first ever discovery of a chemical reaction by predicting it with a computer.

Rainer Herges and Christoph Hoock at the University of Erlangen designed a computer program to search for new ways of making butadiene, a key intermediate in the synthesis of many organic compounds. The computer came up with 72 reactions, two of which were previously unknown. One turned out to work in practice with an efficiency of more than 95 per cent.

The first reaction involved a seven-membered carbene which would lose three of its atoms as a single stable molecule, leaving behind butadiene. More detailed calculations by the computer showed that carbon disulphide (CS_2) would be the best three-atom molecule to lose in this way. The simple carbene that the computer devised is not itself a stable species. However, it is possible to make precursors to the carbene, stabilizing it by attaching other substitutes to the molecule. Herges and Hoock did this in three ways: first, by attaching a tosylhydrazone group; secondly, by converting this to a diazo derivative by heating; and thirdly, by attaching a sulphur atom.

The chemists then converted these compounds to the carbene in several ways: by heating them, by exposing them to ultraviolet light, and by reacting them with phosphine. As the carbene formed, it immediately lost the carbon disulphide, as predicted, and produced butadiene at a yield of more than 95 per cent in each reaction. Herges and Hoock then extended their reaction to see if it would work for a diene that was part of a larger molecule. Again it gave high yields of product.

The second reaction which the computer predicted would form butadiene involved the pericyclic reaction in which a molecule with a chain of seven atoms curls round so that one end can grab an atom from the other while at the same time breaking off butadiene. A phosphite, in which one of the groups attached to phosphorus was a seven-atom chain, was made and shown to go as predicted by the computer. However, this reaction had to be carried out at low pressures and a temperature of 350° C. Even then it gave only a 40 per cent yield of butadiene. This was enough to show that the computer's discovery worked, although this method is not likely to be popular with chemists working at the bench. (This first appeared in *New Scientist*, London, 22 February 1992, the weekly review of science and technology.)

Dutch research gives two implant recipes

At Utrecht University, Amsterdam, physicist Rob Schreutelkamp has developed ion implant recipes that can lead to higher quality ICs. Schreutelkamp has studied silicon-lattice dislocations and their effects on device properties, resulting from implantation of boron and phosphorus. He determined the critical level of total implantation damage above that which defects occur. Then, he developed two recipes for dislocation-free implantation.

The first recipe uses a series of short implantation steps to keep the number of displaced silicon atoms under the critical threshold for dislocations. After each of these short implants, the wafer being doped is heated to anneal the resulting damage. This technique produces a high concentration of boron or phosphorus doping without dislocations.

The second recipe uses an extra high-energy implant following the implant step that establishes device electrical properties. With subsequent annealing, the doping ions from the high-energy implant create many dislocations about one micron below the active circuitry. Accordingly, the free silicon atoms displaced by the doping ions during the regular implant migrate out of the active circuit area to the underlying dislocations.

Tests by engineers at Mitsubishi in Japan have shown that Schreutelkamp's second process recipe is inexpensive to add to production processes.

This research was done at the FOM-Institute for Atomic and Molecular Physics in Amsterdam - a division of the Dutch Foundation for Fundamental Research on Matter - in cooperation with Philips Research in Eindhoven. (Reprinted with permission from *Semiconductor International Magazine*, December 1991. Copyright 1992 by Cahners Publishing Co., Des Plaines, Illinois, USA)

A memorable sandwich

Sandwiches of magnetic and non-magnetic metals with layers about 30 atoms thick could in future be used as three-dimensional memory devices according to physicists at the University of Oxford. Zones in each magnetic layer could be magnetized in one of two directions to represent the ones and zeros of digital data.

The physicists are making structures with layers so thin that their electronic or magnetic properties are different from that in larger pieces of the same material. By changing the composition, number or thickness of the layers, they can "tune" their properties. John Gregg, Roger Ward and Mike Wells of the university's Clarendon Laboratory are growing layers of magnetic rare earths, such as holmium or neodymium, separated by the non-magnetic rare earths yttrium or lutetium. Each of the 100 or so layers is between 1 and 10 nanometres thick.

The layers are deposited by molecular beam epitaxy (MBE), a technique usually used for growing thin layers of semiconductors or superconductors. An electron gun is fired at a solid block of the rare earth, which heats up, and its atoms evaporate off the block and land on the substrate. (This first appeared in *New*

Scientist, London, 14 March 1992, the weekly review of science and technology.)

Now you see it ... now you don't

Renewable photographic images have been created using a film made of a conducting polymer.

Hiroshi Yoneyama and his colleagues at Osaka University projected an image onto a thin film of polyaniline which contains particles of semiconducting titanium dioxide. By electrically manipulating, or "switching", the polymer, they were able to erase the image and use the film again.

Yoneyama and his colleagues replaced the electrodes with particles of titanium dioxide embedded in the polymer. They made the polymer film by passing a current through a solution of aniline, a derivative of benzene. The film formed on the positive electrode, or anode. When the light was shone on the film, electrons in the semiconductor became excited and were absorbed by the surrounding polymer, changing its colour from yellow to green.

Unfortunately, because polyaniline is a good conductor, the charge generated in the semiconductor is quickly carried away from its source. So even if the film is used to depict an image confined to one place, the colour change spreads through the film.

Yoneyama's trick was to use the polymer in a neutral rather than an acidic solution. Polyaniline conducts only in acid because it needs hydrogen ions (protons) to assist its conductivity. Yoneyama included methanol, a proton donor.

When the semiconductor particles absorbed light, this created excited electrons and positive holes. Electrons were consumed by the polyaniline, while the holes were consumed by the methanol, releasing hydrogen ions, which made the solution acidic close to the place where the light was absorbed. This allowed the polymer to be reduced. Because the bulk of the polymer was non-conducting, the charge stayed where it was produced, and a stable image of the light source resulted.

The role of the semiconductor was to assist the transfer of electrons from the methanol to the polymer. At the end, it was unchanged, so it could be used repeatedly.

The number of reactions which take place depends on the amount of light that is absorbed. The image shows this as differences in shade between the two extremes of colour. This gives a much more realistic picture than if the colours were sharply contrasting.

Yoneyama found that if the film was supported on an underlying electrode the whole picture may be erased by making the electrode positive, and oxidizing the whole film so it all became yellow again.

Similar polymers could be used in renewable photocopy systems, optical communications systems or in the etching of chips that use conducting polymers rather than wires or semiconductors.

There are many problems to overcome, however. The polymer and its changes in colour must be made stable for longer periods. Also, it will be necessary to develop more coloured polymers (not everyone wants green) and to make them stable in air. Air will oxidize the polymer and so erase the picture. (This first appeared in *New Scientist*, London, 30 May 1992, the weekly review of science and technology.)

Infrared beams cut cable menace

With hi-fis and TVs sprouting more speakers to cope with stereo and surround-sound, speaker cables can become a hazard. Now Mitsubishi of Japan is using infrared beams to do away with cables.

Some electronics companies have tried using FM radio links between a stereo amplifier and loudspeakers, but the sound quality does not match digital recording quality. Mitsubishi's wireless system uses infrared light to carry digital signals.

The transmitter, placed near the hi-fi or TV, has an infrared light-emitting diode, similar to those used in a TV's remote control handset. The light from the LED switches on and off to create digital pulses which carry a stereo sound signal, of comparable quality to a CD. The beam is split in two and lenses direct the two beams at receivers on top of each speaker.

The receivers convert the digital signal into an analog signal. This is then boosted by amplifiers connected to each speaker which plug into the mains. Both loudspeakers receive the same signal, carrying both left and right sound channels, but each is preset to decode only one of the channels. (This first appeared in *New Scientist*, London, 11 July 1992, the weekly review of science and technology.)

Silicon chip mimics nerve cell

A silicon chip that mimics some of the functions of a real neuron has been developed by Misha Mahowald of California Institute of Technology and Rodney Douglas of the University of Oxford. The device is based on an analog VLSI (very large scale integration) chip - similar to the processors used in personal computers except that it uses an analog (continuously varying) signal instead of a digital (on-off) signal. The device's four active electrical channels are designed to mimic the function of ion channels in the neuron cell membrane. The device reproduces two major functions of real neurons. It exhibits voltage spikes reminiscent of action potentials

and shows adaptive behaviour (reduced response upon repeated stimulation). The silicon neuron could represent a step towards mimicking nervous system function more realistically than artificial neural networks do, the researchers say. (Source: *Chemical and Engineering News*, 23 December 1991)

Unclogging the chip's electronic snarl-ups

Ordinary computer chips can be made to work ten times faster than they do today, simply by rearranging their circuits, according to electronics researchers in North Carolina. They have resurrected a 30-year-old idea to force data through the chips' circuits at nearly ten times the normal speed without getting the information muddled up. Their work could make computers faster without increasing costs.

Computers are slowed down by having to wait for numbers to arrive before calculations can be done. When a computer adds two figures, the circuit carrying out the calculation has to wait for both figures before it can work out the answer. If more figures come along before the expected ones, the circuit will come up with the wrong answer.

The alternative, says Wentai Liu, who is leading the research at North Carolina State University, is "wave-pipelining". His team has designed computer circuits which equalize all delays to the figures to smooth the flow of data, so the necessary figures always arrive at the circuit at the same time. Clocking is unnecessary, and data can be fed into the circuits at a much faster rate. Liu says the idea was first proposed in the 1960s but was technically impossible then.

The biggest circuit they have made so far adds two numbers with 16 binary digits. It is made from a type of circuit known as CMOS, which is widely used in computers because it can calculate reasonably quickly, but uses modest amounts of power. In the latest conventional computers a CMOS circuit can calculate at 100 megahertz, or 100 million times a second. But the new chips in the wave-pipeline circuit run at the equivalent of 25 megahertz.

There are several secrets to the speed. The team uses sophisticated design software to redesign the CMOS logic gate, the basic component of computer circuits, to make all the delays equal. The designs keep electrical noise to a minimum, and make allowances for localized heating, which happens when part of the computer is doing a lot of calculating - both of which can affect the delays. During the design process they simulated the delay of figures to an accuracy of 10^{-10} seconds. The team also took into account the inevitable manufacturing variations in chips.

The new chips are even more remarkable because they were made using old techniques. The smallest features on the chips are two microns across. Many chips today have features of 0.8 microns.

Liu expects the chips to be used in telecommunications equipment, to speed up computers and for instruments which collect data very rapidly. (This first appeared in *New Scientist*, London, 22 February 1992, the weekly review of science and technology.)

Experimental switching chip

Researchers at IBM's Yorktown Heights Laboratories have developed an experimental switching chip which can handle data rates of five billion bits/sec. in each of 16 channels simultaneously. The company believes that the device will be used as a data traffic controller in systems with networks of multiple processors, storage devices and I/O devices, such as parallel processing supercomputers. The chip is built using a novel three-element circuit instead of the standard five transistor switch cell. The IBM circuit consists of two transistors and a resistor. This allowed the research team to build the circuit using only 4,200 transistors on a die measuring 3 mm by 3 mm. (Source: *Electronics Weekly*, 4 March 1992)

Intel doubles chip speed

Intel claims it has doubled the internal clock speed on a second generation of 486 chips, called the DX2, allowing 50 MHz speeds to be achieved on 25 MHz designs.

The chip is compatible with installed software and enables applications to be carried out at twice the speed.

Near zero wait-states can be achieved by combining the chip with high speed design elements, such as a second level cache of data which avoids waiting for the system memory to provide results. It means that 66 MHz performance will be available much earlier than previously thought, probably in the second half of this year.

But Intel says the DX2 uses 40 per cent more power than existing 486 chips, and admits it may require better cooling than on present designs.

And the DX2's higher core speed may cause problems in older software using instruction loops for timing. For example, Bios code uses timing loops to provide sufficient time for critical peripheral operations. (Source: *Computer Weekly*, 5 March 1992)

All-purpose chip breaks world speed record

The record for the world's fastest computer chip was claimed last week by the computer maker Digital Equipment Corporation. The new all-purpose chip, known as Alpha, is twice the speed or better than the

present fastest, says the company. It can also cope with numbers that are twice as long as today's chips handle and can carry out two instructions simultaneously. The Alpha chip is intended for any size of computer, from pocket-sized to supercomputer.

Alpha is a 64-bit processor, handling numbers up to 64 binary digits long. This means that it can label the "pigeonholes" in its memory with any one of 2^{64} (over 10 billion billion) distinct numbers, known as addresses. The larger this "live" memory is, the more the computer can do at any one time - such as making calculations, and showing the results as a colour picture.

Digital says that Alpha's clock, which synchronizes the operation of the chip, runs at speeds of up to 150 million cycles per second (megahertz) now and perhaps 275 megahertz in future. Digital's chip was designed to remove any bottlenecks that might slow data down. Many personal computers work at 25 megahertz today, but even then word processing tasks can take several seconds to complete.

The chip's speed is further boosted because Alpha only uses a small number of simple instructions - a design known as reduced instruction set computing, or RISC. Alpha does two instructions at once, giving it a speed rating of 300 million instructions per second.

One drawback of Alpha is that it emits 30 watts as heat, as much as a dim light bulb. Digital is working on a lower power version. (This first appeared in *New Scientist*, London, 7 March 1992, the weekly review of science and technology.)

British team develops chip that can "learn"

A chip which "learns" has been developed by a group working on neural networks at the University of London.

The revolutionary chip mimics the behaviour of a brain cell more closely than any device so far and operates much faster than any previous technology. Called the probabilistic RAM (pRAM), it also enables neural network hardware to be much smaller than hitherto.

The pRAM can be used in a variety of ways to form artificial neural networks like living nervous systems.

The 84-pin digital device consists of 256 neural nodes realized in a gate array with a conventional RAM chip, and is a thousand times faster than software solutions.

Devices can be linked together to form networks of any size.

The device produces an output in the form of a spiked pulse train like its biological counterpart, and its proficiency can be enhanced by a learning circuit which repeats itself 200 times a second, thereby dramatically reducing network training time - from a year to less than a day in complex applications.

Applications envisaged for the new chip include speech, pattern and vision-recognition, signature verification, fingerprint analysis, "on the fly" engine-management, environmental control, financial forecasting, scientific and statistical modelling, and non-linear control of systems previously thought uncontrollable.

The pRAM was developed by Professor J. G. Taylor and Dr. T. G. Clarkson of King's College, and Dr. D. Gorse of University College, who have been working on it for four years. It has been patented extensively and is available for licensing. (Source: *Electronics Weekly*, 1 April 1992)

Displays borrow chip techniques

LCD makers like to borrow production techniques from chip manufacturers to keep their development costs down. But they need a lower level of failures than can be tolerated by the chip makers and have been simplifying the traditional semi-conductor processing techniques to make it easier to improve their yields.

Chips can be made to work even if individual transistors are manufactured incorrectly. The problem is overcome simply by isolating the faulty circuits. But the human eye can detect missing pixels caused by faulty transistors on an LCD so failure-free processing is critical during production. Leybold has developed a technique which simplifies LCD making, reducing the chance that the panel will have missing pixels.

Active matrix LCDs are made by building up a grid of switching elements on the inside surface of a glass substrate. The switching elements may be two-terminal devices, such as diodes, or three-terminal devices, such as thin film transistors (TFTs).

A simpler alternative, using metal-insulator-metal (MIM) switches has been developed recently. The MIM process uses two masking stages instead of a seven mask TFT process, and MIMs have twice the brightness of TFT LCDs.

Parts of the production process of active matrix displays are similar to IC manufacturing techniques. While the manufacturing process is easier, minimum structure widths are between 2 to 5 microns and film thicknesses are 50 to 500 nm, plus fewer masking steps, the final product has to be 100 per cent failure free.

The transistors themselves are built up from amorphous silicon, deposited on the glass, using plasma-enhanced chemical vapour deposition (CVD). Other thin films include silicon nitride, silicon dioxide, and metals for the transistor gates and source connections.

Insulating materials are deposited in plasma CVD, while sputtering techniques are used for metals. At Semicon Europa 92 in Zurich this year, Leybold demonstrated how in-line processing systems are being used for the interconnect tracks, source, gate and drain electrodes of the TFTs.

In-line processing systems are used because of their ability to increase throughput and reduce particle contamination. The glass substrates can be placed vertically, two at a time, side by side in the load module. There is less particle contamination and scratching.

The production line is completely modular and consists of load locks, heating, cooling chambers, and process modules. It can coat substrate sizes from 350 x 900 mm, up to 830 x 1,500 mm (e.g., each carrier can be loaded with four or 16 substrates of 350 x 400 mm).

In the sputtering chambers, the metal is deposited under vacuum, while the substrates pass through on U-shaped carriers, loaded on both sides. This allows central infrared heating systems to be mounted between the substrates.

The carriers are moved in a continuous flow in front of rectangular, planar magnetron sputtering cathodes. The film thickness is determined by the sputter rate, the number of cathodes and the speed of the transport system. Throughput can be increased by adding more processing modules, but is limited by the cycle time of the load and unload modules.

The transistor dielectrics are deposited by plasma CVD process in separate chambers. In contrast to sputtering, the process is not a continuous one. The precursor material is introduced via a large arc electrode in gaseous form, excited in a plasma, and condensed out on the surface of the substrate.

Since only one substrate is processed per cycle, the throughput at the static CVD stage is lower than that for an in-line sputtering system. In order to increase production, it is necessary to have several systems working in parallel.

To remove unwanted material, plasma etching is still undertaken as a horizontal process, using carrier-free pick and place techniques. There is still a danger that the cassette carrier itself would cause contamination during the etching process.

As with semiconductor wafers, the substrate carriers in the etcher are loaded and unloaded by a robot system in a clean room environment. After loading, the carriers are transferred to a load lock, where it is pumped down, degassed, and if necessary heated. (Source: *Electronics Weekly*, 8 April 1992)

<u>"Surfing" electrons act to speed up processors</u>

A chip that stores electrical charges by letting them "surf" on sound waves promises much faster processing of analog signals. The chip acts as a delay line which breaks up analog signals into packets of charge of different sizes and carries them along on an acoustic wave moving through the chip. This stores the analog information very briefly until it is needed, something that is very difficult to do in conventional chips.

The new chip, developed by Comlinear of Urbana, Illinois, uses a technique called acoustic charge transport (ACT) to store an analog signal briefly. According to Daniel Fleisch of Comlinear, the ability to delay a signal for a fraction of a second, so that it can be compared to a second signal, lies at the heart of signal processing.

This will be important in fields such as pattern recognition and neural networks, which are currently limited by processor speeds. In terms of the speed of processing signals, the technique is "three or four orders of magnitude ahead of digital technology", Fleisch says.

The ACT chip is made of gallium arsenide, a semiconductor, which contains impurities along its top surface to improve its conductivity. At one end of the chip a surface acoustic wave is generated which moves through the material at a speed of 2.9 kilometres per second.

Comlinear expects its first products using ACT chips will be hard disk drives for computers with capacities as large as 1 gigabyte. Fleisch expects them to be on the market later this year. (This first appeared in *New Scientist*, London, 4 April 1992, the weekly review of science and technology.)

<u>Electrons file through the turnstile one by one</u>

Physicists have built a semiconductor chip in which they have observed single electrons jumping into medium microscopic "box" within the structure. By measuring how the movement of the electron affects the capacitance of the chip - its ability to store charge - they can look at the individual quantum energy levels.

A single particle in a very small box at a very low temperature is about as simple a quantum system as it is possible to achieve. Quantum mechanics predicts that a particle in such a box can take up only certain fixed energy levels. If the particle does not have an energy equivalent to the lowest empty one, it will be unable to enter the box.

Physicists have been able to construct such boxes, known as quantum dots, for some time but their studies have usually involved the movements of large numbers of electrons. According to Raymond Ashoori of the AT&T Bell Laboratories in New Jersey, their ability to move single electrons means that "we can probe states you could never look at before". Ashoori presented his results last month at a meeting of the American Physical Society in Indianapolis.

The chip is made from a sandwich of semi-conducting materials. The "bread" of the sandwich is an electrically insulating material while the "filling" is a thin layer of gallium arsenide containing impurities to improve its conductivity.

In a related series of experiments, Leo Kouwenhouven of the Delft University of Technology in the Netherlands and his colleagues used a quantum dot to create an electron turnstile. Electrons are shunted into one side of the dot and out of the other side at a rate that can be regulated. This technique may turn out to be of practical use in providing a precisely known current which can be varied simply by controlling the rate at which electrons are shunted through the turnstile. The Dutch team has generated a current of around a million millionth of an amp. They need to achieve a thousand times as much for a current standard. (This first appeared in *New Scientist*, London, 4 April 1992, the weekly review of science and technology.)

Chip cuts power down to size

A revolutionary chip for miniaturizing power supplies down to the level required for pocket computers has been developed by Silicon Valley start-up Power Integrations.

The $3 chip, PWR-SMP260, can also be used as a universal switching power supply inside pocket phones, LCD TVs, pocket shavers, camcorders, portable faxes and Walkman/Discman type products.

For a pocket computer, the chip allows the construction of a 60 W output switch mode power supply which measures 3.75 x 2.25 x 1.2 in. weighing 4 oz for a component cost of $10. (Source: *Electronics Weekly*, 1 April 1992)

National flash warning

National Semiconductor believes it has found a route to "fully functional" flash - that is a flash memory which can be erased bit-by-bit instead of in large blocks as at present, and which only needs one operating current instead of two, as at present. The technology allows a chip to be overwritten bit-by-bit without a prior erase function. An apparent disadvantage of National's flash technology is that it uses a two transistor cell whereas Intel uses a single transistor cell.

National's first prototype chip in the new technology is due in six months. It expects to reach the 8 Mbit generation in 1994 - two years behind Intel which has 85 per cent world flash market share. (Source: *Electronics Weekly*, 8 April 1992)

IBM first with 16 Mb DRAM

In mid-February, IBM officials claimed to be the first semiconductor manufacturer to ship "limited quantities of 16 Mb DRAMs", catching the new wave of DRAM consumption that forecasters expect to exceed 800 million units by 1996. These chips were designed at IBM's facility in Essex Junction, Vermont, and are being made there and in Corbeil-Essones, France, the latter in agreement with Siemens.

IBM will put their 16 Mb chips in its new high-end AS-400 minicomputer line, which officials also unveiled in February. The AS-400 is 70 per cent more powerful than previous generation systems. The cost of these systems, aimed at small to medium-size businesses, starts at $10,000.

Although a significant first, experts believe IBM leads Japanese DRAM manufacturers by only six months or less. Some Japanese memory manufacturers are shipping test quantities of 16 Mb DRAMs. Japanese-made computers with these chips are expected by mid-1992.

Although IBM has yet to release the details of their 64 Mb process, it is likely they will continue to leverage the same fabrication technologies used for the 16 Mb DRAM. (Reprinted with permission from *Semiconductor International Magazine*, April 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, Illinois, USA)

New terminal

The ubiquitous ASCII terminal first became well established in minicomputer systems in the late 1960s. So it is no surprise therefore that as PC hardware, exploiting the power and memory capacity of the Intel 386 and 486 processors, taking over the role of the minicomputer from the DEC PDP/11 and IBM System/36, the ASCII terminal still continues to thrive.

But ASCII terminals are notorious in that, apart from the basic character set, all extensions are specific to the VDU manufacturer. This is particularly so in the Escape sequences used as commands such as clear screen, position cursor and delete line. There is an ANSI standard but the DEC VT100 is the nearest terminal to this in practice.

Fortunately Unix includes a feature, termcap, which allows the system to be tailored to match the escape sequences of the specific VDU used on each port.

But VDUs have always been monochrome. Only with the PC and its internal EGA and VGA video systems has colour become common to users, implying expensive and complex Local Area Networking of multiple PCs if all users needed colour. This is a desirable solution in some cases but not for conventional small business systems. Yet the PC established a useful extension to the ANSI escape sequences by defining an extra set of sequences to control the colour of the display.

Thus the PC Unix world took a very sensible step forward and included this Colour-ANSI specification as a standard option in term-cap, basically for the internal memory mapped display and keyboard. This set is available for control of a serially connected terminal which obeys these rules, including the PC defined graphics character set.

Technology Concepts, headed by ex-Cardiff University professor Martin Healey, has introduced the new NyCE Colour Graphic Terminal to support the Unix ANSI colour standard and the PC style keyboard. Unlike earlier VDUs the terminal exploits the capability of analog VGA monitors found in modern PCs producing high-quality display.

Although it is slightly more expensive than the monochrome equivalent, the colour terminal could significantly add to the quality of PC-based Unix small business computing. (Extracted from *Unix News*, March 1992)

III. MARKET TRENDS AND COMPANY NEWS

Market trends

Manufacturing revolution required for Gigabit age

The success of semiconductors to date has largely hinged on the industry's ability to make continual improvements in cost, density, performance, reliability and functionality. Its continued success, however, may require some dramatic changes in the way ICs are designed and manufactured, especially as we approach the Gigabit age. This observation was made by Pallab Chatterjee of Texas Instruments. Specifically, Chatterjee points to the escalating costs of IC manufacturing. Capital equipment costs are quadrupling every decade, he says, and with each device generation the need for clean raw materials increases about 35 per cent, die size by 38 per cent, process steps by 25 per cent and test costs by 20 per cent. Increasing yield, improving utilization, increasing wafer diameter, and using *in situ* multiprocessing and modular tools are all "knobs" that can be turned to change the economics of Gigachip technology development, Chatterjee believes.

He also says that the introduction of new technologies is going to become increasingly critical - any new technology must be engineered to the point where it can compete in performance as well as cost of ownership compared to the existing technology. Areas where Chatterjee believes new technologies will be needed or implemented include:

- **Cleaning technologies** that minimize the generation of particles rather than focus on the removal of particles once they are on the wafer;
- **Optical lithography** systems that employ optical image enhancement (such as phase shift masks) and manage the lower depth of focus associated with high numerical aperture lenses. Excimer lasers will also come into play;
- **Rapid thermal processing** tools that use multi-zone heating lamps and *in situ* sensors should make this a key technology in the latter part of this decade; and
- **Plasma processing** systems that use magnetic field or inductive coupling to achieve high selectivity, good anisotropy, good uniformity, low ion induced damage, low particle contamination and high throughput rates.

Other trends cited by Chatterjee include an increasing requirement for ultralow power ICs, driven by the hand-held and desktop forms of electronics; and a two orders of magnitude increase in the productivity of the design and software systems. (Reprinted with permission from *Semiconductor International Magazine*, June 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, Illinois, USA)

Future trends in robotics

World robotics sales totalled $2-6 billion in 1991, depending on how such systems are defined and if they include attachments such as vision systems. In the 1980s many users found that to take full advantage of robots, they had to redesign their products and the way they made them; robots sometimes failed to pay off because they did not efficiently interface with employees and other equipment. Industrial robots in the 1990s can efficiently paint, weld, seal, assemble and package various goods, often with a precision unmatched by human workers or under adverse conditions. In nuclear power plants, they can perform remote inspection, tank cleaning, interior pipe inspection and loose parts retrieval. New applications are opening up in service sectors, such as polishing supermarket floors or delivering patients' meals in hospitals, although uses in

security-guard operations, fast-food restaurants and other service fields are slower to take hold, due to the necessity of interacting with humans and handling more variables.

Transitions Research's Helpmate robot is being used at Danbury Hospital to carry patients' food trays from the third-floor dietary department to the twelfth-floor nursing unit, and speak to the receiving nurse or attendant. Leading firms that survived the shakeout in industrial robots include GMFanuc Robotics and ABB Robotics. Japan still accounts for about 67 per cent of annual robotics sales, according to most industry estimates, due to labour shortages and a successful track record in automation. The service sector still lags far behind industrial robots in choosing tasks that robots can do from those they will be indispensable in doing. Integrated Surgical Systems (Sacramento, California) seeks US Food and Drug Administration approval to begin human clinical trials on a robot to remove, under a doctor's supervision, hip bones for replacement by titanium implants. The robot can make cuts so precise that the gaps between the replacement and the remaining bone are 50 microns, one-twentieth the smallest average gap in surgery performed by humans, according to Dr. Howard Paul of Integrated Surgical Systems. (Extracted from *New York Times News*, 29 April 1992)

Rest-of-the-world chip market grows 46 per cent

Chip manufacturers outside the traditional chip manufacturing areas of Japan, USA and Europe are showing explosive growth (46 per cent in 1991 compared to only ten per cent growth in the world market) says US market analyst Integrated Circuit Engineering (ICE).

Samsung of Korea is the largest company of the group due to its success in catching up with the leaders in advanced DRAM manufacturing with its 16 Mbit device already on the market. Samsung is now thirteenth in the world in semiconductors with sales worth $1.4 billion last year, says ICE.

Rest-of-World Chip Manufacturers

Rank	Company	1991 IC sales ($m)	% Growth	Country
1	Samsung	1,488	20	Korea
2	Hyundai	452	74	Korea
3	Goldstar	360	155	Korea
4	UMC	210	41	Taiwan
5	TSMC	170	113	Taiwan
6	Mosel/Vitelec	165	67	Taiwan
7	Winbond	108	125	Taiwan
8	Chartered	70	40	Singapore
9	Hualon	55	25	Taiwan
10	Holtek	30	67	Taiwan

(Source: *Integrated Circuit Engineering*)

Fastest growth in the group is Lucky Goldstar, also of Korea, on 155 per cent growth to hit $360 million worth of sales in 1992. Goldstar appears to have benefited from its close link with Hitachi of Japan in its DRAM manufacturing.

With Hyundai's $460 million 1991 sales, the Korean threesome are the three largest in the group. The other companies in the top ten are all Taiwanese except for Chartered Semiconductor of Singapore. (Source: *Electronics Weekly*, 3 June 1992)

UK electronics set for recovery

UK electronics companies have dramatically improved their manufacturing efficiencies during the recession and are well placed to compete for orders when business picks up, according to a survey of UK manufacturing industry by consultant Coopers & Lybrand Deloitte.

The report describes the improvement in stock levels as "exceptional".

Some 80 per cent of electronics firms have cut raw materials and work-in-progress stock levels since 1989, and more than 60 per cent have lower stocks of finished goods. Stock levels, representing capital tied up in the manufacturing process, are a key measure of manufacturing efficiency.

Despite the recession 53 per cent of companies reported sales value up since 1989. Sixty-five per cent said they had either maintained or increased investment over the past three years. Over the same period 78 per cent of companies have improved the proportion of orders delivered on time and two thirds have cut delivery lead times. (Source: *Electronics Weekly*, 20 May 1992)

Computer giants aim to work in parallel

Experts in parallel computing, in which anything from a handful to a thousand or more chips work collectively, met recently to sort out what is probably the biggest problem facing them. Programs written for one parallel computer will not work on any other type.

Similar problems have always afflicted new types of computer. Personal computers, for example, only became really successful when IBM's PC, with Microsoft's DOS software for handling the basic instructions, came along. It became the standard, and many companies produced hardware and software which was compatible with it. This has not happened yet in the parallel computer industry.

Tony Hey of the Parallel Applications Centre at the University of Southampton, says there are two important areas of dissent. One is how the computers pass messages - data or instructions - between the processors.

Genesis, a project funded under the European Community's ESPRIT programme, has already produced software which can run on the different computers made by Intel and NCube of the US, Meiko in Britain and Parsytec of Germany.

The other problem area is memory. If this is not catered for there can be anarchy, and the program may make mistakes. But exactly how the memory is controlled varies between computers.

Hey is optimistic that the meetings will have got some of the key companies talking, including Fujitsu, Cray and IBM which all sent representatives. He believes that Europe, which has a large number of small parallel computing companies, is in a position to influence the standards.

There are signs of the parallel processing industry settling down, and independent software companies are starting to write parallel programs - quite a risk unless the hardware is beginning to standardize. (This first appeared in *New Scientist*, London, 9 May 1992, the weekly review of science and technology.)

Chip sales ready to soar in 1992

Semiconductor makers are looking forward to a boom year in 1992, according to the Electronic Component Industry Federation (ECIF). The Federation's forecast for 1992 predicts a 5 per cent growth in sales, driven by an 8 per cent growth in microprocessor sales.

The increase in bookings placed so far this year will actually lead to deliveries of chips, unlike increases in bookings at the start of previous years.

A similar rise in bookings at the start of last year had been caused by worries over the DRAM reference price, and had not been translated into sales later in the year. Ambrose said that there was nothing political or artificial about this year's bookings. (Source: *Electronics Weekly*, 8 April 1992)

Leading US makers of chip equipment gain market share

Resurgent US manufacturers of semiconductor equipment are regaining some of the ground lost to Japanese competitors in the past decade. The latest edition of an annual market study by VLSI Research Inc. of San José, California, shows that American equipment makers that rank among the top 10 suppliers in 1991 picked up an additional 3 per cent of the market shared by that group. "This represents a significant comeback for America," says the report, adding, "It is a noteworthy milestone for [the semiconductor-manufacturing research consortium] Sematech, which has been working closely with all of these companies to improve American manufacturing".

The authoritative study places the 1991 world-wide total spent for systems and services at $9.9 billion with the top 10 accounting for $4.2 billion, or 43 per cent, about the same as the 1990 figure. But the US companies' slice edged up to 40.8 per cent of the total from 38.0 per cent, a gain of $297 million. (Extracted from *Electronics*, April 1992)

Trends in CMOS development

Complementary metal oxide semiconductor (CMOS) integrated circuits may soon rule the world of semiconductors. Market research firm Integrated Circuit Engineering Corporation estimates that by 1994, CMOS will have captured 73 per cent of the world-wide IC market. Already, leading micro-processors, ASICs and DRAMs larger than 1 Mb are almost entirely constructed using CMOS technology.

Key factors contributing to the increasing popularity of CMOS technology include: low power density; relatively good noise immunity and soft error protection; low threshold bias sensitivity; design simplicity and easy layout; and capability for lower power analog and digital circuitry on the same chip.

Another important factor in the success of CMOS has been its ability to be scaled to smaller and smaller dimensions. While the road to the 0.5 μm geometries we are now beginning to see has been anything but easy, it promises to get even more challenging as critical dimensions shrink to 0.35 μm or less by the end of the decade. Even now, CMOS device designers working in advanced process laboratories are developing devices with critical geometries as small as 0.25 μm.

When it comes to geometry shrinking, most of the industry's attention has focused on the ability (or inability) of optical lithography equipment to reliably reproduce structures at such deep submicron dimensions. As critical as this is, that is only part of the challenge: if you were to take the CMOS device structures commonly used today and simply shrink their dimensions, they would not work - at least not reliably - because of the detrimental effects of punchthrough, hot carrier injection and parasitic capacitances and resistances.

One simple way to address some of these effects is to use a lower power supply voltage. While the vast majority of CMOS devices operate at 5.5 V, many new CMOS chips are designed to operate with a 3.3 V power supply. And that is expected to drop even lower with smaller geometries, perhaps to 2.5 V.

Most efforts in CMOS today are, in fact, directed at developing improved gate and drain structures.

The goal of these efforts is to produce a transistor that has high reliability and high performance, the latter being defined in terms of the transistor's short channel effects. But there is a third factor, beyond reliability

and performance, that has become increasingly important: manufacturability.

In most cases, CMOS designers have to look at manufacturing "requirements" as a set of limitations, determined by the capabilities of today's processing equipment and materials: only certain well-characterized materials can be used, temperature sensitivity of previous layers must be kept in mind, doping profiles have to be within the ion implanter's capabilities, and, of course, the minimum geometries have to be reproducible with today's lithography and etch equipment.

Increasingly, it is being realized that the industry's future hinges more on such equipment capabilities, and less on new circuit or device innovations. Indeed, the manufacturing consortium SEMATECH has now appeared to have focused most of their efforts on helping equipment and materials suppliers develop better products.

Such concerns now seem to be weighing heavily on the minds of many of today's CMOS device engineers.

The continued ability of CMOS to be scaled to 0.25 μm and below, while avoiding the problems of hot carrier injection and punchthrough, will require many new innovations in the design of the CMOS structure. Many such innovations have already been proposed, primarily in the areas of twin-well formation, gate and drain engineering and isolation, with many more proposals before 0.25 μm devices move into production, which, after all, probably will not be until the next decade.

It is likely that many of the innovations will rely heavily on the abilities of high energy ion implanters to precisely place small pockets of dopants just where they are needed. Also rapid thermal processing is likely to play a key role in reducing overall thermal budgets.

At the same time, it is probable that the differences between n-channel and p-channel MOSFETs will have to be addressed more openly, perhaps leading to different gate and drain schemes for each type. Similarly, it may be necessary to fabricate the source and drain asymmetrically, as with the HS-GOLD process.

But whichever device structure is ultimately deemed best, one thing is certain: the choice will hinge as much on manufacturability concerns as it does on reliability and performance. (Reprinted with permission from *Semiconductor International Magazine*, April 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, Illinois, USA)

SIA semiconductor forecast sees $77 billion by 1994

Semiconductor shipments will exceed $77 billion world-wide by 1994, according to the Semiconductor Industry Association (SIA).

By the end of this year, total semiconductor sales will increase 9.8 per cent over last year. SIA places the total value for 1991 at $55.5 billion. That represents a gain of $5 billion over last year.

For 1992, SIA is predicting a 14.5 per cent increase over 1991. This will place the value of semiconductors at $63.6 billion. The industry is expected to chalk up a 12 per cent gain in 1993, with shipments valued at $71.2 billion.

The US is expected to show a modest growth of 2.9 per cent next year, W. J. Sanders, chairman/CEO of Advanced Micro Devices, reported. The real opportunities in Eastern Europe, though, are still ahead. Eastern Europe, he added, will not impact the forecast until 1994, at the earliest.

The economic outlook for Asia Pacific remains bright. The near-term outlook, however, is clouded by PC industry's weakness. On balance, Sanders said, Asia Pacific is "the area to watch".

The real growth, he added, is still in MOS, mostly CMOS now. The real excitement in the industry, he added, is in memories, microcomponents and ASICs.

Digital bipolar is in steady decline, losing 2.8 per cent over the forecast period. Analog, which was smaller than bipolar in 1984, is now showing an annual growth rate of 10.6 per cent.

By 1994, ICs will outpace discretes fivefold, Sanders reported. Nevertheless, he added, there are still opportunities in MOSFETS and optoelectronics.

Although the projections are released by SIA, they are compiled by World Semiconductor Trade Statistics Inc. (Reprinted with permission from *Semiconductor International Magazine*, February 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, Illinois, USA)

Company News

Intel top US company

Dataquest, the USA analysts group, have placed Intel as the largest US-based company in its annual review of semiconductor companies. In fact of all the companies in the top 10, Intel had the highest growth rate at 28 per cent, due to the microprocessor market sector growth in 1991.

MOS memory sector grew only 6 per cent, but was a welcome positive, from the 17 per cent decline in 1990. Last year the biggest decline was in the bipolar arena - 9 per cent. In total the world-wide market of merchant ICs grew by 11.5 per cent. Europe grew by 6.6 per cent, according to Dataquest. It was in Europe that Intel made even more significant inroads, jumping over Siemens and SGS-Thompson to become number 2 behind Philips,

in the IC (not total semiconductor), marketplace. (Source: *AMT*, March 1992)

Philips and SGS-Thomson to cooperate in VLSI technology

The cooperative deal recently announced by Philips Semiconductors International of the Netherlands and the Italian-French components combine SGS-Thomson Microelectronics is significant. Industry observers had speculated that Germany's Siemens AG would be part of the new combine, the third party in a grand European alliance that would bring together the continent's big three in semiconductors, an alliance EC authorities favour. Philips and SGS will cooperate in developing advanced CMOS logic processes below 0.7 μm, as well as design rules and libraries. The first joint project will be a 0.5 μm CMOS process on 8-in. wafers. It is to be completed by the end of 1993.

The work will take place at SGS's new R&D centre in Italy and at CNET, the French telecommunication research institute at Crolles, near Grenoble, France. (Source: *Electronics*, February 1992)

Large computer networks for European public sector

Europe's three leading computer makers - Olivetti, Bull and Siemens-Nixdorf - have agreed to cooperate in developing large computer networks for public sector bodies in the Community. The three companies have set up Trans European Information Systems (TEIS) as a first step towards developing projects for compatible information systems in Europe based on common system and software applications. The aim of the TEIS venture is to enable the three companies to offer compatible solutions to European public sector agencies. The three companies have set up research laboratories at Pozzuoli near Naples, as well as Munich and Paris.

The Naples unit will check whether hardware and software from the three companies is inter-operable. (Extracted from *Financial Times*, 16 April 1992)

Fujitsu memory move

Fujitsu is moving into memory module assembly at its Dublin plant using both 1 Mbit and 4 Mbit DRAMs. According to Ron Livingston, Fujitsu's marketing manager for Europe, the move will reduce lead times, reduce pricing because all-European DRAMs are used, and will guarantee quality and reliability. Initially 1 Mbit x 8, 1 Mbit x 9, 4 Mbit x 8 and 4 Mbit x 9 devices will be assembled in fast page mode, nibble mode and low power versions. Packages will be 30-pin Jedec pin-out and options will include leadless plastic Simm and low profile. (Source: *Electronics Weekly*, 3 June 1992)

Toshiba and National in logic deal

Toshiba and National Semiconductor have agreed to jointly develop and market high speed standard logic chips in a five-year agreement. The family of chips will have propagation delays of 3 ns at 5 V and 5 ns at 3 V and realize a switching noise of less than 0.8 V, claimed to be three times faster than the world's best and with the lowest switching noise of all CMOS logic chips. The two companies will market the chips under their own names as mutual second sources. (Source: *Electronics Weekly*, 3 June 1992)

IBM, Toshiba to join forces on new chip

IBM and Toshiba Corporation are planning to join forces in one of the fastest-growing segments of the semiconductor business.

The two companies are expected to jointly develop flash memory chips, a relatively new type of chip that has the potential to take the place of magnetic disks for permanent information storage in computers. IBM and Toshiba are also expected to cooperate in developing products that use such chips.

In a departure from past practice, International Business Machines Corporation is expected to sell the chips to other companies as well as use them in its own computers. Until now, with rare exceptions, IBM has made chips only for its own use.

Flash memories are attracting considerable attention because they can retain the information they store even when the computer's power is turned off, unlike conventional dynamic random-access memories. That makes them ideal to replace bulkier magnetic hard disks in energy-hungry laptop computers.

Flash memories, which are expected to take market share from D-RAM chips, also have the potential to replace magnetic disks. They are faster and smaller and, because they have no moving parts, should be more rugged and use less power.

Flash memories, however, are significantly more expensive than disks and provide lower capacity.

But as costs come down, the use of these chips is expected to increase. Dataquest, a market-research firm in San José, California, expects sales of flash chips to surge to $1.5 billion in 1995, from $130 million in 1991.

The companies, which already have a joint venture to produce screens for notebook computers, are expected to cooperate on manufacturing and marketing as well. (Source: *International Herald Tribune*, 22 June 1992)

The new IBM: radical change becomes routine

The reshaping of IBM Corporation has become a string of dramatic changes and startling about-faces. The company has reversed a keystone of its marketing strategy by declaring that it would begin selling PCs made by someone else. That was followed quickly by the news that IBM was courting Sun Microsystems Inc. as a partner in Taligent Inc., the software firm set up by IBM and Apple Computer Inc.

It is believed that the new computers would be made in Singapore by Hong Leong, with which IBM established a joint venture last year to sell PCs in Asia. The new company is called International Application Solutions.

The Sun-Taligent gambit - the goal would be to control the direction of desktop software - is also a challenge to Microsoft Corporation, IBM's sometime partner, which later this year is to introduce its own workstation software. IBM and Apple formed Taligent to create software based on object-oriented programming for desktop computers and workstations. (Source: *Electronics*, April 1992)

Philips cuts R&D

Dutch electronics giant Philips is cutting back on research and development.

Staffing has been cut by 5,000 this year to 27,400, with funding reduced from 7.9 to 6.8 per cent of turnover. Philips has always boasted that its high investment in R&D secures the company's future. It was spending in the past which now earns Philips a royalty of 3 cents (US) on every compact disc record sold anywhere in the world.

The cutback is mainly the result of Philips's decision to pull out of the Mega Project, a scheme to make 1-megabit static RAM chips in Europe. (This first appeared in *New Scientist*, London, 7 March 1992, the weekly review of science and technology.)

Fujitsu turns on 16 Meg

Fujitsu is to move into high volume production of its 16 Mbit DRAM at its wafer fabrication plant in Iwate, Japan. The company has identified market opportunities in every segment of the computer business.

The 0.5-micron devices access in 60, 70 and 80 ns and are organized X1 and X4. There is also a nibble mode X1. World-wide and byte-wide organizations and 3.3 V power versions are planned. Packages are 24-pin plastic ZIPs, 28-pin plastic SOJs and 28-pin plastic TSOPs.

Fujitsu's plan is to transfer production to its latest fab in Co. Durham, UK, whenever the market demands it. (Source: *Electronics Weekly*, 8 April 1992)

Kodak to launch photo workstation

Kodak expects to start shipping the hardware which enables 35 mm photographs to be transferred onto compact discs for use with its Photo CD equipment. Kodak's Photo Imaging Workstation uses three parallel arrays of charge-coupled devices to turn colour photographs into 18 Mbytes of digital information. By the time Photo CD players hit the high street this summer Kodak aims to have a nationwide network of dealers up and running, offering to put consumers' pictures onto disc. CD-I players, which can also display Photo CD pictures on a TV, were due in the shops in spring 1992. (Source: *Electronics Weekly*, 8 April 1992)

NEC sets 64 M DRAM date

Early next year NEC intends to sample its 64 Mbit DRAM in three speed categories and three organizations. Customer sampling is scheduled for September and mass production for March 1994.

The first three organizations will be X4, X8 and X16. Speeds are 60 ns, 70 ns and 80 ns.

NEC's 64 Mbit is made on a 0.38-micron process using the stacked capacitor technique. In March 1994 engineering samples of X9 and X18 organizations will be available and these versions are due for volume production in September 1994. The 64 Mbit will be the generation at which NEC moves to eight-inch wafers.

Although companies such as IBM, Hitachi and Samsung are making 16 Mbit DRAMs on eight inch wafers now, NEC believes that six inch will be the most economic wafer size for 16 Mbits. (Source: *Electronics Weekly*, 25 March 1992)

Grassroots consortia go back to the basics

A small California software company is proving that it is possible to create innovative and profitable industrial research consortia without massive government subsidies or cumbersome bureaucracies. Biosym Technologies, a company based in San Diego that specializes in molecular and chemical modelling software, has started four consortia involving more than 100 industrial members and put products on the market. By focusing on basic molecular modelling tools with broad application, the company has managed to find a "generic" niche that is still state-of-the-art. Another part of the formula for success is to let its own employees - not researchers on loan from its member companies - do the work. That approach provides a buffer between

the competing partners and ensures that no proprietary technology is leaked. Members meet every nine months to vote on research directions, but otherwise they simply put in their money and wait for results. This grassroots approach to consortia has won nothing but praise. The products keep coming, and members say that they are getting what they want at a fraction of what it would have cost them to do it themselves.

Biosym started on molecular and chemical software tools and has never looked back. Its four consortia - polymers, catalysts, potential energy functions and a materials project that will start in July - each have about 15 full-time programmers. The polymer consortium charges each of its 51 industrial members about $80,000 a year. In exchange, it gives them new software every nine months and asks them to vote on the next project. The members get one year of exclusive access to the software, after which Biosym can sell it to anyone.

Universities may join by paying 15 per cent of the commercial rate, but they have no vote in setting the direction of research. Any company that joins late must pay all back fees. Biosym's academic connections have unearthed dozens of specialized algorithms and software tools, many of which were available essentially without charge. The consortia has also succeeded in finding good software that was nevertheless lying fallow because of its clumsy user interface or unusual hardware requirements.

Apart from those working on software, most of the small consortia are based around university groups (such as catalysis consortia at the University of Delaware and the University of Chicago) and unique problems. For example, a number of chemical companies who are looking for alternatives to the ozone-killing chlorofluorocarbons (CFCs) have joined together to do toxicity testing on the new compounds. (Extracted from *Nature*, Vol. 356, 2 April 1992)

New data interface

IBM and 10 other companies are trying to fuel the growth of the high-speed local area network market with a technique that permits 100-Mbit-per-second transmission over ordinary copper wire. The method, dubbed SDDI, is a new version of the fibre distributed data interface (FDDI) high-speed LAN standard that was originally adopted for optical fibre.

The companies, including chip makers National Semiconductor Corp. and Advanced Micro Devices Inc. and network vendors Chipcom Corp. and SynOptics Communications Inc., hope to capitalize on the huge installed base - wire makers estimate about 17 million offices world-wide - of shielded twisted pair (STP) wiring.

Businesses will be more likely to purchase products to link desktop devices, those vendors say, if they would not have to tear out old wiring and put in optical fibre, which can cost $500 to $700 per connection. SDDI connections will be less costly, analysts say. Moreover, both FDDI and SDDI support cable lengths of up to 100 metres between workstations. But, because SDDI does not require line encoding to meet FDDI standards for distance and signal integrity, suppliers can develop SDDI products more quickly. (Extracted from *Information Week*, 18 May 1992)

IV. APPLICATIONS

Application of surface nanotechnology

Making tiny electrical connectors for electronic circuits at least a quarter the size currently possible is one of the latest applications of technology that allows the machining of surfaces at almost atomic scale.

As electronic systems become more complex, the need grows for more compact electrical connectors. The current limit is five to 10 spring-loaded contacts per centimetre. But as the number is increased, the force required to mate and unmate the multitude of contacts rises to unacceptable levels. This is because of the presence of a very thin film of metal oxide which has to be broken each time a contact is made: its electrical resistance increases with a reduction in contact area.

3M researchers have succeeded in increasing the number of contacts by a factor of four or more per centimetre. This has been achieved by diamond machining, on a nanometre scale, V-shaped grooves in plastic and applying a separate copper or gold conductive film to each trough sidewall.

The connection is made when its male counterpart slides in. The area of contact made along each sidewall is many orders of magnitude greater than that in a metal leaf spring contact. And because of the frictional characteristics of the contact, the electrical contact resistance is also kept low.

Man-made replacement lenses for the eyes of cataract sufferers is another successful example of machining on a nanometre scale. The technology has proved a success in a trial on 300 US patients alone.

The lenses are made of polymethyl methacrylate micromachined to a tolerance that is a fraction the wavelength of light. (Extracted from *Engineer*, 2 April 1992)

DSP technology

Another European company is developing DSP technology for the growing market of portable communications. Austria Micro Systems, located at Unterprenstaetten in Austria, is now developing a programmable DSP core intended to deliver high

processing power at very low levels of power dissipation. In its first version of the chips, based on 1-micron CMOS, the ICs will operate at a maximum speed of 13 MHz with an instruction cycle of 77 ns. Up to five instructions - typically time-critical instructions such as multiplications or additions - will be executed simultaneously.

Later, AMS plans to offer a second version of the chips, built with a 0.8-micron CMOS process licensed from Pioneer Semiconductor of Santa Clara, California. (Extracted from *Electronic World News*, 20 April 1992)

P-ROM disk commercialized

Fujitsu Ltd. has become the first company to commercialize a 3½-inch partial ROM magneto-optical disk. The P-ROM MO disk combines ROM and RAM so applications software can reside alongside rewritable memory in a single small medium featuring fast access, high density and removability. Targeted initially at the Japanese desktop publishing market, the P-ROM disk has Fujitsu's Font Library software recorded in the ROM tracks. The disk is priced at US$ 3,700 and requires a US$ 2,200 drive for playback and recording.

The P-ROM is equipped with the read-only memory capability of CD-ROM, removability of a floppy disk and high-speed seek time almost comparable to that of a hard disk and has the potential of becoming a popular consumer-use disk format in the latter half of the 1990s as an all-in-one system.

The real advantages of P-ROM depend on its logic format. If that is standardized, information recorded in the ROM of the MO disk will be able to be read by any operating system on any computer. (Extracted from *Electronic World News*, 20 April 1992)

Ultratech can "tattoo" each chip with a unique ID

Ultratech Stepper has come out with a unique chip identification system that should help semiconductor manufacturers better track IC failures, inventory and security.

Called Chip ID, the process can uniquely and permanently identify each chip on a wafer by exposing a "serial number kind of structure". Applied at the pad-mask level, the identification mark is in a plain-text form that is visible through a microscope. Identification can include lot number, wafer number, exposure step and chip location within the exposure step, operator identification, process information, etc. Thus, one can determine the processing history of any chip even after separating it from its wafer.

Reportedly, Chip ID does not significantly affect throughput or manufacturing costs.

According to technologists at Ultratech Stepper, this capability will allow engineers to do much better failures analysis. They can compile statistics on a particular run and the number of failures in the run to find a failure pattern. In addition, the root cause of chip failures can be tracked even after chips are sold.

Perhaps even more significant for reducing manufacturing costs attributable to security problems, the Chip ID technique should help track and control chip inventory, theft and forgery. (Reprinted with permission from *Semiconductor International Magazine*, January 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, Ilinois, USA)

PC cards pack a punch

Tiny, convenient, impervious to physical damage or X-rays, compatible with any size of PC from desk-top to palmtop, an emerging generation of PC memory cards looks set to be the answer to a number of prayers. If these features were not enough, the cards will also come with the capacity to run programs on computers that lack the memory to support those programs.

The cards are developed using a new standard developed jointly by the USA-based Personal Computer Memory Card International Association (PCMCIA) and the Japanese Electronic Industry Development Association (JEIDA). Established in 1989, the PCMCIA has more than 170 members, including a number of big name computer corporations.

At first, the emphasis of the PCMCIA was exclusively on cards for mobile computers. However, the credit-card sized peripherals proved to have advantages in terms of reliability, durability and power consumption that made their wider use an obvious next step. One of the more recent cards allows users to transfer data from a palmtop computer into a PC, by using it like a floppy disk.

The cards can transfer much more than ordinary text; they are being looked at as a way of transferring images from video cameras into a PC, for example. Another important use will probably be in pen-driven computers, which can be subject to more abuse than ordinary computers - by being dropped on the floor, for example (not a good way to treat a hard disk).

The new standard is extremely flexible, which has prompted major PC manufacturers to include slots for the cards in their most recent models. The second version of the PCMCIA standard has an additional feature known as "execute in place" XIP, allowing a program on a PC card to run from the card itself, without placing any demands on system memory. This raises the prospect of being able to run very powerful programs on PCs with modest memory. (Reprinted with permission of *DATAMATION*® magazine®. Copyright

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The shrinking world of supercomputers

The world's first personal supercomputer came closer to reality with the announcement by the Japanese company Fujitsu of a single-chip supercomputer. The company plans to release commercial samples of the chip this year.

Fujitsu already makes supercomputers, but has not announced a timetable for a complete system built around the new chip. The chip could be used in what would be the world's first "personal supercomputer".

Supercomputers are designed for high-speed scientific number crunching. The best known and fastest are mainframes such as the Cray X-MP, but similar designs have been used in powerful minicomputers, which are slower and have less memory.

The Fujitsu chip uses a "vector" architecture, which simultaneously performs similar repetitive calculations on several different numbers. This is important in computer processes which simulate the changes of many different parameters, for example in climate models or weather forecasting.

The new chip contains 1.5 million transistors, and can perform up to 289 million floating point operations (megaflops) a second, comparable to the first Cray X-MP mainframes, introduced in the mid-1980s, but still considerably slower than state-of-the-art mainframe supercomputers, which exceed 1,000 megaflops. The most important feature of the new chip is a technique which keeps data flowing at a constant high speed through its execution "pipelines".

Adding a host microprocessor and an external memory to the Fujitsu chip would create a personal supercomputer which belongs to a brand new system category. (This first appeared in *New Scientist*, London, 22 February 1992, the weekly review of science and technology.)

New electronic vehicle control system uses fuzzy logic

Mitsubishi Motors' new electronic vehicle control system uses a fuzzy logic microprocessor to improve safety and comfort. Invecs (intelligent and innovative vehicle electronic control system) continually monitors the vehicle and driving conditions, and electronically compensates for changes. The fuzzy logic microprocessor will be able to automatically choose the best gear while accelerating and braking, thus compensating for a variety of existing road and vehicle conditions. In addition, an ultrasound monitor will scan the upcoming road surface and instantly select the optimum suspension setting to improve comfort. The Invecs system will start to be used in passenger vehicles by the end of 1992, according to the company. (Extracted from *Asian Wall Street Journal*, 27 April 1992)

US firm launches baby hard disk drives

A recently formed US company, Integral Peripherals, of Boulder, Colorado, has launched a generation of baby hard disk drives.

On a 1.8 inch unit Integral Peripherals is offering 20 or 40 Mbytes.

The tiny drives measure 50.8 x 69.85 x 15 mm, compared with 101.6 x 146.05 x 25.4 mm for 3.5 inch disk drives. They weigh only 93.64 g compared with 482.38 g for the 3.5 inch disk drives.

The single platter Mustang 1820 drive can store 20 Mbytes and the dual platter Stingray 1842 can store 40 Mbytes.

Designed for notebook and palmtop computers, the drives are being shipped to manufacturers and are expected to make their first appearance in portable computers later this year.

The drives have ramp head loading and unloading to withstand 10G vibration and a 300G shock force in non-operating mode.

A patented servo system has been designed to maintain on-track stability against shocks during operation.

The average power consumption is stated at less than 0.5 watts and read/write operations draw 2.0 watts per second compared with 2.8 watts per second for 2.5 inch drives. (Source: *Computer Weekly*, 19 March 1992)

C-Cube launches video compression chip

Image compression specialist C-Cube has launched the world's first single-chip MPEG (Motion Picture Experts Group) standard full-motion-video-decompression IC. The CL50 is aimed at high volume, low cost consumer products such as interactive CD players (CD-I), video games systems and karaoke machines, priced at £250 for samples and $50 for large volumes. It decodes SIF resolution (352 x 288 pixels at 25 Hz) MPEG bit streams in real time, at data rates from 1.2 MBit/s up to 3 MBit/s. The chip has a purpose-built Risc engine which can be programmed to suit specific applications, a direct interface to 68000 family host processors, a DRAM controller and a YUV to RGB colour converter. (Source: *Electronics Weekly*, 3 June 1992)

Electronics supermarket shelf labels

TCG-ILID (Melbourne, Australia) has developed a system to transmit data via a supermarket's lights to electronic shelf labels. The Indoor Light Interactive Display system (ILID) would coordinate prices in the store's computer with prices marked on shelves. A modulator is wired into the store's lighting system to change the wave form of the current. The lights (of any type) then flash the signal. The appropriate shelf label is activated by the code. The company claims that shoppers do not notice the change in the lighting. Shoppers could get further information on the product simply by covering the light sensor on the label briefly, switching the display to another screen. Store personnel could change the labels or get further information not available to shoppers by using a light wand.

Other firms are working on other types of shelf labels to tie into a store's central computer. Some systems would be hard wired into the computer, while others would rely on radio transmitters. (Extracted from *New Scientist*, 25 April 1992)

Apple predicts huge market for Newton PC

The first of what is claimed to be a new generation of electronic products, with a potential market two or three times larger than that for PCs, has been launched.

Newton, a pen-based keyless hand-held computer designed as an electronic diary, was unveiled at the Summer Consumer Electronics Show in Chicago by US PC maker Apple. The machine is an executive organizer that is approximately the size of a thin video cassette. Reportedly, it will come with software that can read printed notes and then automatically add an appointment to a calendar, dial a phone, or send a fax. The machine will network with other personal computers via a built-in fax and data modem or a wireless infrared link that can dispatch and receive information as far as six feet away. Future models will offer voice recognition. The hand-held computer is not a variant of the Macintosh personal computer. It is the first of what Apple chairman John Sculley refers to as "personal digital assistants", a new class of hand-held products.

Newton-type machines could help boost demand for chips during the 1990s if Apple succeeds in its plan to create a world-wide standard for what it calls personal digital assistant technology.

Apple will widely license Newton technology, according to John Sculley. Japanese consumer electronics giant Sharp is already signed up; others will follow. Apple expects royalties to form a major part of its Newton income. (Extracted from *Electronics Weekly*, 3 June 1992 and *Computerworld*, 4 May 1992)

Communications aid for the disabled

A microprocessor-based communications aid to help very disabled children has been designed at the University of Lancaster (England). The aid, known as ORAC, includes human and synthetic speech facilities, touch-sensitive switches and keyboards, and light scanning systems. The microprocessor simulates speech, hearing, touch and smell for children inflicted with many handicaps, who were so far not capable of communicating. ORAC is fitted with concept keyboards for speech, keyguards to aid those having limb tremor, and joysticks for movement control. (Extracted from *Machine Design*, 9 April 1992)

Computer gives robot's eye view of optical surgery

Surgeons will soon be able to enter the eye to carry out operations - at least in a virtual sense. Techniques derived from virtual reality - the computer system that immerses operators in an artificial computer-generated world - will allow surgeons to feel as well as see the inside of the eye during an operation, creating the illusion that they are actually there.

Researchers at the Biorobotics Laboratory of McGill University in Montreal are building a robot, known as Micro Surgery Robot-1, that will perform delicate operations under the control of a human surgeon. MSR-1 is specifically designed for performing eye surgery but could have other applications, such as the removal of brain tumours. The system could also be used to allow surgeons and their students to practise simulated surgery that feels like the real thing - without the real consequences for the patient.

During the operation, the surgeon manipulates a set of controls known as the master. These are connected through a high-performance computer to the robot. Both the master and the robot have two limbs. When the surgeon moves the master's limbs, the robot's limbs move in exactly the same way, except that the movements can be scaled down as much as a thousand times. This will eliminate hand tremor and poor accuracy and thus reduce the damage to the eye that can occur with present microsurgery techniques. Each of the robot's limbs has a minimum movement of one micrometre - more than one hundred times the precision of the human hand.

The computer also creates a three-dimensional robot's eye view of the inside of the eye that the surgeon can see by wearing a virtual reality helmet that has a small screen in front of each eye.

Another system will feed back to the surgeon physical sensations that the robot experiences when in contact with the eye, such as the forces generated by cutting with a surgical tool or the mechanical difference between healthy and diseased tissue.

To provide the surgeon with such a realistic experience, MSR-1 must be able to move rapidly, but this requires extremely fast computing. To handle the computational demands of instant interaction, the McGill team is constructing its own parallel-processing computer. It is also studying areas such as muscle mechanics, artificial intelligence and optics, and has already built another microrobot, MR-1, capable of manipulating a single living cell.

Although commercial applications of the new system are not expected for several years, its basic mechanical components will be ready for testing in a few months. (This first appeared in *New Scientist*, London, 20 June 1992, the weekly review of science and technology.)

Flash memory chip applications

Floppy disks and magnetic tape are being made to look cumbersome and inefficient by a memory chip called flash and a strip of paper that can store a huge amount of information.

Today's roving photographer can beat the clock with a digital camera which stores images as a string of binary numbers rather than on film. In minutes the digital information can be phoned in to the office, where the pictures are reconstructed by a master computer. Once used, the digital information behind the images can be filed in the newspaper's electronic picture archive.

In low-capacity applications, flash memory chips are challenging magnetic disks, while ICI's digital paper is eating into the high-capacity market dominated by magnetic tape archives.

For a portable system, flash is ideal. Stripping away the drive cuts weight and saves as much as half of the power used in a conventional laptop. A lower power requirement means a greater choice of batteries, often cutting weight further still. Data can be switched from one computer to another on pull-out memory cards even smaller and lighter than disks but with a higher capacity.

Most archiving is now done on high-capacity magnetic tape. These reels of tape, seen spinning in every film-maker's footage of high-power computing, may contain a few hundred megabytes each. This means intensive data users need many racks of tapes that have to be frequently changed. A more compact alternative beginning to get a hold in the market is optical tape. This uses the same laser technology that plays a CD to store huge quantities of data on one tape.

The tape is made from digital paper, developed by ICI's Imagedata business. This "paper" is a polyester-based material, similar to the base material for magnetic audio and video tape, coated with a dye polymer for optical recording. The tape is cut into 35 mm widths of up to 830 m long. Canadian company Creo makes the first drive. A low-power laser scans across the tape, burning pits into the polymer coating to represent digital information. Data can be packed in very tightly with up to 4 Mbytes in 1 cm^2 and one terabyte on a single tape. Once data is stored it cannot be erased. (Extracted from *Engineering*, 2 April 1992)

Flat screen future for HDTV

The Japanese electronics manufacturers currently striving to make liquid crystal displays large enough to serve as wall-mounted TVs may be beaten to it by a different technology. Canon is hoping to leapfrog the competition and produce flat TVs with wide, high-definition screens using a technology called ferroelectric LCD (FLCD).

Canon demonstrated a 38-centimetre prototype screen which displays colour still pictures of a quality close to that of high-definition television (HDTV). The largest conventional LCD prototypes are around 42 centimetres across, and manufacturers are having a hard time making them bigger. At the end of this year, the company will launch a desktop word processor with a 38-centimetre monochrome FLCD screen.

Canon's ferroelectric material is a mixture of 20 different low-viscosity liquid crystals containing fluorine, but the exact recipe is a closely guarded secret. The glass plates of an FLCD screen must be spaced just 1.5 micrometres apart. The spacing must be accurate to the nearest 0.05 micrometres - one-thousandth the width of a hair. Canon achieves this accuracy by coating the glass plates with a layer of insulating material one molecule thick, and peppering the gap with transparent spheres of insulating material which act as spacers. The plates are held in position against shocks by an air cushion mount.

Canon's latest prototype has pixels as small as 0.2 millimetres; a 38-centimetre screen is therefore 1280 pixels wide and 1024 pixels tall. This resolution comes close to that of HDTV. Canon's future HDTV screen will use a stretched screen format with 1920 pixels in each of 1152 horizontal scanning lines.

Each pixel is made up of four smaller cells, which are combined in monochrome displays to create four shades of grey and in colour displays to create 16 colours. But TV images require subtle gradations of light and shade. The company has developed digital circuits which analyse the colour required and compare it with the colours available; the circuits then switch on a jumble of pixels to create a mix of colours which fools the eye into seeing colours which are not in theory available from the screen. (Extracted from *New Scientist*, London, 30 May 1992, the weekly review of science and technology)

Aid for poor sight

Goggles fitted with a video camera and two tiny video screens could transform the lives of millions of people whose vision has deteriorated due to diseases such as diabetes or simple ageing. Researchers from NASA's Stennis Space Center in Mississippi and the Wilmer Eye Institute at the Johns Hopkins Medical Institutions in Baltimore unveiled the video goggles last week.

For people who have serious visual impairment but are not completely blind, the new system not only magnifies images but adjusts the contrast. One of the chief complaints among people with impaired vision is the inability to recognize faces, due to loss of contrast sensitivity, says Robert Massof, an inventor of the system and director of the Lions Vision Center at the Wilmer Eye Institute. The new system can also reverse the contrast so that black print on white paper appears as white print on black paper, decreasing the scattered light and aiding some readers.

The plastic goggles wrap around the front and sides of the head and house a video camera the size of a finger nail, and two cathode-ray tubes that produce black and white images. The adjustable headset weighs about 600 grams and connects by wire to a battery pack worn on a belt. The goggles can also be plugged directly into a television or video recorder.

The collaboration between NASA and the Wilmer Eye Institute began in 1985 with the aim of adapting vision and imaging technology developed from the space programme to benefit people with impaired vision. They considered adopting the "virtual reality" helmets NASA had designed for the proposed space station, but the liquid crystal displays did not have sufficient contrast, and the helmets were too cumbersome.

The team is already working on the next generation of video goggles, which will include an eye-tracking system hooked up to a computer that can process the images to correct specific visual problems. Douglas Rickman, NASA's head researcher on the project, has designed software that can alter the video images instantly to compensate for a hole in the centre of the visual field caused by macular degeneration, for example.

Rickman believes that within five years the processing could be done on a computer small enough to wear. He also foresees wearing computers that will mix sonar, X-ray, or thermal images into a video headset. A firefighter wearing such goggles could look at the wall of a building and see the plumbing and wiring running through it, as well as any flames lapping at the other side. (This first appeared in *New Scientist*, London, 23 May 1992, the weekly review of science and technology.)

Using computers to design artificial limbs

Prosthetic firms are designing artificial limbs for below-the-knee amputees faster thanks to a software program developed at the University of Texas Health Science Center at San Antonio. The system may also be a more precise and accurate way of making sockets that will end up lasting longer. The software works more in a three-dimensional format than others currently on the market to allow more interaction from the prosthesis. Sockets to fit the patient's residual limb are produced at a quicker rate than the traditional method, which involves time-consuming manual steps. After the patient's limb is wrapped with plaster to acquire the desired shape, a mechanical digitizer "reads" the inside of the hardened wrap and a computer-guided milling machine creates a plaster pattern for the socket. Researchers at the Health Science Center have also completed work on a laser/video prosthetic imaging device that eliminates the plaster wrap stage and can sense the shape in only 10 seconds - even faster than a digitizer. (Source: *BioBytes - San Antonio Biotechnology News & Information*, produced by Dublin-McCarter & Associates, May 1992)

The video recorder that speaks in many tongues

Video fanatics have always been frustrated by the fact that the TV format used in Europe is incompatible with the one used in the United States and Japan. Converting from one format to the other is expensive. But the Japanese company Aiwa, a subsidiary of Sony, will start selling a video cassette recorder which plays tapes in either standard, will display the picture on a TV of either standard, and will make a copy onto any other recorder in either standard.

Aiwa's recorder will cost less than £400, little more than a conventional recorder. Most people who want to watch tapes from abroad must go to a video or photographic shop and pay at least £25 to convert each half-hour of viewing.

The pictures taken from a tape using the standard employed in the United States and Japan known as NTSC, and displayed on a European PAL screen, are not as good as the original, but they will be good enough for most viewers wanting to watch tapes sent by relatives abroad.

This is likely to distress the movie industry which has relied on the incompatibility of the two standards to police copyright deals with different countries.

The new Aiwa recorder contains solid-state memory which stores each field as it is read off tape. The fields are then taken from the memory and fed to a TV set or another recorder. While reading an NTSC signal out to a PAL TV or recorder, the memory repeats

50 of the stored lines to convert the 262.5 line field to 312.5 lines.

The memory also skips every sixth field that is stored, reducing the 60 fields per second to 50. The recorders also convert the colour coding system from NTSC to PAL, by changing the frequency at which the colour information is carried. The resulting signal is true PAL.

To convert PAL to NTSC, the memory repeats every sixth field, to increase the field rate from 50 to 60 per second. At the same time it converts the colour coding frequencies from PAL to NTSC and combines 50 lines of each field to reduce it from 312.5 to 262.5 lines. (Extracted from *New Scientist*, London, 18 April 1992, the weekly review of science and technology)

Toshiba to launch 3 V logic before year end

Portable equipment makers will be able to buy a wide range of 3 V logic devices from Toshiba before the end of the year.

The company, which ships 80 million 5 V standard logic devices every month at the moment, is responding to the increasing move towards 3 V CMOS which started last October when the first low voltage micros went on sale.

Toshiba's VHC series will be made using 1 µm CMOS as a stepping stone before mass produced 0.6 µm logic is introduced. (Extracted from *Electronics Weekly*, 8 April 1992)

Two-man band leads chip race

A two-man Scottish electronics design company is about to become Europe's only PC chipset supplier, with a world-beating two-chip package that works with both 386 and 486 processors.

Glasgow-based Future Technology Devices (FTD) hopes to follow in the footsteps of fabless PC chip firms such as Chips and Technologies, with a product it will sell at between $20 and $25, some $10-$15 cheaper than rival three-chip versions. The company has cut the number of chips required by integrating all peripheral control functions onto the two core devices.

The 7,000 gate Asics will be manufactured by NEC using its 1µ CMOS technology. Full production was due to start in April.

FTD's technical director Craig MacAdam and managing director Fred Dart had to go to Taiwan to get private funding for its chip operations, after three months of rejections from UK investors. "The people here just didn't understand the technology", MacAdam complained.

The two designers are already working on the next project, a two-chip EISA PC chipset that they say will be cheaper than more efficient products now available. (Source: *Electronics Weekly*, 25 May 1992)

RAMbus DRAMs come to market

Radical upheavals in the way in which computers are manufactured are in prospect as the first silicon implementation of RAMbus DRAMs are about to get into the market.

RAMbus makes DRAMs so fast that they remove the need for secondary cache, allowing microprocessors to directly access DRAMs.

NEC intends to market a 16 Mbit RAMbus DRAM in the first half of next year. Access time of the chip is 2 ns. Fujitsu and Toshiba plan 4.5 Mbit devices this year.

The RAMbus architecture was invented by US professors, Mark Horovitz of Stanford University and Mike Farmwald of the University of Illinois who founded Rambus Inc. in 1990. The RAMbus interface operates at 500 Mbytes/s with a 250 MHz clock transferring a byte on each clock edge - every 2 ns. Manufacturers say they have fabricated DRAMs which meet the 250 MHz clock rate goal. (Source: *Electronics Weekly*, 25 March 1992)

Micromechanisms uses from microsurgery to magnetic recording

Micromechanisms, tiny machines which can be used for microsurgery, magnetic read heads or atomic force microscope positioners, may be divided into two broad types: sensors and actuators. Actuators convert electric energy to mechanical energy; sensors convert physical quantities such as force and pressure to electronic signals.

Of all micromechanisms, the one with the largest share of the market is the pressure transducer. Modern versions are basically a sealed pillbox which deforms in a predictable way with applied pressure. The two types - wafer-to-wafer bonded structures and surface micromachined devices - are both made from silicon. Surface micromachined devices use the silicon substrate and a low-pressure chemical vapour deposited polysilicon layer with predetermined mechanical properties to form the pillbox. The interior of the cavity is defined by a silicon dioxide post which is removed by lateral etching or surface micromachining.

Extensions of this technology to lower pressure ranges requires differential transducers utilizing deflection sensing with electronic sensitivities larger than those which can be achieved with polysilicon piezoresistors.

This has resulted in a new device, a force sensor, based on a vacuum encapsulated clamped-clamped resonating beam. Typically 200 microns long, 40 microns wide and 2 microns thick with a fundamental resonance of 500 kHz, the transducer is excited via a centre electrode which forms a capacitor between the fixed shell and the movable beam. Typical drive voltages are 100 μV, output signal is 1 mV per V and force sensitivity is roughly 150 cps per dyne of force.

The transducer has been operated in an oscillator in which it forms the frequency-determining element. The resonator may come to be used as a replacement for quartz resonators in communications networks.

The second type of micromechanism, actuators, have motion as part of their primary function. This may well involve a bearing for a shaft or a gear where the problem is: fashioning the bearing for a one inch diameter shaft requires tolerances of ± 25 microns; reduce the dimensions by 1,000 and you get a 25-micron diameter shaft requiring tolerances of ± 25 Å.

So the manufacturing of a shaft or gear requires submicron processing which is achieved by modified chip manufacturing techniques. The problems are the relatively thin layers which can be surface micromachined and the brittleness of the materials. Microactuators need a much larger material base and significantly thicker films than microelectronics. Moreover, the films need edge acuities which avoid any pattern runout with thickness. Lastly, economic considerations require batch fabrication which typically results in the use of photoresist processing.

The only known process capable of fulfilling these requirements is the LIGA process, first described by W. Ehrfeld at the IEEE Solid State Sensor and Actuator Workshop in 1988, and involving: a mould with perfect edge acuity produced by thick photoresist technology; exposure by a highly collimated X-ray source; developing with perfect exposed-to-unexposed selectivity. The mould is then filled with electroplated metal. The process can produce highly complex micromechanical systems.

The conversion of electrical energy to mechanical energy in micromechanisms is achieved via electrostatics. However, when the micromechanisms are based on ferromagnetic metals they use either electrostatics or magnetic excitation. Fully integrated micromechanical systems are possible with today's electronic technology if magnetic rather than electrostatic drives are used.

The conversion of the external magnet drive configuration to a current-driven topology is now in progress and the need for coils is obvious. These can be fabricated by assembly if the number of turns is restricted. The use of three turns with one micron gaps requires a peak drive current near 100 mA. Anticipated speeds with air bearings are near 1 x 10 m rpm which requires clock periods below 100 microseconds. A control system to provide for this has been designed and tested.

Sensors, particularly resonating sensors, have all the earmarks of practical applications, not only in traditional transducer applications but in humidity sensors, gas flow monitors and new magnetic devices. (Source: *Electronics Weekly*, 19 February 1992)

Mobile telephones

Will mobile telephones replace fixed-link ones? In places starting almost from scratch, they are already doing so. In the poor countries of Asia, Latin America and Eastern Europe, existing networks are so small and bad that those who can afford it buy mobile telephones just to make calls at all. That is no accident. Wire-line systems are best at providing lots of capacity over a small area, making them a natural fit, albeit a limited one, for the rich, crowded, first world. Radio-based systems excel at providing a little capacity over a wide area, making them an obvious choice for the third world. Mobile networks are cheap and quick to build. Millicom's Mr. Bryan reckons he can give a small country initial coverage within two years for $5 million or so, and then add extra radio transmitters as the market requires. In poor countries, radio networks are also easier to safeguard against theft (no attractive copper wires) and to repair (no need to send linesmen out into the bush).

In countries with good wire-line systems already in place, the economics tilt the other way. While mobile operators are still spending heavily on expanding their coverage, wire-line companies, their initial network investment long written off, can always beat them on price. Many Governments increase the imbalance by requiring mobile operators to lease the long-distance lines used to send calls between distant radio masts from the wire-line company, instead of building their own. By charging mobile firms exorbitantly for those lines, a monopoly wire-line operator can put an effective floor under the prices of its mobile competitors.

More constructively, wire-line networks are beginning to mimic some of the features that make mobile telephones attractive. AT&T has just introduced what it calls a "virtual mobility" service. For $7 a month, customers can hire personal numbers which follow them throughout the United States. Away from home or office, the user punches in codes to tell the network where he is. From then on, calls to his number are routed to that telephone. Like mobile telephones, this does away with the caller's need to know the location of the person to be reached. The service also allows the customer to decide which calls he wants routed where. As deregulation spreads from the mobile industry - which is where most governments first experimented with it - to the fixed-link one, the wire-line operators will no doubt become nimbler at inventing such services.

Even if voice traffic does gradually migrate to radio, that does not mean that wire-line networks are condemned to die. On the contrary, they will probably enter a glamorous renaissance. High-capacity - possibly fibreoptic - wires will allow the sort of in-home, multi-media services that still mostly exist only in the imagination - on-line picture and data libraries, dial-up films, interactive game shows and documentaries.

The telephone prophet's favourite pipedream is the "universal communications system" - the tiny do-it-all unit that connects to any network, at any time and in any way that the user wants it to. That is not likely. Telecommunications deregulation is pushing things emphatically the other way. The tidy one-company, one-country networks that have provided telephony for the past 100 years are quickly being overlaid by a messy but fertile tangle of rival, overlapping systems, each equipped with terminals of its own.

For a glimpse of the telephone's future, look at the cab of the next taxi you take. It is likely to be crammed with communications devices - a two-way data system for taking and sending routine messages to the fleet controller, a voice back-up system for special queries, a mobile telephone for taking calls from private customers, another for passengers to use; plus a credit-card swiper, linked by radio to a verification centre, for taking the fare.

The ordinary citizen could soon be hung around with just as many gadgets. He may already own an ordinary wire-line telephone, a cordless handset and a small mobile telephone. Soon he will install a permanent cheap-rate car-phone for breakdowns. He will hire a bulkier and more expensive portable for use while abroad; and, when he needs it, a satellite telephone with which to keep in touch while he treks through the Amazon rain forest. All those things are available now, or will be within five years. What comes after them is up to the customer's imagination. (Source: *The Economist*, 30 May 1992)

Is there a "virtual reality" in TCDC's future?

Currently a favourite topic in the world of information and communications technology is what is called "virtual reality", a paradoxical-sounding term, since it suggests something almost real but not quite - which is not far from the truth. Virtual reality is a system for creating, through computer software or other means, a highly convincing model of a real situation, which we can interact with dynamically.

Various methods can be used to heighten the illusion of reality. For example, computer users can now buy hardware interfaces, which may consist of three-dimensional eyeglasses, motion-sensing devices or even special gloves which can produce the sensation that one is actually touching an object shown on the screen. Such gadgets are designed to create the sense that one is physically manipulating a non-physical (or at least a digital, electronically generated) reality.

Very often applications take the form of games or entertainment software. Many, however, have a very serious intent. One of the mainstays of this kind of software is the Microsoft *Flight Simulator*. Even a brief acquaintance with this software package will compel the user to decide whether he or she really wants to learn how to fly an aeroplane or to give up the steep learning curve involved in playing the game. In a quite different vein, an interesting piece of software named *SimCity* (Maxis/Broderbund Software) allows you, the user, to manage a city and its problems. Another package called *SimEarth*, from the same manufacturer, enables you "to experience the evolution of a world that you create! Set in motion the forces of nature - the origin of oceans, the spread of rain forests, the development of life. Begin with one of seven pre-built planets, or form your own ...". Obviously, the objective of such software is to teach rather than merely amuse.

Another type of virtual reality is being created by the ongoing revolution in telecommunications. The melding of computer and telecommunications technologies has already made possible the system known as teleconferencing in which participants physically located in different parts of the world, can "sit" around a table at a meeting, deliver addresses, converse and reach decisions in real time without ever leaving home.

How does all this relate to TCDC? In terms of development, the ability to experiment with simulated or virtual realities brings the possibility of trying out strategies and activities at very little cost and with no negative side-effects.

It has been said that experience is a hard taskmaster. One of the potential advantages that developing countries have over the older industrialized societies is that they may be able to avoid some of the costly and damaging mistakes which have been made in the name of progress. Virtual reality is a way to learn from experience without the costs of actualizing it in the physical world. Its applications in the environmental field are obvious. The path of a projected motorway, for example, can be tested in advance for its impact on the surroundings.

Although at present most of the virtual reality software is being developed in the northern industrialized societies, this need not deter developing countries from applying it for their own purposes. Already a number of computer networks exist in the developing world under the auspices of various regional and subregional organizations. If these networks had the capacity to use virtual reality, the countries involved would have at their disposal a powerful tool for sharing experience. Lessons learned by a particular country could be fed into a virtual reality "bank" to be drawn upon by other countries. However, much closer

cooperation among developing countries is needed to make full use of these possibilities.

There are also exciting prospects offered by the advances in telecommunications. As these become more widely available in developing countries, they open up the possibility of a much wider sharing of capacities among developing countries. Expensive educational, scientific and testing facilities could be shared, both within countries and across national boundaries. Some developing country institutions are already making effective use of distance learning. An example is the University of the South Pacific, which has its main campus at Suva, Fiji, and many extension centres in such scattered locations as Tonga, Niue and the Cook Islands. Through distance education methods, these centres are now able to make direct use of the teaching staff, library and laboratory facilities at the Fiji headquarters. Similarly, research institutions in different parts of the world, with shared aims and activities, could be twinned. This opens up a whole new possible application for the INRES database. Institutions could use INRES to identify potential twins, with a view to linking up through telecommunications.

Teleconferencing, now a widespread business practice in the industrial north, could greatly facilitate TCDC events such as capacities and needs matching meetings, workshops, training sessions and international meetings of focal points. It would obviate the need to pay air travel costs and living expenses for the participants, thereby eliminating one of the major obstacles to TCDC.

The dream of a "global electronic village", in which people all over the world can freely communicate and exchange ideas with each other, is steadily coming closer to achievement. The implications for the developing world are exciting, and those involved in South-South cooperation should be aware of them. (Source: *TCDC / INRES*)

Personal computers

Personal computers are running into a technological cul-de-sac. Over the past decade, tens of millions of them have been sold, along with hundreds of millions of word-processing, spreadsheet and other programs to run on them. Understandably, custon.ers want to use their old programs on their new machines. But enabling them to do so greatly restricts computer makers' freedom to innovate. Worse, when innovation is possible, it is more easily and economically done by chip makers, not by the computer makers themselves.

Take four examples of innovations that will improve the personal computer over the next year or so:

- Videos. Soon computer makers will offer machines that can display video on the desktop. Some will even be able to do video-conferencing. The key to providing these capabilities will be chips from Intel and, possibly, a small Silicon Valley chip maker called C-Cubed;

- Local-area networks. Computer makers could soon offer machines that can be more easily plugged straight into an Ethernet local-area network - thanks to new chips from Advanced Micro Devices;

- Communications. New chips from Rockwell are making it cheaper than ever for computers to send faxes and to chat to each other over telephone lines;

- Faster processors. Intel is trying to convince computer makers to design machines which would let customers boost the power of their PCs by plugging in a new microprocessor brain. Intel, of course, hopes consumers will buy its own chips to do so. This could rob computer makers of the chance to sell new, improved models. They may have little choice but to go along, because their own industry has become so fiercely competitive.

By packing all the necessary circuits onto a single piece of silicon, chip makers can add functions to a computer while keeping it compatible with older programs - provided, that is, they can sell the chip to many computer makers at once, to cover the high development costs of the chip. This has not left much in the way of technical wizardry for computer makers themselves to do. One sign of the squeeze on their ability to innovate is that the last-minute changes to Compaq's new product range, which kept the firm's engineers working round the clock, concerned not arcane technical detail but the shape and colour of the machine's plastic cabinet. (Extracted from *The Economist*, 20 June 1992)

IT chipset targets videophone market

Do-it-yourself videophones are on the way as a result of a chipset developed by Silicon Valley start-up company Integrated Information Technology (IIT).

IIT's two-chip chipset performs the all-important data compression function at the heart of videophone technology.

For instance, to send a single video frame down a phone line would take nine minutes without compression. With the IIT compression technology it takes one tenth of a second to send a frame, which is the performance needed to transmit a real-time moving video picture.

Moreover, the IIT chipset allows the construction of a videophone which will work over a standard analog

telephone line, the type of videophone planned by BT, Amstrad and AT&T. AT&T's videophone uses IIT's chip. IIT's chipset conforms to the major standards for videophones - JPEG, MPEG and H.261. The chipset is programmed by IIT to conform with whichever standard is required by the customer.

The chipset costs about £150 including the software. By spring next year it is likely to be 25 per cent cheaper.

The chipset is manufactured by Hewlett-Packard and National Semiconductor. The first of the two chips, called the vision processor, has been in production for a year and is used by video compression market leaders Compression Labs in two video-conferencing systems.

The second of the two chips, called the vision controller, became available in May. (Source: *Electronics Weekly*, 8 April 1992)

Genetic algorithms used in a growing number of computer applications

Evolution has been spectacularly successful in extracting higher life forms from the primordial soup in a comparatively brief slice of eternity. In observing this modern problem, solvers are developing computer algorithms which mimic biological processes to tackle difficult questions.

These so-called "genetic algorithms" are being used in a growing number of applications, including finance, semiconductor and aircraft design, production scheduling and process control. In many cases they are achieving higher success rates in a shorter time than conventional methods.

Genetic algorithms were invented by John Holland, who, inspired by nature's methods of optimizing from its base materials, developed computer techniques that use the equivalent of reproduction, mating and mutation to evolve higher order solutions from random solutions.

A genetic algorithm starts with a "population" - a set of possible solutions randomly chosen. The solutions must be coded into a form the computer can manipulate. This can be sets of binary strings, or integers or real numbers. The encoded solutions are "chromosomes"; their binary digits or numbers are their genes.

The chromosomes are placed in an environment in which they can evolve. A set of conditions and factors determines which individual chromosomes will reproduce into the next generation, which will die, which will "combine sexually" with other individuals and which will mutate.

Sexual combination is the process by which some genes from one individual are swapped with genes from another - the first half of one binary string may be swapped with the second half of another, for example.

Mutation is the random change of one or more genes in an individual. A one may be added to the third and fifth digits in a binary string, for example.

Once the individuals and the conditions of the algorithm have been set, it is left to run for a specified period. There is usually some evaluation process at the turn of every generation to identify and record fit individuals, good solutions in other words.

Populations in genetic algorithms are generally small by nature's standards. Sometimes they are as low as five but usually they are between 50 and 100.

Survival is always probabilistic rather than deterministic. In other words, the best individuals in a population will have a higher chance of surviving but it will not be guaranteed.

A runt individual may have genes which will be useful when recombined in a later generation. Genetic algorithms are suited to applications where it is required to find the best option among many possibilities.

The synthetic evolutionary process has been shown, at first theoretically and now increasingly in practice, to move rapidly towards an optimal solution.

They are also good at the kinds of problems usually tackled by operations research - scheduling, routing, layout and so on. They can also be good for enhancing solutions already arrived at by other methods.

The Lockheed aerospace company in the United States has developed a generalized genetic algorithm software package, which has been used to improve aircraft design and determine near optimal schedules for manufacturing processes.

In one project, engineers set about designing a small remotely piloted combat aircraft with a limited life-span. Using conventional methods, the engineers produced a design with a combat lifetime of 2.4 minutes.

The genetic algorithm package was then applied to the design and in six hours of computation time improved the life-span of the craft by 25 per cent.

The genetic algorithm is the right algorithm for a problem where a small increment of improvement is worth additional development time. Genetic algorithms in practice give typically a 4 to 10 per cent improvement on the results of conventional methods.

It seems ironic in the ultra-logical world of computing that mimicking biological processes can produce significant gains. Those working in the field are

aware of this. (Extracted from *Computer Weekly*, 16 April 1992)

Genetics chips into improved designs

Chip manufacturers are looking at a new technique which mimics the evolutionary processes of nature to achieve more efficient designs faster.

The technique can be used to solve problems at individual design stages or applied after conventional design processes have taken place to further improve layouts.

The technique employs what are called "genetic algorithms", computer-based procedures which simulate biological evolution to produce higher order solutions. The algorithms start out with a "population" of possible solutions which are interbred and mutated until the fittest solutions appear.

In the United States where the technique has been pioneered, semiconductor and engineering design improvements in the order of 4 to 25 per cent have been reported. An attraction of the algorithms is that they reach their results quickly compared with conventional techniques. UK chip manufacturers are beginning to investigate the potential.

Genetic algorithms were invented in the early 1970s by US researcher John Holland. He was inspired by the comparative rapidity with which evolution produced higher order life forms from the primordial ooze. The theoretical framework which Holland set out has been applied to produce computer algorithms to solve a wide range of optimization problems.

Genetic algorithms start out with a problem to which there are some known solutions. Layouts are a good example - the components are known; the problem lies in achieving the most efficient use of space. A random selection of known solutions forms the initial population.

The solution must be encoded into a form that the computer can manipulate. This can be strings of binary digits, or lists of real numbers or permutations of elements and so on. The digits in the strings or real numbers are the equivalent of "genes"; the complete strings or real numbers are "chromosomes".

An "environment" must be established for the population of chromosomes to inhabit. This takes the form of an evaluation function which measures how well each chromosome does at solving the given problem. It is the mechanism by which each generation is measured to identify which chromosomes are fit to survive.

Although the fittest individuals of each generation - i.e., the best solutions - might be recorded for future reference, survival will be probabilistic rather than deterministic. A chromosome which is evaluated to be very fit will have a high but not guaranteed chance of survival. It has been discovered that just as in the natural world a runt individual can survive against the odds and make a contribution to its species, so poor chromosomes in a genetic algorithm might contain genes that are useful to a later generation.

Each generation is modified by the application of genetic operators. These define how and when chromosomes will "mutate" or "sexually combine".

Mutation is achieved by randomly changing one or more genes of one or more chromosomes. For instance, in a population of 50 binary string chromosomes, every tenth chromosome might have a one added to the third and fifth digit.

Sexual combination is the swapping of some of the genes of one chromosome with those of another, for example the first half of the digits of one string with the second half of another string.

Parameters for the algorithm need to be defined. The size of the population must be decided - depending on the application it can be as low as four or five, but typically it is between 50 and 100 chromosomes. It must also be decided how long to run the genetic algorithm. This can depend on how quickly the solution is required or how much processor time is available.

"Genetic algorithms are good for solving complicated combinatorial optimization problems - layout problems, scheduling problems, routing problems and so on", said Dr. Lawrence Davis, a US genetic algorithms consultant, speaking at a conference in London recently.

According to Dr. Davis genetic algorithms have been successful in improving the results obtained by other methods in design applications, including semiconductor design. The improvement has been typically in the order of 4 to 10 per cent, says Dr. Davis. However, in one instance quoted the Lockheed aerospace company achieved a 25 per cent improvement after running a genetic algorithm for six hours on engineering designs produced by human engineers.

European semiconductor companies are already investigating what genetic algorithms might offer. The algorithms might have most to offer in the area of logic synthesis and at least one UK company is looking at this possibility.

Genetic algorithms are not the best solution to all optimization problems. In many cases the increment of improvement is modest. The algorithms are also said to lack "the killer instinct" - they get near to an optimal solution but do not go the final step to producing the absolute winner.

Even if semiconductor companies do not find genetic algorithms useful in the design arena they might want to apply them to their financial dealings.

One promising area of development is the combination of genetic algorithms with conventional methods. These hybrid algorithms have been tried successfully already in some applications, and could be suited to semiconductor design. (Source: *Electronics Weekly*, 11 March 1992)

V. COMPUTER EDUCATION

Super Janet

UK academia is leading the world in its use of computer networking. Local area networks of varying sophistication have been installed at 200 universities, polytechnics and research sites and, linking them in a network of networks, is the United Kingdom Joint Academic Network, better known as Janet.

With data transmission speeds of two megabits per second, Janet is the highest performance X.25 packet switched network in the world. It forms the basis on which the world's most advanced fibre optic network is being developed.

This has been given the name Super Janet and will give the United Kingdom a global leadership in the field. By the end of the decade it will have helped expand computing and communications technology way beyond academia.

One small definition of academic freedom is the option to choose the right computer for the right job. Academics, by their refusal to be tied to certain systems, demonstrate free market behaviour but unlike the rest of the market, their disparate computers all talk to each other; Janet is an open system which demonstrates how wildly variant computers can be tied together.

Janet has a mix of over 20 operating systems, perhaps 50,000 terminals and nearly 2,000 electronic mail services. As a matter of routine, the seriously computer literate at every university in the country have remote PC's accessing supercomputers like the Cray at the Rutherford Appleton Laboratory near Oxford, the Fujitsu at Manchester University and the Convex system at the University of London. The less technically minded also take Janet for granted.

An iron law of computing is that what is easy to operate relies on hidden complexities. Janet has involved high levels of cooperation between industry and academia, between government departments and within the European Community and beyond.

In five years' time, the Super Janet fibre optic network will support a multimedia kit such as the Pandora terminals currently under development at Olivetti's laboratory in Cambridge. It will be underpinned by a raft of new CCITT standards supported by equipment from telecommunications manufacturers such as Siemens, Alcatel and Northern Telecom.

Synchronous digital hierarchy (SDH) and asynchronous transfer mode will enable computers to transmit and receive digitized video and audio signals as mounted on each Unix terminal will be a video camera.

On the screen will be pictures of the user and colleagues taking part in a desktop conference. Aside from desktop conferencing and video processing, there are other image-based applications: visualization techniques to explore output from supercomputers; access to multimedia libraries; distance learning; medical scanning for remote medical diagnosis; and experimental facilities networked to allow research workers at remote sites to monitor and control experiments from their offices.

Janet has already stimulated growth of companies like Spider, Camtec and Netcomm. The latter's high performance X.25 switches have found buyers throughout Europe.

Products such as Pandora open a Pandora's box of technical difficulty because, while computer data transmission is better suited to asynchronous communication in short bursts, video and voice need a steady synchronized flow of information.

For example, instead of the Janet packet-lengths of up to 1,000 bytes, the new network will apply the automated teller machine standard so that data is packaged in fixed length 53-byte cells.

SDH is defined for up to 2,488 Mbits per second but by 1995 transmission speeds of up to 2.5 Gbits per second are predicted. (Extracted from *Computer Weekly*, 14 May 1992)

Informatics education in secondary schools

IFIP's Working Group on Informatics Education at the Secondary Level (WG3.1) recently published a paper on "Informatics Education in Secondary Schools" (in this paper, "secondary schools" means schools for pupils from age 11 to age 18, in general), the first in a planned set of Guidelines for Good Practice. These Guidelines are a part of the continuing efforts of WG3.1, over the past two decades, to provide international leadership in informatics education. A similar series of papers, first released in 1971, paved the way for informatics education in secondary schools. That series outlined the state of the art of a rapidly developing field prior to the advent of the small, portable microcomputer, which has

made secondary informatics education a real possibility for all students. The new series is designed to have the same global impact, reflecting decades of change and advances in informatics education worldwide, and presenting the current state of the art. It should provide assistance to those modern pioneers who are now addressing the problem of informatics education in the secondary classroom. The authors of the new paper, Harriet Taylor (USA), Robert Aiken (USA), and Tom van Weert (NL) reached the following conclusions:*

> Most of the developed nations have taken major steps in the large-scale integration of computers into the educational process. Many of the developing nations are now exploring using informatics education to improve the quality of life of their citizens. These nations must overcome barriers such as lack of financial resources, shortages of trained teachers, lack of software, and absence of an infrastructure to support the integration of information technology into schools. International cooperation and collaboration is essential to overcome the barriers and connect the people of the world through technology.

IFIP and UNESCO

IFIP and UNESCO have a history of producing publications on information technology from a global perspective and in organizing international convocations to further the development of informatics education world-wide. Many of these efforts are described in publications that may be obtained from Elsevier/North-Holland or by contacting UNESCO.

This paper is the result of such a development process. WG3.1 has produced this paper as a starting point in a series of papers on codes of good practice in secondary informatics education. Within this paper are many references to more detailed works of experts in the field. Readers should use these sources as stepping stones for more information and for developing the framework for information technology in education. Future papers, in areas such as social and ethical issues and telecommunications, are envisioned.

Because this report is so interesting, we have selected further quotations from it, which we print here:

> The paper reflects debate that has been going on within WG3.1. This debate has shown that there is not simply one answer to a problem. Especially in an international setting, cultural and other specific circumstances have to be taken into account. In this paper, the collective expertise in the Working Group offers pointers to successful directions of development but does not lay down categorical statements.

Problems of informatics teachers

Informatics education involves new ideas, curricula, teaching methods, materials and tools. The informatics teacher must often work in relative isolation to develop a curriculum, with little support and guidance from outside. Beyond the training and curricular needs outlined above, many other special problem areas can be identified. Some of the most common special areas are listed below.

Keyboarding skills. Often students are keyboard novices as well as computer novices. The teacher must then teach keyboard skills.

Textbooks and support materials. In early stages, textbooks and other support materials in the native language that are geared to the secondary level will be scarce. Teachers must work together to develop materials and support each other as the curriculum and texts to support it evolve.

Student guidance. The informatics teacher must provide guidance for students about careers in information technology and preparation for post-secondary informatics education. The teacher should also consider enrichment activities such as computer clubs and programming contests to increase student interest and involvement.

Professional development. Information technology and informatics education are rapidly developing, dynamic fields. Teachers must constantly update their skills and curricula through in-service training as well as alliances with universities and professional societies. Teachers should have release time to participate in special meetings and conferences and training, in order to maintain currency.

Isolation. Informatics teachers often are the only ones in their schools with expertise. They need opportunities to interact with colleagues with similar interests and problems. It is especially advantageous for them to have access to electronic mail and bulletin boards in order to communicate with others, as well as to receive the latest information. It is also important that they be given the opportunity to attend workshops, short courses, etc. so that they can keep pace with the rapid developments in this field.

Retraining teachers

When facing the task of moving computers into the secondary schools, most nations have been able

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* ● IFIP.

to acquire the hardware and software to support the move. Finding teachers who are prepared to cope with the task has been a much larger problem. The most natural solution has been to retrain existing teachers. Often a core of teachers is selected to retrain, and these teachers in turn are responsible for training others.

Retraining is a key to the development of informatics as an academic discipline. Successful retraining programmes can have many forms. National goals, economic development, cultural and geographical diversity, and educational system frameworks must all be considered. Most retraining programmes will include partnerships between Governments, States, or school systems and universities and will be interdisciplinary. While curricula can vary, we have outlined a general framework around which they can be built.

In many nations, programmes for retraining are still computer-literacy or tools courses for teachers. These programmes will help teachers use computers more effectively and will assist them in teaching computer applications. They will not, however, prepare teachers to teach informatics as a subject within itself. Few national programmes or programmes on a large scale can do this. Teaching informatics is not a chore for the masses, but instead for a few select teachers. Most retraining programmes are local in nature, involving cooperation with one or more universities, and involving courses that are structured as university courses.

The paper then discussed the following aspects of retraining programmes:

- They must be selective;
- They must have incentives to motivate the teachers;
- They must be timely;
- They must contain provisions for certification;
- They must provide access to equipment and assistance;
- They must have a strong informatics component;
- They must contain an integrated educational component;
- They must include group projects and activities;
- They usually involve cooperation;
- They will require national support and funds.

Computer ethics

The introduction of new technological advances into a society naturally results in a change in the social atmosphere. The secondary informatics teacher has a major responsibility to prepare students to live in the computerized society that is evolving - not only by teaching technical skills but also by developing a generation of students who will enter adulthood with the ethical foundation needed to use computers to benefit rather than abuse society.

In many cases, the teacher represents the first contact with a "computer professional" for the students. The students' attitudes about the nature, scope and importance of ethics in computing will be developed through their experiences in the classroom. The teacher must therefore act in a legal and ethically correct manner. A major step that teachers can take is to make the students aware of codes of conduct, written and unwritten, that exist for professions, and the emphasis placed by the professions on upholding these standards. In particular, the teacher could consider as a personal code the Code for Computer-Using Educators developed by the International Society for Technology in Education (ISTE). The ISTE Code of Conduct is one of the first formal policy statements to address ethics in all areas of computer education, including instruction, administration, student support and equity (equity is discussed below).

The teacher must also act responsibly in maintaining the integrity of data stored electronically and of software. This includes preserving confidentiality of records stored in databases or computerized grade books. Perhaps the major ethical dilemma faced by the teacher is in the area of use of copyrighted software. Teachers and students are often confused by the legal and moral issues surrounding software use. Teachers must educate students on the value of intellectual property and the legal protection that copyrights should afford. Teachers should post in laboratories rules that define proper and improper use of software in the laboratories.

Ethics education must be a part of computing instruction at all levels. The secondary teacher, whether teaching computer applications or programming, must integrate computer ethics education into all courses. Despite a growing awareness of the presence of computer crime and abuse in society, few texts for computer science students deal with ethical issues and methods for teaching computer ethics. Methods that have been used successfully include introducing students to

situations or moral dilemmas through surveys, case studies or debates.

Computers have the potential to increase inequities across societies and across groups within societies. In particular, computers can widen gaps in societies between groups of different race, gender or socio-economic levels. Nations must adopt policies that provide for equality of access and opportunity to computer education for all citizens. Computers must be made available to all schools, not just the schools for the economically advantaged or the intellectually superior. Teachers in all schools must have opportunities for training. Teachers must ensure that all students have equal access to laboratories, courses and materials and must actively search for ways to encourage minority students and females to participate in computer education.

VI. SOFTWARE

The key to locking out computer saboteurs

The recent spate of computer thefts from politicians and public figures highlights the risk of storing confidential information on computer disk. The risk is far greater if data is stored on CD-ROM. One 12-centimetre optical disk can hold more than 600 megabytes of data, equivalent to 600 million text characters.

The UK company C-Dilla Associates has now teamed up with Nimbus Records to develop an encryption system which locks data on a CD-ROM so that no unauthorized person can read it.

For business users there is much more at stake than personal embarrassment. For example, banks need at least 30 large instruction manuals for their electronic cash transfer systems. All this data will fit easily on a single CD-ROM, but a disgruntled employee could steal the disk, and either sell the information or use it for sabotage.

Systems exist which let users search data from a CD-ROM only if they have the correct password. But computer hackers can easily use an editing program to display the raw data files.

CD-Secure works in conjunction with the DOS operating system used by most personal computers. Data inside the files on a disk are encrypted by rearranging the digital bits according to a mathematical expression called a "seed key". A hacker can find files on the disk but the data they contain will appear garbled on a screen.

The provider of the information for the disk is given an individual seed key, so the disks produced are coded differently from other disks using the system.

An authorized user of the disk, for instance a branch of a bank, is given a floppy disk containing a short program which is loaded into the memory of the computer to be used with the CD-ROM. This program contains a second key. But to read the data, a third key is needed which ties the two other keys together. This must be typed into the computer by an authorized user.

The third key, which is in practice a string of numbers, can be designed so that it only allows access to part of the information on the disk. So car dealers in one country get one key, which enables them to access one batch of files, and dealers in another country get another key for their country's files. A software company could put all its products, such as printer fonts, word-processing programs and games, on the same disk. The purchaser of the disk gets a key only for the software they have paid for.

The key can also be made to stop functioning after a certain date. This lets the producer of the disk rent them out on a subscription basis or for trial before purchase. This may also be useful to drug companies: old disks, lacking important information on side-effects of drugs, cannot remain in circulation after a certain date.

The de-encryption process can work very quickly, so encrypted moving graphic images are displayed on screen at the same speed as images stored without encryption. (This first appeared in *New Scientist*, London, 22 February 1992, the weekly review of science and technology.)

Scientific visualization developments

Developments in scientific visualization, the visual display of multidimensional, time-dependent or complicated data, have influenced engineering design and examination. The present computing environment is getting to be more suited to the interactive investigation of behaviour as it happens in three dimensions. Also, more data are being put into individual images and animated sequences, supplying fourth dimensions or more for showing states of behaviour. In the future, advances in hardware and display methods are expected to provide a more interactive real-time environment where users can poke and prod movable three-dimensional models to investigate many aspects of behaviour. It is still a young and commercially vital area, with a good deal of work still to be carried out. Present trends in 3-D volume visualization represent evidence of the vitality, giving the design engineer methods to supply an improved understanding of an actual 3-D state of behaviour. (Extracted from *Mechanical Engineering*, May 1992)

Borland gains advantage over Microsoft with world's fastest PC database

US software house Borland has upstaged Microsoft by demonstrating what it claims is the world's fastest PC database for both single and multi-user environments.

Version 4.0 of the Paradox DOS database is claimed to be, on average, 35 per cent faster than the Foxpro 2.0 from Fox software, previously acknowledged as the fastest PC database.

Borland's rival Microsoft bought Fox Software in March to acquire a technology named Rushmore, which significantly reduces the time taken for a database to process data queries.

Borland chairman Philippe Kahm says Paradox 4.0's improved performance comes from a 60 per cent rewrite of Paradox code in Borland's object oriented C++ development language.

Paradox 4.0 is 10 times faster than the previous version, 3.5, but will sell at the same price - £500.

Borland admits some users are concerned that the file locking system in versions 3.5 and 4.0 are different, which means if a network of users are using both versions of Paradox at the same time, they cannot simultaneously access the same database table. (Source: *Computer Weekly*, 4 June 1992)

Computer graphics learns rules of the game

Designers on opposite sides of the world will soon be able to work on the same 3-D computer model using ordinary personal computers linked by ordinary phone lines, rather than powerful graphics workstations.

Software being developed at the Guildford research centre of the Japanese company Canon reduces the amount of data needed to display 3-D objects on a computer screen. The reduction is such that images of moving objects changing 10 times a second can be sent down phone lines.

Graphics workstations are normally needed to display moving 3-D objects because of the huge number of calculations needed to work out which objects are nearest to the viewer and cover up those further away. Three coordinates, x, y and z, represent each point of an object. z represents the distance into the screen, and is stored in a memory called the z buffer. When the computer displays a table in front of a wall, for example, it compares the z buffer values to find out which should appear in front of the other. This has to be done for every pixel (or dot) on the screen, and there are more than 300,000 on many computer monitors.

If an object is moving, all the calculations have to be done several times a second. Adam Billyard, the inventor of Canon Interactive Graphics (CIG), used to write computer games, which demand very economical use of data to keep down costs. He decided it would be quicker to group the pixels; if part of the table is in front of the wall, all of it must be. This slashes the number of calculations needed.

Graphics workstations which use z buffers have extra silicon chips to speed them up. But CIG uses very little data, so needs no extra chips and can be run on almost any desktop computer. Billyard and his colleague Richard Haddy began work in March 1991, and the software may be available some time next year. It all fits on one floppy disk, and the faster the computer it is used on, the faster it works.

Billyard says that each change to a scene takes about 100 bytes of data, and at least 10 updates a second are needed for a moving image. This is about the same data rate as a modern fax machine achieves.

Canon's researchers have not tried a phone link yet, but they believe it will be possible to do so. They say there are methods of coping with phone delays and two people trying to change the same thing in different ways simultaneously.

David Lau-Kee, the project leader, says that CIG uses so little of the computer's processing power that it is possible to do other things at the same time. For example, the computer could carry out scientific calculations while also showing the results as a 3-D graph.

Even experts find it difficult to compare graphics software. Intergraph, a computer-aided design company, says one of its computers can draw pictures containing 50,000 polygons in one second, but Canon claims its CIG can draw 80,000 polygons in a second with a computer that is 20 per cent slower - though Canon polygons are not necessarily identical to Intergraph ones. Intergraph recently launched a CAD Conferencing system so that designers far apart can work together, but it requires computers costing at least £15,000. There has also been interest in CIG from the virtual reality industry. (This first appeared in *New Scientist*, London, 23 May 1992, the weekly review of science and technology.)

Hurtling the language barrier

A consortium of researchers and industry engineers is about to start a project that aims to fulfil one of mankind's oldest dreams: overcoming the language barriers between different peoples. By the year 2000 the group hopes to develop a portable and automatic system that translates languages into spoken English.

The so-called Verbmobil project, sponsored by Germany's Ministry for Research and Technology, aims at a system that translates spontaneously spoken language. The common denominator is English; in other words, it is assumed that two people in conversation - say, a German and a Japanese - have a fair command of English. The Verbmobil translates each partner's spoken words into English. Depending on the two persons' language capabilities, the system will either translate the entire conversation or deliver only the more difficult words and passages.

Under contract to the ministry, two independent teams, one from Stanford University in Palo Alto, California, and the other made up of German researchers, have completed feasibility studies for the Verbmobil system. Encouraged by these studies, the research ministry is now outlining an eight-to-10-year research and development project. In the first four-year phase, work on certain project elements will begin.

Participating in the effort will be a number of German universities, the German Research Centre for Artificial Intelligence, the Institute for Applied Information Technology, and the industry, specifically Siemens AG and IBM Corp. in Germany.

The ministry is also looking for participation from the European Community as well as Japanese and US partners - for example, the Advanced Telecommunications Research Institute in Kyoto and Carnegie Mellon University in Pittsburgh.

One big challenge is the development of suitable processor chips for a system with real-time response capabilities. (Source: *Electronics*, April 1992)

Canadians develop debt management software

Since the debt crisis in its present proportions erupted in 1982 when Mexico, the world's largest third world debtor, suspended its debt service payments, resolution of the crisis has been sought through a combination of policies, including debt forgiveness, debt reduction, debt rescheduling with varying degrees of concessionality, and structural adjustment programmes.

For their part, developing countries have been encouraged to improve their economic management capacity by establishing appropriate debt-management operations in the face of fluctuating interest rates and commodity prices and other variables.

The complexities of international debt management, however, have continued to plague many third world Governments. Given the size and technical complexity of developing-country debt, the task of recording and organizing loans has proved beyond the capacity of many countries. This has led to massive confusion with respect to information and procedures regarding debt payment.

Indeed, proper loan administration and well-informed debt management are factors now recognized as critical in dealing with the current debt crisis.

In 1983, the Technical Assistance Group (TAG) of the Commonwealth Fund for Technical Co-operation (CFTC), Commonwealth Secretariat, established a programme of advisory services in external debt management with the understanding that effective debt management was one of the first of many steps required for surmounting the debt crisis.

The objectives of the programme were to address the information crisis resulting from countries' inability to cope with the volume of data on external debt, and to provide a low-cost, microcomputer-based, user-friendly system for the accurate recording and quick recall of debt-related data.

TAG/CFTC turned to the International Development Research Centre (IDRC)* for technical and financial support for the development of the specialized software required to run this system, which is now known as the Commonwealth Secretariat Debt Recording and Management System (CS-DRMS).

Apart from assisting in the development of CS-DRMS, IDRC has also been active in disseminating and enhancing use of the system, including the installation of the system in Sri Lanka on a pilot-project basis; co-financing, with CFTC; the development and testing of training materials to help prepare staff in the use of the software, and assistance to the Eastern Caribbean Central Bank (ECCB) to make CS-DRMS available to its eight member States.

To date, the system has been installed in 26 Commonwealth countries, providing them with an overall legal and institutional framework to monitor the contracting, spending and repayment of loans. They can practise both "passive debt management" (e.g., they now know when payments are due) and more active management (e.g., the development of an effective borrowing policy, *inter alia*, to keep debt service costs to the minimum).

The CS-DRMS system enables Governments to develop the ability to make a payment on time, and to view their "payment profile" (the "bunching" of due payments) to assess whether a loan could be refinanced and paid off with one bearing lower interest.

In fact, one Government saved close to $5 million in interest payments using this method on the basis of

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* IDRC, an organization that assists developing countries in solving their pressing development problems, may be contacted at PO Box 8500, Ottawa, Canada K1G 3H9. Fax: (613) 238-7230.

the data supplied by the system. Another Government department recognized after implementing the system that it was owed money by other local bodies to which proceeds of a loan had been on-lent. CS-DRMS, therefore, notifies Governments of whom they owe money to, and who, in turn, owes them money. User countries have covered the costs of the system often through the savings generated by one refinancing operation.

The CS-DRMS system also generates nearly 100 different reports, including one that calculates the payments due on a day-to-day basis over a one-month period, and another "arrears report". It can also generate reports specifically required by the World Bank and the International Monetary Fund.

The fact that various international financial institutions require different reports has given many a developing country official nightmares. Despite the difficulties involved in building and maintaining the database, the potential benefits to be derived from the effective use of the system are tremendous.

One of the limitations of the CS-DRMS system, from a wider third world perspective, is that the distribution and installation of the software is confined to the 49-member Commonwealth, although it has been installed in Mozambique and Thailand through special arrangements.

Recently, a joint project by IDRC and the Canadian International Development Agency (CIDA) aimed to expand its availability by establishing an in-house capability, in IDRC, to deliver a programme of advisory services in debt management to non-Commonwealth countries, with a focus on the countries of francophone sub-Saharan Africa.

IDRC has already conducted an in-depth survey, in conjunction with the United Nations Institute for Training and Research and the French Ministry of Cooperation and Development, to determine the state of the art with respect to debt management and to assess the needs of specific countries in francophone sub-Saharan Africa. The IDRC/CIDA project will also look into the feasibility of developing a French-language version of the software. (Source: *Development Forum*, Vol. 20, No. 2, March/April 1992)

New simulation software package to go on general release shortly

The TNO Road-Vehicles Research Institute plans to launch a versatile software package for modelling multi-body systems, within the next few months. The new software package, which has been developed in collaboration with scientists and engineers at Delft University of Technology, incorporates a Bond graph-based Algorithm for Modelling Multi-body Systems, hence the program's name: BAMMS.

The program can be used in various ways to analyse both linear and non-linear systems. It can perform time domain simulations or frequency response analyses and, if required, it can be used to derive a complete set of equations to describe a system in any conceivable domain.

After an extensive six-year development programme, which was initiated by the Vehicle Research Laboratory at Delft University of Technology, plans are now well advanced to offer the BAMMS system as a general purpose simulation package. During the development programme, a number of verification trials were successfully completed. These involved aspects such as modelling four-wheel steering systems, predicting road-vehicle vibration modes and performing capsize simulations.

The program's user-friendly design makes it a convenient tool for modelling a wide class of systems. Use of the BAMMS package allows the performance of road vehicles to be studied in detail, without the need for elaborate and costly test procedures. This is particularly useful when vehicle stability or vibration patterns are being investigated as these are not only difficult to check under practical conditions, but such tests can also be quite dangerous to perform. By modifying characteristics such as the mass and stiffness of various components, optimum designs can be produced relatively simply. This makes the BAMMS package an extremely cost-effective and versatile design tool.

For further information, please contact: C. H. Verheul, M.Sc., TNO Road-Vehicles Research Institute, Department of Vehicle Dynamics, PO Box 6033, 2600 JA Delft, the Netherlands. Fax: +31 15 62 07 66. Phone: +31 15 69 74 05. (Source: *Applied Research*, February 1992)

WordPerfect fixes bugs with latest 5.1

WordPerfect is to issue a fresh release of its latest PC word-processing package aimed at fixing a number of user reported faults.

The update to WordPerfect 5.1 for Windows will correct the troubled graphics import facility in the original release launched last November.

It will also fix problems affecting display handling of high-resolution monitors.

WordPerfect is the leading player in the PC word-processing market with more than 8 million users of its products worldwide.

WordPerfect 5.1 for Windows, the company's first product for Microsoft Windows, has almost 1 million users.

In addition to problem fixes, the update comes with new and improved features.

Improvements have been made to the macro language which lets users create quick commands. Users can now add dialogue boxes to their macros and create macros from a pop-up menu which lists macro commands.

New features include drag and drop text editing and a zoom editor that allows users to see and edit text magnified up to 400 per cent. (Source: *Computing*, 16 April 1992)

Software identifies plankton

UNESCO's Promotion of Marine Sciences Programme (PROMAR) and the Institute of Marine Research, Bergen, Norway, have produced a software module on CD-ROM for identification of the algae, protozoa and selected zooplankton of the north-east Atlantic.

Linnaeus, as the package is called, focuses particularly on the waters of Scandinavia, and allows for the entry of new taxonomic and ecological data.

Development of Linnaeus attracted support from the Norwegian Technology and Natural Sciences Research Council, and the Norwegian Fisheries Research Council.

The Linnaeus CD contains three major sections: Linnaeus Protist, Linnaeus Zooplankton and the Linnaeus Toolkit. Linnaeus Protist contains information on over 300 Protist species, and makes up the bulk of the information on the CD. The Linnaeus Toolkit lets users enter their own data. Linnaeus Zooplankton is an early version of the program.

Further information on Linnaeus, which was designed for use with Macintosh computers equipped with Hypercard, can be obtained from PROMAR, the United Nations Educational, Scientific and Cultural Organization (UNESCO), 7 place de Fontenoy, 75700 Paris, France. (Source: *ACCIS Newsletter*, 10(1), May 1992)

How to secure a portable PC

PC manufacturers are slowly beginning to address the unique security needs of portable PCs using a variety of hardware and software techniques. For the most part, these features are designed to keep precious corporate data away from prying eyes in the event the machine is lost or stolen.

Compaq Computer Corp.'s portable 486c colour computer announced last October, and a new generation of 386SL LTE notebooks announced earlier this year, carry a number of built-in security features. They include a power-on password, a keyboard password, a disk lock/screen blank function and diskette boot control. A cable lock also allows each system to be physically secured to a desk.

Borrowing a number from James Bond, Beaver Computer Corp.'s first notebook computer, the SL007, takes security to another level. It uses a special Data Encryption Standard (DES) coprocessor to automatically encrypt all hard disk files. Data going to and from the floppy drives, serial ports, fax/modem and printer port can be encrypted as well. Such extensive security precautions are not cheap; the SL007 is an Intel 386SL machine priced at $4,995. And the DES option adds another $995 to the final cost.

Although hardware-based solutions generally are not cheap, they provide the highest level of security available in portable PCs today. However, many standard PC utility packages also offer features of interest to security-minded individuals at lower cost. Version 7.1 of Central Point Software Inc.'s PC Tools, for example, includes virus checking, password protection and a directory lock. Included with the package from the Beaverton, Oregon-based company is PC Secure, a data encryption program.

Similarly, Norton Utilities version 6.0, from Symantec Corp. in Santa Monica, California, has a feature called Diskreet that creates password-protected areas on hard disks and automatically encrypts files in the background.

More specialized security packages can offer even more control, however. Most restrict access to files, directories, floppy disk drives, external ports and provide users with audit trails.

Some such packages are aimed specifically at the portable PC market. Personal Computer Card Corp. of Lakeland, Florida, sells just such a product called LapGuard. This $99 package uses a standard 3.5-inch floppy disk as a physical access key or "key disk" to the portable computer. Once the LapGuard's key disk is inserted into the floppy drive, no one can use the machine without a personal identification number - and without the disk in place. True to its name, the LapGuard system causes the portable PC's speaker to "bark" a warning if an unauthorized user attempts to access the PC while it is in suspend mode.

Portable PCs that connect to networks pose a more difficult security challenge. To deal with this issue, many IS managers rely on the same enterprise-wide security packages that are used to secure desktop PCs rather than the many utility packages designed for stand-alone use.

While everyone agrees that technology is needed to combat the growing security threat represented by portable PCs, taking simple steps - like asking users to

be more careful when travelling - can be equally effective. (Reprinted with permission of *DATAMATION*® magazine© copyright by Technical Publishing Company, a Dunn and Bradstreet Company, all rights reserved)

Word processors

Ten years ago, few business people did their own typing. Reports from managers, memos from administrators, and program specifications from systems analysts were handed to a copy-typist - usually several times, allowing for revisions.

Now things are different. Flatter organizational structures, with fewer administrators, are reducing the number of typists available. In parallel, PCs and Apple Macs have become accepted as multi-purpose business tools, so it seems natural to install and use a word-processing program as well as a spreadsheet, database or specialist software. Links to electronic mail systems have encouraged business users to learn to type, and the rise of graphical user interfaces, such as Microsoft Windows, has removed much of the keyboard fear previously felt by managers. Full-time typists and secretaries have also taken to PC word processing; unlike a multi-user system it allows them local document storage and guarantees consistent response times.

Word processing is now the biggest software market for PCs, accounting for more than 30 per cent of sales. In the United Kingdom, sales grew by 30 per cent in 1991. According to research company Romtec, the top sellers are WordPerfect, Microsoft Word, Wordstar, IBM DisplayWrite and Lotus Ami Professional. Most of these are only available on the PC and the Apple, although WordPerfect has versions for Unix and some proprietary multi-user systems. Other software houses claim there is not the demand to make versions for other platforms worth while. The booming market has encouraged software vendors to add complex features, such as multiple columns, multiple fonts (typefaces in a certain size) and the ability to reproduce pictures, which have taken their products beyond the limits of a 1980s word processor, into the realms of desktop publishing.

Some software houses, such as Microsoft, are wary of pushing their products as an alternative to DTP, and you will not find the kind of sophisticated features - colour separations, control of kerning (letter spacing), for example - required to produce a colour magazine. But monochrome newsletters, presentations and advertisements are all possible with products such as Ami Pro, WordPerfect and Word. Microsoft's own independent user group produces its 48-page newsletter entirely in Word.

However, this increasing complexity can be counter-productive for occasional users. The DOS version of WordPerfect, tuned for speed of use by typists, is notoriously difficult for the novice to pick up. This has caused a split in the market, with simplified products written especially for the occasional user, or users of portable PCs, which place a premium on ease of use and ease of learning and are designed primarily for writing rather than formatting text. They are also half the price of the heavyweights (£150-250 compared to about £400).

These products, like SPC's Professional Write Plus, do not have facilities for long documents, elaborate tables or drawing tools. But users can still expect support for a variety of fonts, multiple columns and simple charts. Some software houses produce both types of product: WordPerfect has a little brother, LetterPerfect, and Lotus sells both Ami Professional (for the professional typist) and Lotus Write (for the professional person).

Files can be shared easily between the two, so that documents can receive the finishing touches from a typist trained in correct layout. (All word processors can share files in vanilla Ascii format, but this makes it impossible to include formatting commands. The most popular formats, for example WordPerfect and Wordstar, are often supported by other word processors, as are other common formats such as Lotus 1-2-3 spreadsheet files.)

The popularity of graphical user interfaces, particularly Windows on the PC, has given a further kick to the word-processing market. Windows has little to offer to copy-typists. It is slower than DOS, requires more powerful and expensive hardware and, for a user familiar with all the keyboard commands of a package, a point and click interface is of little benefit. For occasional users, however, or for people producing complex documents with graphics, mixed fonts and elaborate layouts, a graphical interface can be very useful.

People with limited experience of such machines can find commands and functions more easily, which means they use them more and produce better-looking documents. And, because it supports graphics, Windows allows you to see what the document will look like before you print it - what you see is what you get (wysiwyg). This saves both time and paper. Most packages now allow you to edit both text and layout in wysiwyg mode. The latest release of Windows, version 3.1, has simplified this process, by including support for True Type fonts, which are scalable to any required size.

Printing, the bugbear of word processing, is also simplified with Windows. Instead of having to rely on the software house providing a driver for your particular printer, or for a popular model like a LaserJet which yours could emulate, you can now use drivers supplied with Windows (but make sure you are using the latest version). Software user groups often supply drivers to members.

Windows' Dynamic Data Interchange feature allows data to be incorporated from other sources, such as a spreadsheet or database; if the original data is changed, the document automatically reflects the new version. A new feature, Object Linking and Embedding, takes this further, treating the imported data as an independent entity, so you can run your spreadsheet from within your word processor, every time you click on a table of figures. OLE also allows different applications to share specialized programs and sub-routines, so that your presentation package could have the same spellchecker as your word processor, with your personal vocabulary added.

DDE and OLE are part of a steady change in word processing, and applications software in general. The aim is that users should feel they are working on a document, not using a word processor, spreadsheet or whatever. With object-oriented documents combining all the necessary processing functions, and links to email systems or fax hardware allowing these to be shared with others, a word-processing (or documents-processing) package could form the basis of an office automation system.

There is already a thriving market in document management, or work flow management, systems based on word-processing packages. Many high-end products, like Word and Ami, already allow documents to be date-and-time stamped, and circulated for comments without the original being altered. Even quite humble products let you set up templates of standard documents (essential if you have a lot of occasional users and want your documents to retain a uniform layout). Retrieving, say, names and addresses from a database is common too. Gaps in the standard products are often filled in by third-party add-ons.

Despite these advances in document design and integration, word-processing software is still lacking in the most basic area: the text itself. The title word processor is a misnomer. A word processor does not understand words. It can check spelling, but it has no idea what they mean when you string them together. Grammar checkers are appearing in some products, but they are crude. True understanding and automatic generation of text still requires a supercomputer.

A final word of buying advice. Most software purchasers are buying blind. For instance, you do not really know whether an accounts package will meet all your needs until you have used it for a few months. Word-processing software is different. You can take along the document you want to produce and get the dealer to reproduce it. (Source: *Computing*, 28 May 1992)

Image processing

Until quite recently image processing was an arcane science, remote from mainstream computing. It is often assumed that image processing is some technical aspect of graphics or is solely about the storage and management of documents in digital form.

Important as the market for document imaging is, it is only one application of image processing. Image processing professionals wearily explain that with graphics, the computer generates images from numerical data. Image processing, on the other hand, takes images from the real world - captured by camera, infrared sensor, ultrasound scanner or other device - and manipulates then in some way.

The classic applications of image processing are, for example, remote sensing, often from images beamed back from satellites; machine vision, usually in manufacturing where a device will look for faulty parts on a production line; and medical imaging, such as the enhancement and analysis of scanned images of the body.

But the fact is that techniques developed in these specialist fields are being quietly incorporated into a range of mainstream computing applications. This is likely to continue as images become more common on the desktop.

The same can be said for multimedia, especially where video is incorporated into applications. Video image compression, enhancement, warping and so on can all require image processing techniques.

The way in which these techniques are becoming integrated into mass market products is illustrated by a project currently under way at Hitachi. Hitachi's central research laboratory in Tokyo is developing an easy-to-use computer video editing system aimed at the multimedia and consumer markets.

The system, called Impact (interactive motion picture authoring system for creative talent), performs an interactive automated analysis of a video tape, summarizing its contents in a series of annotated icons on the computer screen. The system captures the video frame by frame and digitizes it. Then it identifies the cuts between one sequence of filming and another by examining the correlation of colour between frames. Next, the frames are classified according to camera movement - fixed, pan, zoom - and by the internal movement within the scene, such as a car driving from right to left.

This analysis uses another image processing technique called regional pattern matching. The frame is divided into a number of small regions. Each region forms a template and the following frame is searched for the best match to a template.

The position of the template in the second frame relative to where it was in the first frame will indicate the direction and speed of movement in the video

sequence. Other techniques such as "noise" reduction, edge detection and object extraction are used to produce a detailed summary of the video's contents which is presented iconographically on the computer screen. This summary can then be used for editing.

Artificial intelligence (AI) and robotics research are pushing image processing into new areas. Paradoxically, the challenge of providing vision to moving machines in a dynamic environment may prove simpler than static machine vision used in manufacturing.

Although mobile robots must interpret not just one but a stream of images, each differing only slightly from the one before it, researchers such as Thomas Mitchell at Carnegie Mellon in the United States believe that the complexity of the problem can be greatly reduced by giving a robot two eyes and moving them.

Binocular vision and the movement of the robot's head from side to side - a more accurate mimicking of human vision in other words - provides information that can simplify interpretation problems. Moving the robot's head can give an alternative view of an image that resolves ambiguities or simply moves beyond the problem area.

In many cases a robot will not need to identify an object, only to know it is there and to avoid it. Trying to interpret the world with static vision can be like trying to ride a bicycle standing still, or a hunter trying to spot a tiger in a thicket. While the tiger is motionless, its striped coat blends with the vegetation, and is difficult to see. But when the tiger moves, it is easily distinguished.

There are plans to build cameras sensitive to movement rather than steady states. These would operate like passive infrared detectors which are triggered by a sudden change in their environment. Although image processing started out as a completely separate technology from graphics, the two are now beginning to overlap.

Other areas where graphics and image processing are being combined are in the presentation of satellite data and the remote control of robots. At the UK National Advanced Robotics Research Centre in Salford, data captured by sensors on a remote robot is superimposed on a graphics model of the remote environment.

In the hostile environment of a nuclear installation, for example, combining the two technologies can be the most effective and economical way of creating an accurate simulation of the robot's environment for the operator.

Also, in the rapidly expanding field of data visualization where complex data is turned into pictures for easier interpretation, image processing techniques are being built in to increase the power of the visualization software.

It is likely that many computer users in the future will make everyday use of image processing without ever knowing it by name. (Source: *Computer Weekly*, 21 May 1992)

VII. COUNTRY REPORTS

European Community

European VLSI design initiative enters second phase

The "Eurochip" initiative that provides European academic institutions with access to VLSI design services and fabrication facilities entered its second phase. One of the aims of the initiative is to alleviate the perceived lack of VLSI engineers in Europe by training an additional 3,000 students in VLSI design every year.

In 1989 Eurochip was placed under the VLSI Design Action section of the ESPRIT programme with a funding of about $17 million for the first two years. The second phase will run for three years with similar funding from ESPRIT III. Different charges will be introduced for participants from within the European Community and those from outside it.

A conference to mark the end of the first phase of Eurochip concluded that this phase had exceeded far beyond its expectations with the initial involvement of 50 higher educational institutions expanding to 200. During the second phase a further expansion to 300 is expected. (Reprinted with permission from *Semiconductor International Magazine*, February 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, Illinois, USA)

JESSI takes stock

JESSI (Joint European Submicron Silicon Initiative) has concluded the start-up phase of its European microelectronics programme with a review of what has been achieved.

When the programme was started up two years ago, the founding members of this industrial initiative were then looking at four subprogrammes concerned with chip technology, equipment and materials for production, future applications in new systems and basic research in the microelectronics field.

Overall, the JESSI Board has investigated over 300 individual project proposals and more than 70 entries were allowed to proceed. Major projects thus

far have included the memory project, the logic project, optical lithography, a frame project for designing chips using CAD and a research programme to pave the way for future chips.

The start-up phase has involved a financial outlay of approximately ECU 460 million, of which 40 per cent of funds were provided by national governments, 10 per cent by the EC and the remainder by the industries and institutions involved. (Source: *AMT*, March 1992)

JESSI pushing chip development for HDTV

Now entering its main phase, the Joint European Submicron Silicon Initiative has embarked on one of its ambitious "flagship" projects: high-definition TV. Such projects involve joint developments that, instead of aiming towards esoteric goals in science and technology, lead to products that it is possible to market commercially and thus manage to catch the public's attention.

Participating in the effort are 10 companies from five countries: Belgium, France, Germany, the Netherlands and the United Kingdom. For the project, which is scheduled to run until 1994, JESSI officials have earmarked about $140 million, with roughly 25 per cent of that money to come from Germany.

JESSI officials hope that the high-speed, high-complexity HDTV circuits to be developed will serve as pacesetters in designing ICs for other portion of the consumer electronics market. They are also banking on HDTV to create a huge demand for high-performance consumer chips, a demand considered crucial if Europe is going to manage to develop a stronger base in microelectronics. (Source: *Electronics*, April 1992)

Increased budget called for

The European Commission has called for a near doubling of its research budget from the current ECU 2.4 billion ($3 billion) per year to ECU 4.2 billion ($5.25 billion) by 1997. In disclosing the proposal, which must win unanimous support from the Council of Ministers, Research and Development Commissioner Filippo Maria Pandolfi said that the increased funding should help EC industry catch up with competitors in the United States and Japan in the field of advanced technology.

In addition to the request for more funds, Mr. Pandolfi also outlined plans for a major overhaul of Community R&D policy. He told a press conference "We must adapt our research policy towards the needs of our industries", explaining such a concept would entail a better balance between traditional research objectives and more technology-oriented projects on which European industrial competitiveness depends.

By Commission estimates, the Community and the 12 member nations spend roughly 2.1 per cent of their annual gross domestic product on R&D, compared with 2.8 per cent by the United States and 3.5 per cent by Japan.

Commission sources explain that the proposed doubling of spending will help the Community keep pace with its rivals, which since 1975 have increased research spending much more rapidly than the EC. For example, since 1975 Japan has increased research spending by an annual 7.4 per cent while the United States has increased its research budget by an average of 4.6 per cent. During that period the Community increased spending by only an average of 4.1 per cent per year. (Extracted from *Electronic News*, 20 April 1992)

EUREKA welcomes first East European member

Hungary has become the first East European member of EUREKA, the high-technology programme of the European Communities (EC).

Last June, EUREKA announced it would extend membership to countries in Eastern Europe. Since then, EUREKA has established contacts with Hungary, Poland, the Czech and Slovak Federal Republic, Romania, Estonia, Lithuania, Albania, Slovenia and the countries of the Commonwealth of Independent States (CIS). EUREKA officials say that they expect Poland and the Czech and Slovak Federal Republic to become full members of EUREKA within the next 12 months, although neither country has yet applied formally.

Although non-member countries can take part in EUREKA projects, the entrance criteria are more restrictive than for members. The new partner must take a major role in the project, and research must be carried out mainly in the member countries. Administrative procedures are also more cumbersome. In 1991, some 17 EUREKA participants in 10 projects were from East Europe.

Hungary is expected to participate more fully in existing EUREKA projects now that it is a full member; it already has limited involvement in several EUREKA projects under the rules for outside participation. In the longer term, access to the EUREKA network of Western companies, institutes and research projects should help Hungary to build research networks, break into new markets and commercialize its technologies. EUREKA membership also improves the chances of Hungarian companies obtaining cash from their Government for research. In turn, Hungary will begin to contribute to EUREKA, paying as much as 35 per cent of any project in which it participates.

This enlargement of EUREKA illustrates the continuing expansion of the frontiers of European research programmes. Last year, the European Commission opened up all of its Environmental Research Programme to the countries of Eastern Europe, and admitted Hungary, Poland and the Czech and Slovak Federal Republic to the EC's COST (Cooperation in Science and Technology) programme.

Some issues relating to participation remain unresolved, however, a result of differing research philosophies. EUREKA, with a tiny secretariat in Brussels, helps companies seeking government funding to develop their ideas for joint projects. Most of the projects in the EC's Framework programme, on the other hand, are designed by the Commission and then carried out by consortia. (Source: *Nature*, Vol. 357, 4 June 1992)

India

Indian software exports on the up

Indian exports of software are expected to reach Rs 11.5 billion (£200 million) during the current financial year compared with Rs 9.3 billion (£162 million) last year, according to an Indian Government report. India's Electronics and Computer Software Export Promotion Council said exports from rupee currency areas will fall although exports from general currency areas will rise. The aim is to increase exports fivefold by 1994. (Source: *Electronics Weekly*, 8 April 1992)

Ireland

Power Electronics set for innovation

A new programme in advanced technology has been set up to turn university research into commercial opportunity. Known as Power Electronics Ireland, the programme will function as a division of Eolas.

Research staff working in the various universities of Ireland have identified a number of projects which will be of significant benefit to Irish industry and will, apparently, create over 200 jobs over a period of two years.

University College Cork (UCC) represents the largest research centre in the programme. The UCC centre is headed by Professor John Murphy and Dr. Michael Egan. They are currently working with Apple on the development of disk drives and are anxious to provide support to any Irish company working in the area of motion control.

As well as Apple's links with UCC, other major European companies have already established partnerships with Power Electronics to develop research projects at university centres in Dublin (UCD), Galway (UCG) and Limerick (UoL). The companies include Philips, Motorola and Menthor Graphics.

UCD has two research centres where the Power Electronics Simulation Group has been working on developing innovations that will simulate how power electronics circuits perform. The other centre is the Machines and Magnetics Group.

UoL is the power supply centre for the programme while facilities are also established at UCG and Dublin City University.

Power Electronics Ireland is currently 75 per cent EC funded but will be a self-financing service company by 1996. Watch *AMT* magazine for future technical articles on Power Electronics. (Source: *AMT*, March 1992)

Japan

Ten-year microstructures project

Six companies have been chosen by Japan's international trade and industry ministry, MITI, to take part in a 10-year project to fabricate and characterize quantum effect microstructures for us in 1 Gbit and larger memory devices.

The six are NEC, Matsushita, Fujitsu, Sony, Hitachi and Motorola.

Plans call for the Government to provide almost $40 million over the project's length to support development efforts at each of the companies.

The programme will concentrate on the wave properties of electrons and hopes to achieve a scientific breakthrough for semiconductor devices.

Technologies will be developed for devices with design rules ranging from 0.1 to 0.01 micron with research divided into three stages.

The first stage, from 1991 to 1994, will study and evaluate basic technologies for constructing quantum effect devices. The second, from 1995 to 1997, will develop and test high speed, low power consumption, multifunction devices, high density memory devices, and ultra parallel processing devices that use quantum effect devices. The third and final stage, from 1998 to 2001, will aim to create more advanced and highly integrated devices and test them in information processing systems.

Japanese interest in this area is based on preliminary evidence that quantum effect technology will reduce electron scattering to achieve high electron mobility and ultra-fast devices; and be able to use the phenomena of electron wave interference to realize devices with lower power consumption and entirely new functions.

Proposed applications include ultra high-speed computers, ultra high-precision image processing equipment, and compact, high-performance translating machines.

Hitachi is setting up an R&D facility to prepare for the production of 1 Gbit DRAMs. The facility will be based at Hitachi's central research laboratories and is scheduled to open within the year. Hitachi expects to begin manufacturing 1 Gbit DRAMs on a commercial scale around the year 2000. (Extracted from *Electronic Times*, 6 February 1992)

Japanese memories up

The Ministry of International Trade and Industry (MITI) has released its estimates and forecasts for the second half of 1991 and first half of 1992 of Japanese MOS memory devices. Details for the first half of 1991, expressed in millions of units, are:

	First half of 1991	Second half of 1991	First half of 1992
1 M DRAM	100.4	102.3	93.0
4 M DRAM	2.1	19.4	22.9
SRAM	165.7	194.1	187.6
EPROM	37.2	34.0	35.5

Over the last 12 months we can see from the above numbers that a drop of 7.4 per cent has been applied to the 1 MEG DRAM output whilst 4 MEG DRAM growth, between the first half of 1992 and the same period last year, is a significant 89.3 per cent.

Indeed, the Japanese have had their problems with profits, for the first time ever over the last year - all due to memory price falls, especially in DRAM. Toshiba have gone on record stating their desire to reduce memory per cent of semiconductor revenue to under 30 per cent in an attempt to stabilize its profits.

Currently, their revenues are split; discrete's 23 per cent, bipolar 15 per cent, logic 30 per cent and memory 32 per cent. NEC have reduced their profit forecast by 26 per cent from its October 1991 projections. This they state is due to the personal computer world-wide market down-turn and pressure from its semiconductor unit prices. It has cut capital spending plans for semiconductor factory production lines from $2.12 billion to $2.04 billion. Fujitsu are even worse with a projected reduction of pre-tax profit by 44 per cent and expects a shortfall in capital spending on semiconductor facilities. Both companies have entered into "arrangements" to start supplying 4 MEG DRAMs to other companies on an OEM basis. Fujitsu is to supply INTEL, Europe with 4 MEG, from its Durham factory in England. (Source: *AMT*, March 1992)

Euro image

Other Japanese manufacturers are looking at innovative ways of gaining European image. Oki, not a large player in the DRAM merchant market, has come to an agreement with SGS-Thompson to assemble 4 and 1 MEG DRAMs in France. The numbers could be 300,000 units per month, mixed between the two DRAM types.

Mitsubishi has completed the construction of its IC assembly plant in Germany. It will commence with 4 MEG production this April. They also started building a wafer fabrication plant in September 1991 on the same site which is on-schedule for completion in the summer of 1993.

1991 rank	1990 rank	Company	1991 market share
1	1	NEC	8.5%
2	2	Toshiba	8.2%
3	3	Hitachi	6.7%
4	5	Intel	6.3%
5	4	Motorola	6.0%
6	6	Fujitsu	4.8%
7	7	Texas Inst.	4.2%
8	8	Mitsubishi	4.0%
9	10	Matsushita	3.7%
10	9	Philips	3.2%

(Source: *AMT*, March 1992)

Fifth-generation project lives on

After spending more than ten years and ¥50,000 million (US$ 400 million) to develop a fifth-generation computer, a machine supposed to revolutionize the world of computing, Japan's Ministry of International Trade and Industry (MITI) plans to spend another ¥4,000 million and two years to make the computer compatible with commercially available machines. MITI's decision represents the final ironic twist in a project that, when announced in the early 1980s, sparked fears in the West that Japan would capture the world's computer markets with a new generation of machines that would make conventional computers obsolete.

MITI and project officials justify their decision to extend the project, which has already lasted one year longer than planned, by pointing to a glowing assessment by academics and industrialists closely associated with the project. The new effort, devoted to linking the Japanese computers to those that use the US-developed UNIX operating system, serves instead to highlight the shortcomings of the original project.

In the past two years, the project's Institute of New Generation Computer Technology (ICOT) has donated

terminals to the US Argonne National Laboratory, the US National Institutes of Health and the Lawrence Berkeley National Laboratory. ICOT publicized the donations as a joint US-Japanese effort to develop fifth-generation software. US researchers now see ICOT's move as largely a publicity stunt and complain that the fifth-generation computers are slow, cryptic, prone to errors and incompatible with any other computer.

Shunichi Uchida of ICOT acknowledges the complaints and says that the aim of the extension is to overcome such problems and make the fifth generation computer available to everybody. Uchida notes, however, that the speed of the fifth-generation computer will be reduced to "half" in linking up to UNIX computers. (Source: *Nature*, Vol. 357, 25 June 1992)

Japan turns on the heat to destroy CFCs

CFCs have been widely blamed for depleting the Earth's ozone layer. Japanese researchers are now claiming advances in technologies to break down these chemicals.

One technique which disintegrates CFCs into harmless salts has been developed in a joint project between Tokyo Electric Power Company, Nippon Steel and the National Institute for Resources and the Environment. The disintegrator works by heating CFCs mixed with water to around 10,000° C to ionize the molecules. The resulting plasma of electrons and ions is then cooled and sodium hydroxide and calcium hydroxide added. These react with the CFC gases to form harmless sodium chloride and fluorite.

Although the energy consumption is high, it is not so large compared to other technologies, such as combustion. The price is high - as much as £2 million per machine - but further research will bring the cost down. Processing costs will be around £2 per kilogram of CFC at a rate of around 50 kilograms of CFCs per hour. The researchers say destruction is 99.99 per cent efficient.

A rival group at the Tokyo Institute of Technology is working on a similar idea but on a smaller scale. It has demonstrated a thermal plasma, generated by a simple electric arc which decomposes CFCs.

The system consists of a cylindrical copper anode and a tungsten rod cathode, placed on top of a reactor tube 46 centimetres long and 8 millimetres in diameter. A direct voltage applied to the electrodes in the presence of a stream of inert argon generates a thermal plasma at 10,000° C which degrades CFCs blown into the reactor tube.

The reaction produces hydrogen chloride, hydrogen fluoride, carbon dioxide and carbon monoxide. The team suspects it may also produce small quantities of chlorine gas - another ozone depleter.

Meanwhile, another group at the electronics company Toshiba, once one of Japan's largest users of CFCs, is working on a process that involves no high-temperature plasma. The crucial agent is ultraviolet light, the same light that makes CFCs reactive in the upper atmosphere.

The Toshiba apparatus dissolves CFC-11 in alcohol and reacts it with sodium under ultraviolet light, so that it breaks down into salt. The advantage of the technique is that it can be done at room temperature and using ordinary electrical voltages. However, the team still has to scale up the apparatus to a useful size. It is also developing the technique into a continuous flow process.

The biggest users of CFCs vary from country to country. In Europe, most CFCs come from aerosols; in the United States, from refrigerators. But in Japan, the biggest use is for the cleaning of semiconductors. (This first appeared in *New Scientist*, London, 11 July 1992, the weekly review of science and technology.)

Singapore

New design centre

Toshiba Corp. has opened a small design centre in Singapore, focusing on ASICs and semicustom LSI circuits. The design centre will initially focus on 4-bit and 8-bit microprocessor designs for customers throughout South-East Asia. It will offer 1.5-micron and 0.8-micron design geometries, primarily for gate-array designs. Workstations at the centre are linked by satellite to Toshiba's semiconductor engineering system in Kawasaki, Japan. Toshiba has been discussing how it can cooperate with local electronics companies, such as Chartered Semiconductor Manufacturing, the island's only foundry. The design centre may ultimately fabricate some of its products at Chartered. (Extracted from *Electronic World News*, 20 April 1992)

Turkey

Electronics market grows

Turkey has become a healthy market for electronics. Sales of information-technology equipment there hit $300 million in 1991, and growth is 30 per cent a year. This explains why IBM, Bull, Hitachi, NEC, DEC - in fact, all the major world players in computing - are already there.

But how does a country where the average per capita income is $5,000 manage to create a heavy demand for telecommunications and information technology? Analysts say there is a sharp division in Turkey between the traditional economy based on agriculture, which remains stable, and the rapidly growing modern economy based on manufacturing and services. The latter is growing fast, pushing real GNP to grow about 6 per cent a year.

A member of NATO, the country looks to the United States as its model for development. "We retain our ancestral culture, but there is no reason why it should prevent us from adopting your technology", says Riza Nur Pacalioglu, director of the Bogazici Elektronik Sanay data communications firm in Istanbul.

In the 1980s, Turkey opened its markets to world competition. During the decade a significant part of the State-owned industries was privatized. As a result, banks and manufacturers began a race to modernize, investing in new technology the better to cope with foreign competition.

The move to a competitive economy has had an enormously stimulating effect on Turkish business. The Istanbul stock exchange, created in 1986, now has capitalization and trading volume that rival those of the Milan and Madrid bourses. Turkish banks provide services that are equal to those of other European countries.

In fact, the banks were the first to move in the Turkish investment wars, and they have continued to purchase equipment at a breathtaking pace, going directly from preinformation-technology stages to mainframe technology, largely with dumb-terminal clients. They have also moved rapidly into the most advanced data-communications technologies.

In the 1980s, the Turkish PTT converted more than 85 per cent of the country's exchanges to electronic switches. It also developed Turkpac, the national packet-switching exchange, to a point where it can be used reliably for electronic funds transfer and data interchange throughout the country.

Even the outlawed Kurdish Separatist Movement is known to use X.25 communications for its internal communications.

One area where Turkish manufacturers clearly do not need help is consumer electronics. Turkish TVs, manufactured by local producers, have found a solid niche market in Germany and England. Turkey exports about $100 million worth of colour TVs, mostly to Europe. But the internal market for consumer electronics is also impressive. (Extracted from: *Electronics*, April 1992)

United Kingdom

EEF survey predicts electronics recovery

British Engineering is poised on the edge of a slow recovery, with electronics forecast to be the fastest growing sector after motor vehicles, according to the latest Engineering Economic Trends survey from the Engineering Employers Federation (EEF).

Sales of electronics equipment in real terms will not recover to 1989 levels until at least 1994 and the EEF admits there is no indication from the published figures that the decline in sales is tailing off.

The EEF pinned its recovery hopes on a growth in fixed investment in manufacturing, most of which will be spent on engineering products.

Sales of electronic goods are expected to grow by 5.2 per cent between the second half of last year and the first half of 1993, compared to an average of 4.1 per cent for engineering overall.

Over the past 18 months electronics sales have dropped by 13 per cent. The EEF said slow growth will begin in the middle of the year, accelerating into 1993.

Job losses, however, are expected to continue, with a further drop of around 13,000 in electronics and electrical engineering and 60,000 in total engineering employment over the next 12 months.

The trade gap in electronics is expected to widen, with imports up £3.5 billion and exports rising by £2.8 billion next year.

Labour's trade and industry spokesman Gordon Brown described the loss of 60,000 more engineering jobs as appalling. (Source: *Electronics Weekly*, 1 April 1992)

CFC-free industry planned by 1995

The United Kingdom will phase out production of chemicals used in electronics manufacturing that destroy the Earth's protective sunscreen by 1995, according to the Department of the Environment and British chemical giant ICI.

ICI says that production of chlorofluorocarbons (CFCs), widely used in the electronics industry for cleaning, will end by 1995 - two years ahead of the European Community target date.

The announcement follows recent worrying revelations by US space agency NASA that the ozone layer, which protects life on Earth from harmful ultraviolet solar radiation, was being destroyed far faster than predicted.

NASA is convinced that the build-up of chlorine monoxide, a derivative of CFC pollution, is responsible for increased ozone destruction.

President Bush responded to the NASA findings by bringing forward the target date for US companies to stop making CFCs by five years to 1995. Germany announced that it intended to phase out CFC production

by the end of 1994. (Source: *Electronics Weekly*, 19 February 1992)

Microengineering Network (MEN)

The BNF-Fulmer Microengineering Centre has launched an important new UK initiative - the Microengineering Network.

The Network will support BNF-Fulmer's original concept of a comprehensive microengineering centre facility and will allow it to progress. It will provide industry with a focal point. Fully comprehensive services, ranging from R&D through to commercial manufacture, will enable industry to exploit this important new technology.

The DTI, who were approached to part-fund the expansion of BNF-Fulmer's present R&D capabilities into a comprehensive centre, including low volume manufacture, commented that, although not under one roof, all of the required equipment and facilities already exist in the United Kingdom. Industry also found it difficult to justify a strategic investment during the current economic climate. These responses lead to the alternative approach of a network.

The combination of facilities, capabilities and expertise will improve the communications and flow of information between the various corporate, university and government facilities and, most importantly, will allow contract work coming into the Microengineering Centre at BNF-Fulmer to be completed efficiently by the Centre and the network participants.

The Network brings together R&D facilities, process specialists and manufacturers. The current list of participants is as follows: BNF-Fulmer, British Aerospace, Harwell Laboratory, Edinburgh University, Southampton University, Birmingham University, Middlesex University, Dundee University, Warwick University, Exitech, Electrotech, Corning, Semifab, Centronics and Druck.

BNF-Fulmer has also been asked by the United Kingdom Sensors Group (UKSG) to start a Common Interest Group (CIG) in Microengineering. This group of users and potential users of the technology will complement the Network splendidly. (Source: *BNF-Fulmer Press Information*)

Universal Sensor-interface IC (USIC) project

The Microengineering Centre is participating in a major European project, worth 10 million ECU, called JAMIE (Joint Analog Microsystem Initiative of Europe). The project will complement the microengineered sensors and other devices developed at the Microengineering Centre and will be of enormous interest to sensor manufacturers, especially those of low-to-medium volume devices, who at the moment cannot justify the development costs necessary to produce an interface chip.

BNF-Fulmer's contribution is £930 thousand of which almost 50 per cent is funded by the DTI. The aim of the program is the development of a semicustom/custom ASIC concept which combines high performance analog functions with high resolution (16 bit) so that users who require analog and digital ASICs in low to medium quantities at an attractive price can be satisfied.

BNF-Fulmer's role is the definition, design, development and characterization of the driver product, in this case a Universal Sensor-interface IC (USIC). The USIC will be able to interface with a wide variety of sensors and sensor inputs (mixed analog and digital), can incorporate digital offset, span and linearization, and will provide a variety of outputs.

BNF-Fulmer are currently in the process of defining with industry the functionality of the chip and are also looking for sensor manufacturers and end users to become involved at an early stage with a view to evaluation and eventual supply.

The other European partners are:

- AMS - Austrian Silicon Foundry;
- Mikron - German/Austrian ASIC design house;
- Joanneum Research - Austria Electronic systems design;
- Instituto Superior - Portuguese, special analog cells.

For further information, please contact: R. Santilli, BNF-Fulmer, Wantage Business Park, Wantage, Oxfordshire OX12 9BJ. Tel.: (0235) 772992. Fax: (0235) 771144. (Source: *Supplement to Microengineering Network Press Release*)

United States of America

Report urges software patent fix

A new report* recommends that Congress should intervene to help the US Patent and Trademark Office come to grips with the issue of patenting computer software.

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* *Finding a Balance: Computer Software, Intellectual Property and the Challenge of Technological Change*. OTA, 1992.

Noting that no issue short of patenting life has confounded the patent office more than the blizzard of claims for everything from basic mathematical principles to the use of on-screen symbols, the congressional Office of Technology Assessment (OTA) recommends that Congress should consider changing the law to clarify or restrict the scope of software patent and copyright claims.

In the meantime, OTA recommends several more immediate measures, including a database of non-patented "prior art" - algorithms, programs and concepts considered to be in the public domain or otherwise unpatentable. Giving the public access to the database would help to keep it up to date, OTA says, and would allow software developers to judge the quality of their claim without actually filing an application. (Source: *Nature*, Vol. 357, 7 May 1992)

Companies take advantage of Russian thaw

AT&T's Bell Laboratories research division has hired 100 researchers from the Russian Academy of Sciences to enhance its expertise in the field of fibre-optic technology. The team, the cream of Russia's technical élite, will continue to work from their base in Moscow. The institute is the recognized leader in fibre-optic research and development in Russia. In some areas - high strength fibres, for example - it is the world leader.

Another attraction to Western companies is the price tag the Russians attach to their skilled workforce. Because the Russian Government can no longer afford the researchers' salaries, US companies with R&D budgets running to millions of dollars a year have no difficulty wooing staff. (Source: *Computing*, 4 June 1992)

VIII. STANDARDIZATION AND LEGISLATION

Top five plan PC network link standard

Five leading companies have joined forces in a bid to make it easier to manage PCs linked to corporate networks.

Microsoft, Intel, Novell, Sun Microsystems and SynOptics announced the joint venture in May. They intend to establish rules governing the way networks manage tasks such as PC workstation configuration, performance and security.

There is no standard method for integrating this information into existing network management systems. PC workstation management is often both time-consuming and inefficient.

The standards are expected to be completed this year and will be offered free to software developers and computer manufacturers.

In a separate joint venture, Microsoft is working with Compaq and Analog Devices to develop technology which will allow PC applications to use audio capability. (Source: *Computing*, 28 May 1992)

IBM-Apple multimedia standard

International Business Machines Corporation and Apple Computer Inc. said they were recruiting major Japanese electronics companies to establish an international multimedia standard.

Company executives said they had approached a number of Japanese electronics companies seeking support for a new joint venture, Kaleida, to be formed to establish a multimedia standard.

Multimedia is a new kind of technology that combines images, sound and data. It is expected to help merge computers and home electronics equipment such as televisions, videocassette recorders and game machines. (Source: *International Herald Tribune*, 23-24 May 1992)

Flash memory card specification

The Personal Computer Memory Card International Association (PCMCIA) has announced two specifications for a standard way of handling mass data storage on flash memory cards. The PCMCIA specifications have been long awaited and will help the development of mass memory cards for small computers such as palm-tops and pen-based systems. The specifications also provide a standard way of storing electronic images. Small sub-notebook computers represent one of the fastest growing segments of the computer industry and new models from Hewlett-Packard, Apple Computer and Japanese companies are expected by the end of this year. The two PCMCIA specifications will be published within the next month. (Source: *Electronics Weekly*, 13 May 1992)

First computer products certified as interoperable

The first computer products to be certified as interoperable by Europe's Standards Promotion and Application Group are now available to users.

SPAG, a Brussels-based organization of nine information technology suppliers, developed Europe's first independent interoperability testing procedure, called the Process to Support Interoperability (PSI). Products that pass PSI get a label certifying that they will interoperate with products of other vendors.

SPAG announced on 26 March that X.400-based message-handling products from Alcatel, ICL plc, Olivetti and Siemens-Nixdorf Informations-systeme AG qualify for a PSI label. Currently, Groupe Bull, Digital Equipment Corporation, IBM, ICL, Olivetti and Siemens-Nixdorf are involved in the first test phase for File Transfer Access and Management products.

Manufacturers and users hailed the emergence of the first PSI-labelled products as a significant step towards increasing confidence in open systems in Europe. Users said they are encouraged by the fact that suppliers participating in the programme must have their PSI-labelled products retested and requalified should they later fail in any way to interoperate with other PSI products.

At present, only SPAG's nine members - Alcatel, BT, DEC, Bull, Hewlett-Packard Co., IBM, ICL, Olivetti and Siemens-Nixdorf - have committed to participating in the PSI programme. But several other companies that are not members of SPAG have expressed interest in participating. (Extracted from *Communications International*, 6 April 1992)

ANSI to adopt standards

Unshielded and shielded twisted pair implementations of the 100 Mbit/s FDDI local area network standard are both likely to be adopted by the US standards body ANSI. A new proposal to reduce radiation on unshielded cables by Cabletron and National Semiconductor is under review by ANSI. It uses non-return to zero inverted (NRZI) two level signal encoding to reduce high frequency content of data signals. Companies intend to use the large installed base of data grade unshielded twisted pair cable to promote the use of high data rate LANs right up to the desktop. (Source: *Electronics Weekly*, 4 March 1992)

Network standards to bridge generation gap

By August of this year users and suppliers of products for managing large networks should have guidelines for interoperability standards.

Key bodies representing both users and suppliers in the networking industry have agreed on a programme of work which will bring out a series of standard profiles for interoperability.

Following a course defined under the leadership of the Network Management Forum, participating groups have defined markers along the route. These bring together defined functionality, stable standards and industry agreed specifications.

The first marker, to be known as an Open Management Interoperability Point, or Omnipoint, is due this summer. Refinements will then appear every two years. At each point there will be a developer's handbook and a procurement guide to help suppliers and users keep in step.

Covered by the first Omnipoint are specifications for reporting, logging and filtering alarms, testing management, scheduling management, trouble ticketing, configuration and change management, security and path testing.

The road map program coordinates the forum and user groups, industry consortia and standards bodies. Users can turn to the UK government's CCTA and the US National Institute of Standards and Technology as well as the Forum's user advisory council. (Source: *Computer Weekly*, 13 February 1992)

WORM standard

The preparation of electronic images is covered by a new standard published by the British Standards Institute in January 1992.

The standard, DD 206: 1991, recommends ways to capture and store electronic images of hard-copy documents to ensure the preservation and integrity of data. It applies to the WORM (Write Once, Read Many) optical disc format.

The first such standard to be published, it costs £22.50. For further information, contact the British Standards Institute, 2 Park St., London W1A 2BS, UK (TP+44 908/220022). (Source: *Information World Review*, February 1992)

First patent from SRC-SEMATECH research

Research at the Sematech New Jersey Center of Excellence in Plasma Etching, contracted by the Semiconductor Research Corporation (SRC) and Sematech, has resulted in the first patent issued for university research. The patent, "Triode Plasma Reactor with Phase Modulated Plasma Control", is based on research carried out at the David Sarnoff Research Center at Princeton by Dr. John H. Thomas III and Dr. Bawa Singh as part of the magnetic-enhanced reactor development programme.

According to SRC, the new approach covered in the patent solves a problem common to previous triode plasma reactor designs: rf excitation generates its own sheath voltage and dc bias, and this results in the undesirable coupling between the process for generation of the reactive chemical species and the processes for etching and deposition.

The newly patented innovation overcomes this problem through the use of phase-modulated excitation to two of the three electrodes. Using this method, the processes can be independently controlled, permitting optimization of the resultant silicon structure. Phase-modulated excitation results in fine tuning, better

control, and the ability to produce a high concentration of reactive species operating at low self-bias and low pressures. (Reprinted with permission from *Semiconductor International Magazine*, 31 January 1992. Copyright 1985 by Cahners Publishing Co., Des Plaines, Illinois, USA)

IX. RECENT PUBLICATIONS

UN system bibliographic citations on CD-ROM

The ACCIS Secretariat has begun work on a massive pioneering effort to bring together all citations to UN system publications available in machine readable form, on a CD-ROM. Entry into the area of CD-ROM publication is in itself a new departure for ACCIS.

At its meeting in April 1992, the ACCIS Steering Committee approved the recommendation of the ACCIS Working Group on Database Dissemination (WG/DBD) to produce a CD-ROM containing all machine-readable bibliographic citations to publications, reports and documents generated by the United Nations, its specialized agencies and the International Atomic Energy Agency (IAEA). The ACCIS Secretariat was entrusted with carrying out this project. Organizations are currently being contacted regarding their ability to make these records available.

At this stage it is hard to foresee the size of the database that will result from this merger, but it seems safe to say that it will fit on one CD-ROM. The criteria for inclusion will be availability of the citation in machine-readable format, rather than the date of publication.

The CD-ROM publication will be a first for the UN system in terms of consolidating all machine-readable bibliographic records into one database.

Readers will be aware of the scope of the task of merging data from what could be as many as 30 diverse databases into one; issues of possible duplication and of subject retrieval are only the tip of the iceberg of what can be involved.

However, the importance of making this information available to Member States was considered to be such that a "quick and dirty" approach was seen as being better than none at all.

The hope is that the CD-ROM can be made available from UN Sales Offices by late summer 1993.

Health guide published

ACCIS is proud to announce the publication of the *ACCIS Guide to United Nations information sources on health*, the latest in its series of guides to UN system information sources.

Prepared in response to many inquiries on how to obtain United Nations system information on health issues, the Guide is intended for use by public health workers and planners, researchers and students, and information professionals seeking to locate authoritative, economical and varied sources of health information for their clientele.

As well as a high proportion of entries on health information sources within the World Health Organization (WHO) - the UN system's major actor in the field of health - the Guide locates sources of health information within other organization that have significant health activities, and in offices outside headquarters.

The Guide looks at information sources on a wide range of health-related topics, including: disease prevention and control; environmental health; health promotion and care; health system infrastructure; humanitarian assistance and disaster management; maternal and child health; nutrition and food control; occupational safety and health; population; and statistics and epidemiology.

Organizational descriptions, and a list of over 700 health reference libraries around the world, are other features of the Guide.

The Guide (Sales No. GV.E.91.0.11; ISBN 92-1-100363-6) is available from UN Sales Sections in Geneva and New York.

UN-EARTH

What countries are Member States of UNESCO? How many Tanzanian nationals work at IAEA? What goods does the UN procure from Sweden? Is there an ILO office in Egypt? Supplying the answers to these, and a host of other questions, will be the task of UN-EARTH, a user-friendly, PC-based information system currently being developed by the ACCIS Secretariat.

The first version of UN-EARTH will be available - from UN Sales Offices - in late 1992, on three high density diskettes. Most of the data was gathered from sources within the ACCIS Secretariat, although some data was also obtained from the UN Inter-Agency Procurement Services Office (IAPSO).

Depending on how UN-EARTH is received, and on the availability of further funding, it is hoped that subsequent versions will contain more UN data, as well as updates of the data on the first version.

Demonstrations of UN-EARTH to UN organizations are planned to take place in Geneva, New York and Washington, DC in the coming months.

Agricultural statistics on diskette

The Food and Agriculture Organization of the United Nations (FAO) has announced the publication of AGROSTAT.PC, a new agriculture database system available on diskette. It contains 29 years' worth of time-series statistics on population, land use, production, trade, food balance sheets and forest products, to be updated annually.

Data can be consulted using English, French or Spanish as the working language, and can be manipulated and downloaded in ASCII or as Lotus format files.

For use with a PC-compatible microcomputer, AGROSTAT.PC is distributed by a UK company, Microinfo, at a price of £355 for the complete set. Diskettes with statistics on individual subjects can be obtained, at correspondingly lower prices.

For further information, contact Microinfo (TP+44 420/86848; Fax+44 420/89889).

CONCISE network for European researchers

Three quarters of a million researchers throughout Europe, it is estimated, will be able to exchange information electronically by taking advantage of CONCISE, an 18-country (to date) research network based on OSI (Open Systems Interconnection) protocols. CONCISE was on show at an exhibition in Brussels, Belgium in 1991, in harness with PARADISE. Designed to gather and share contact details, PARADISE is the world's biggest experiment so far in X.500 electronic directory services.

Both these new facilities are aspects of the COSINE (Cooperation for OSI Networking in Europe) programme. The newly launched CONCISE (COSINE Network's Central Information Service for Europe) is open to academic and related industrial and commercial researchers throughout the European Community and in Austria, Finland, Norway, Sweden, Switzerland and Yugoslavia. Its 750,000 potential total usership is boosted by linkage to Internet in the USA.

The first users of the service, which came on stream late in 1991, can only exchange electronic mail; but soon they will also be able to access information interactively and to transfer files.

Funded by the governments of all the countries involved, plus the European Commission, CONCISE is free until the end of 1992, when it is scheduled to become self-financing.

The PARADISE project, which started in 1990 and also lasts until the end of 1992, stands for Piloting a Researchers' Directory Service for Europe. The directory already details some 150,000 people in Europe from over 1,000 organizations. Links to national pilots in Australia, Japan and the USA increase this figure to 420,000. As features are added, users will be able to obtain information about colleagues and research workers anywhere, by searching on their attributes. They will even be able to see their pictures.

For information on both these facilities, contact the central contact point for COSINE, c/o RARE Secretariat, Singel 466-468, 1017 AW Amsterdam, The Netherlands.

Directory of African Experts

The Pan-African Development Information System (PADIS) has published a new edition of its *Directory of African Experts*. The directory pays particular attention to experts in the priority fields of the United Nations Programme of Action for African Economic Recovery and Development (UN-PAAERD).

Among the fields included in the new edition of the directory are: food and agriculture; agro-industries; transport and communication; trade and finance; drought and desertification, and human resources development.

The directory is the printed product of PADIS' PADexp database of African experts, which now contains over 2,000 records. Copies of the directory are available free of charge from PADIS. For African experts who wish to be included in the database, data collection forms may also be requested from PADIS at the following address: PADIS, UN Economic Commission for Africa (ECA), P.O. Box 3001, Addis Ababa, Ethiopia.

World Media Handbook: selected country profiles

This reference tool provides a summary of selected media and related data for countries that host United Nations Information Centres/Services (UNICS). Demographic and communication statistical indicators are included in the entry for each country. A listing of a maximum of 15 newspapers and 20 magazines and periodicals for each country is also included.

The 299-page book, published by the United Nations Department of Public Information, also contains information on news agencies, journalistic associations, and institutions involved in communication education. It carries ISBN 92-1-100426-8; UN No. DPI/1021, and costs US$ 38.

SPECIAL ARTICLE

Computer-integrated manufacturing: A new menace for developing countries

Karl-H. EBEL*

Introduction

In the quest for higher productivity and greater competitiveness, and in response to market demand for diversified and high-quality products with short life-cycles, broad sections of the manufacturing industry in industrialized countries have embraced the principle of computer-integrated manufacturing (CIM). 1/ The adoption of CIM technologies is essentially market driven, although it has also been boosted by military and space projects, in which market considerations carry much less weight. Considerable efforts are being invested in research and development, and in financing and implementing new production systems; 2/ and despite the fact that the initial euphoria, which saw them as the answer to all production difficulties, has worn off, there is a lot of pressure for extending their use, not only in industrialized countries but also in the developing world. This article will consider the probable consequences of more widespread CIM adoption in developing countries and examine its benefits and drawbacks, touching also on its implications for training, industrial relations and employment.

The mixed experience with CIM

Slightly caricatured, the argument for introducing CIM in the third world runs as follows: advanced manufacturing technology will rapidly solve the industrialization and production problems of developing countries and foster economic growth, since (assuming high utilization rates) it requires less in the way of capital, labour and skills per unit of output. It will help to leapfrog obsolete technology and will provide up-to-date capital goods with built-in skills, thus diminishing dependence on industrial lead countries. Let the developed world therefore transfer the latest technology to help such countries make good their industrial backwardness, and never mind the cost. Nor need it be out of pocket in the long run, since it will thereby promote future sales of sophisticated equipment.

Before considering further the prospects of CIM in developing countries it is worth recalling that it has been on the agenda in the industrialized countries for over a decade now. In that time lessons have been learnt which apply to manufacturing industry anywhere in the world.

CIM has, of course, produced some remarkable success stories, including spectacular gains in lead time, product quality, labour productivity and product diversification. However, the failure rate of new installations, as shown in many case-studies, is equally striking; and what is reported is sure to be only the tip of the iceberg, because enterprises are naturally coy about admitting defeat. For instance, up to 50 per cent system downtime has been quoted. On balance the use of information technology in manufacturing has not generated the substantial productivity gains originally expected. 3/ With the exception of Japan and some newly industrialized countries there has even been a productivity slowdown, if one disregards advances in the electronics sector. It is interesting in this connection to note that Japanese manufacturers have not put much emphasis on developing computer integrated production. One is tempted to formulate a manufacturing paradox: *the more investment in information and CIM technologies, the slower the overall growth in productivity*.

Many explanations have been advanced for the relatively poor returns from the new technologies, including the fact that CIM has a particularly long learning curve (it typically takes between two and ten years to plan and install the system and iron out all the wrinkles). Other factors mentioned are insufficient organizational adaptation, deficient planning, shortage of qualified manpower, user resistance to new systems, lack of standardization of computer operating systems and interfaces, inadequacy of existing CIM models for the infinite variety of manufacturing needs, counterproductive information overload, inadequate hardware and software, etc. Be that as it may, investment in CIM has so far not resolved the productivity dilemma and the returns on such investment have frequently been disappointing. At present investors are holding back 4/ and computer manufacturers are feeling the pinch. To state these facts is not to deny the potential of the new information technologies (of which CIM is an offshoot) in many fields, but in manufacturing at least progress in achieving that potential seems to be slow. It may well be also that manufacturers implementing CIM are being taken up many technological blind alleys which - considering the cost of CIM technologies - entail considerable risks and losses.

Because there is no standard formula for CIM the development costs are high, and for some firms prohibitive. And since the return on investment is uncertain, financing is difficult to obtain. The integration of old and new equipment is generally not possible, owing to the lack of standardization and compatibility. Faulty software and inadequate sensors and activators are another widespread complaint. Suppliers deliver underperforming systems and, lastly, new systems tend to become rapidly obsolete.

At the macroeconomic level, too, the scarcity of foreign exchange in many countries hinders the

* International Labour Office.

acquisition of hardware and know-how, while cyclical effects such as sluggish demand may not encourage firms to experiment.

As more and more empirical evidence on CIM implementation becomes available, the enthusiasm for CIM is subsiding. Some studies arrive at rather pessimistic assessments, finding that strategic applications of CIM concepts do not really exist in practice and appear to reflect little more than the optimistic assumptions of hardware and software producers. 5/ While many manufacturing enterprises in industrialized countries contemplate the damage done, it is time to consider the lessons that their experience may contain for developing countries.

Transferring CIM technologies to developing countries

Many studies have looked at the prospects of transferring advanced technologies, including CIM, to developing countries. Following a supply-side approach, they often come to the conclusion that this is possible and beneficial provided a few conditions are met. They consider the various strategies and methods that will boost such countries' technological potential and frequently settle on a transfer of advanced technologies as a means of closing the ever-widening development gap. Some well-intentioned development agencies at the national and international level have gone fairly far in this direction. 6/ They seem to overlook, however, that countries which are able to meet the many preconditions for success will already have reached a fairly high level of industrial development.

After more than 40 years of technical and development assistance, it is becoming evident that innovation at any price will get the developing economies nowhere except into debt. The argument in favour of introducing advanced technologies overlooks the fact that technical innovation, and the acquisition of know-how which accompanies it, involve a long incremental learning process. It also fails to recognize that the use of CIM technologies offers little prospect of a reasonable return on the investment if it is not market driven. Finally, it ignores various fundamental constraints to be discussed below. Transfer of advanced technology is no quick fix for bridging the development gap.

At the same time, such an approach would not be possible without an abiding belief on the part of many decision-makers in developing countries that the latest manufacturing technologies do indeed offer the best chance their emerging industries have to overcome the "vulnerability of dependence". They may have been led to think that the acquisition of state-of-the-art technology will *ipso facto* result in the raising of labour productivity and in higher living standards for their populations. Above all, they generally resent their countries becoming the dumping ground of obsolete technologies, which they see as perpetuating inequality and the political, economic and cultural hegemony of the industrial powers. 7/

They may, of course, have other, more or less legitimate motives for seeking a foothold in CIM technologies. These need to be briefly addressed.

First of all, there is the question of how far manufacturing industries in developing countries wish or are forced to compete in global and dynamic markets or whether they can tolerate the widening technology gap and cater mainly for domestic markets, which on the whole have less stringent technical and quality requirements. If enterprises are supplying customers in global markets they must respond to their requirements and may well find it advantageous, if not indispensable, to adopt certain components of CIM such as computerized numerical control (CNC) or CAD in order to become more flexible and deliver quality goods on time. These enterprises will be the leading manufacturers in the small modern sector of the economy and often they will be joint ventures or transplants of multinational enterprises with relatively easy access to technical know-how. Competition in global markets, after all, is a game played to harsh rules. For instance, it has been observed that the formerly fairly competitive East German machine tool industry suffered a 75 per cent drop in sales to Western countries between the early 1970s and 1989 mainly because it failed to integrate adequate information technology into its products.

Another driving force seems to be the urge of certain countries to have an independent base for producing sophisticated military equipment. In the electronics age this invariably requires the mastering of advanced technologies with government support, regardless of the cost. There may be spillover effects on civilian industry, or at least demonstration effects, and these possibilities are often used to justify high expenditure. Eventually it may also lead to the wider adoption of CIM technologies for the production of non-military goods with high added value. Such industrial policies pursued in the name of "national technological security" rarely seem to be successful, as in the case of the former "socialist" countries. They give rise to the misallocation of capital and human resources in circumstances where the general economic and social environment is ill-prepared to use them and skill formation is insufficient. Fairly broadly spread scientific and technological capacity and know-how and a highly qualified workforce remain a *sine qua non* for CIM.

In some cases the installation of advanced technologies has become a matter of prestige overriding economic and commercial considerations, particularly in government projects. This is probably the worst of reasons, particularly since such projects have a tendency to fail, technically and economically. Their promoters can fall victim to high-tech rhetoric and sometimes to the high-pressure salesmanship of equipment

manufacturers. Instead of helping to close the development gap, the waste of capital widens it. Funding for more worthwhile, viable, economically and socially beneficial projects will be cut to make way for oversophisticated hardware working far below capacity or not at all. Debt-ridden developing countries can ill afford such squandering of resources.

Another (unavowed) non-economic motive for using labour-saving CIM technologies may well be the wish to diminish union influence and bargaining power. Advanced technologies make it possible to reduce the workforce, to redistribute it over small units and dispersed plants, and to subcontract more, thereby weakening the base for union organization.

Particular constraints in developing countries

Not all the above constraints are equally applicable to industrialized countries, and it is possible that those that are will eventually be overcome, given time, money, patience on the part of users and further technological advance through research and development. In developing countries, however, they are generally compounded and magnified by a whole range of factors. The local technical infrastructure - technological institutions, professional and industrial associations and universities - is often incapable of supporting or promoting complex advanced manufacturing; there is mostly no culture based on science and technology; rapid access to engineering consultancy, system integrators and service firms, and therefore to the repair and maintenance of systems, is not assured; markets are fragmented, unstable or too narrow; communications and transport systems are inadequate; suitable energy and material inputs may not always be obtainable; components and spare parts may be locally unavailable; the education and skill level of the workforce is insufficient owing to lack of funds for technically oriented education and training systems; workers tend to have little feel for accuracy, precision and need for maintenance; quality consciousness is often lacking; there is little notion of time management; enterprises are undercapitalized; and financing for ventures into fast-moving immature technologies tends to be unavailable.

At the enterprise level there is a further strong argument for being circumspect in considering the adoption of CIM technologies in developing countries: the capital intensity of hardware and software is very high, even though the cost of certain components, e.g. CAD packages and programmable controllers, is decreasing rapidly. A high investment in human resources in the form of continuous further training is also required and engineering consultancy services, which may not be available locally, have to be secured. The combined cost of all this is substantial and only high capacity utilization will make it pay. This is difficult enough to achieve even in highly industrialized countries; but in developing countries, where capacity utilization is notoriously low, such investment can easily become ruinous.

Another constraining factor can be the technology policy adopted by some developing countries aimed at the local production of much of the necessary advanced equipment. The price of locally manufactured programmable controllers and NC devices in Brazil, for example, is about three times the world market price, while local NC machine tools are two to four times dearer than equivalent machines offered on the world market. 8/

A further obstacle is that so far most CIM design is irrelevant or inapplicable to small and medium-sized enterprises (SMEs). However, the vast majority of manufacturing enterprises in the developing world are SMEs with a tenuous capital base serving local markets. Few of them have the stock of accumulated organizational and managerial knowledge, technical know-how and experienced staff on which CIM technologies could be grafted. Nor can they usually afford the necessary research and development effort. They therefore lack the competence either to assess offers made by system and equipment vendors or to plan and coordinate such complex systems. Exclusive dependence on outside advice in technological matters can only increase their vulnerability. Few SMEs are innovative or are motivated to be so. They produce small series and usually have no high-quality requirements. Low labour costs enable them to get by with low productivity. In such circumstances NC equipment would be out of place, for as a rule (and contrary to the common assumption) relatively large batch sizes are required for the efficient utilization of such machines. These firms also produce for low-income markets with relatively stable patterns of demand for simple appliances and goods. Very few are in a position to supply export markets. For them it would be a gamble with possibly fatal consequences to launch into CIM if they cannot stand the capital losses likely to be incurred. The slow diffusion of NC technologies - particularly well documented for Latin America - is the safest course to adopt. 9/

In the industrialized countries CIM technologies are beginning to percolate down to SMEs. In fact, training-cum-demonstration centres have been set up for that purpose in various countries, e.g. France, Germany, Switzerland and the United States. It is possible that models will evolve which will be useful for SMEs in developing countries, but the conditions for their use must of course still be right.

Technology is always embedded in a social and cultural context which may favour or hinder its assimilation. In this respect industrial relations patterns play a very important role. CIM technologies are capital-intensive, often unreliable and vulnerable. Only a stable, reliable, competent, responsible and motivated

workforce can operate the systems, compensate for any deficiencies and keep them going. Team spirit appears to be one of the essential ingredients of a successful CIM system. Industrial relations practices based on trust, encouraging cooperative behaviour on the part of the workforce, playing down management prerogatives, facilitating communication and consultation and instituting democratic bargaining procedures, are essential for the acceptance of new technologies by the workforce. CIM technologies have a profound influence on work patterns. They may require less job fragmentation and greater functional flexibility of labour, new wage systems, flexible working hours, better capacity utilization through shift work, wider delegation of decision-making to the shop-floor on various matters, including shop-floor programming, and a flatter hierarchical structure in which management will have to relinquish some of its powers and admit the influence of shop-floor workers on technical options. How many managements in developing countries are prepared to face these issues squarely?

Finally, as regards the possible employment effects of introducing CIM into developing countries, any discussion has to be hypothetical, given the improbable prospect of widespread adoption of these technologies. So far, any employment effects are marginal at most. It need only be remarked that the attempt to implant CIM technologies in economies which are not ready for them will only aggravate existing income distortions and that the misallocation of capital will inevitably have negative employment effects. The formidable entry barriers can only be overcome at high social cost.

To sum up, the socio-economic and technical environment in developing countries is usually extremely hostile to the introduction of complex, vulnerable advanced manufacturing technology. The environment may be in great need of reform, but that is not the point: business and manufacturing strategies can disregard it only at their peril.

Prerequisites for CIM application

Given that CIM technologies may be useful to developing countries in some circumstances, what would such circumstances be? Managers of enterprises in developing countries clearly have difficult decisions and choices to make, often with few facts to go on, since information about the potential and limits of CIM technologies is not always easily accessible or reliable. They may well opt for technologies for the wrong reasons and on the basis of poor knowledge and advice. It should be recognized that CIM technologies are, above all, enabling technologies. They are useful in so far as they help to solve a specific manufacturing problem, no more and no less: they should not be allowed to become the problem themselves. Management will have to define the problems that occur in the production process or the product, or both, and recognize them for what they really are. This includes identifying the barriers to the application of technologies. As a rule the production process and the product design will need to be streamlined and simplified. But in most cases such reorganization, which will involve eliminating unproductive time from the process and enhancing the technical capability of the workforce to prevent machine downtime, can and should be carried out without the use of CIM technologies. Experience has shown that resource-saving rationalization of this sort, including total quality control programmes and the elimination of unnecessary buffer stocks and inventories, often brings greater benefits than the introduction of CIM. It is a fallacy to assume that advanced technology is the only key to higher productivity. State-of-the-art technology is rarely required to organize production efficiently, even in industrialized countries.

It could be that once such organizational rationalization is completed, specific, accessible and mature CIM technologies might bring further improvement, provided all the necessary conditions are present for using them. Some complex parts, for instance, can only be machined with a sufficient degree of precision and quality when CNC equipment is used. Fairly cheap CAD packages might enhance the design capabilities of a firm, which could be crucial for greater market penetration. If comprehensive feasibility studies evaluating all the technical options come to the conclusion that CIM technologies are the solution and adequate expertise is available in the form of an in-house research and development capacity, the gradual introduction and adaptation of such technologies may well be beneficial. All this, however, presupposes that management is motivated to modernize and to invest in efficiency; and this is not necessarily the case, as documented by several case studies. 10/

Other potentially useful technologies, in addition to CNC and CAD, include programmable controllers for operating preventive maintenance programmes, computer-based equipment monitoring, computer-based energy consumption monitoring to optimize energy use, and computer-aided stock control. The application of information technology in administration or research and development to sift and manipulate large quantities of data may well be feasible also. It would be advisable to proceed step by step so as to facilitate the learning process with a later integration of the various functions through an open systems architecture. In any case, enterprises should not try to run before they can walk.

Some "threshold" countries with a fast-growing manufacturing base, such as Brazil, India, the Republic of Korea, Malaysia, Mexico and Thailand, have started to introduce programmable automation using the more mature CIM technologies such as CNC and CAD, as well as industrial robotics in some areas, e.g. painting and welding, for occupational safety reasons. They have normally steered clear of more risky integration such as flexible manufacturing systems (FMS) and networking, since excessively complex and sophisticated production

systems are very difficult to manage, quite apart from their high cost. CNC and CAD, however, have a demonstrated capacity for skill saving and may within limits compensate for low skills. As mature technologies - NC has been on the market for 40 years - they are now fairly robust, simplified and user-friendly. They have also become affordable, and can now be bought off the shelf. However, these are only the discrete components of CIM systems. The systems themselves do not come as turnkey installations. They must be designed and adapted to the enterprise on the spot with the participation of the future operators. This complex task is beyond the vast majority of enterprises in developing countries so far, owing to their lack of expertise, and may only become possible in the long term.

Conclusions

After the foregoing analysis of the general situation it would be premature to come up with any strategy recommendations regarding the use of CIM technologies in developing countries, except to say that industry in these countries is perfectly rational in hesitating to employ them. CIM would contribute little to solving its immediate production problems, exceptional cases apart. At the microeconomic level, however, much can be learnt from the organizational patterns and principles that underlie CIM and serve to eliminate unproductive time and bottlenecks. More rational work organization is definitely helpful in enhancing labour productivity.

At the macroeconomic level the message is that before advanced manufacturing systems can take root governments will have to create a suitable infrastructure and knowledge base, as well as an economic, social, educational and legal environment conducive to their sustainable development. Such provision, which involves designing and implementing balanced industrial policies that take due account of social and labour parameters, is itself the best investment incentive in market economies. The monitoring of technological change, the creation of advisory services for enterprises, the education and training of a qualified workforce capable of mastering advanced technologies, and the promotion of enterprises and managements equipped and motivated to assume the challenge would have to be top priorities. If technology is transferred, the process must be properly planned. This requires a combination of technical and managerial knowledge and experience as well as business acumen, a rare commodity indeed. 11/ Developing countries will have to choose their own specific approach, depending on their factor endowment, their stage of development and their international trade links. Technological self-reliance and the potential for innovation can only be built up systematically, step by step. It would be wasteful and counterproductive to put the cart before the horse.

Notes

1/ There are numerous definitions of CIM. Here it is taken to mean a "concept of organizational structure which has as its objective the coordination of all the functional aspects of a manufacturing organization into a unified system" (see Strathclyde Institute: *Computer integrated manufacture for the engineering industry* (London, Financial Times Business Information, 1990), p. 9). The emphasis is on integrating different subsystems of production (such as design, planning, manufacturing, warehousing, materials handling and quality control) through computer links, using a common database, and also on organizing the flow of data and information. A full CIM system comprises and integrates a number of advanced technologies such as computer-aided-design (CAD), numerically controlled (NC) machinery, automatic assembly and automatic materials handling. Its essential characteristic is that, through the synergism of its component technologies, the whole is greater than the sum of its parts.

2/ For a comprehensive assessment of this new production paradigm in industrialized countries, see K.-H. Ebel: *Computer-integrated manufacturing: The social dimension* (Geneva, ILO, 1990).

3/ A graphic description of contrasting success and failure with CIM may be found in S. Caulkin and Ingersoll Engineers: "The human factor in IT: Man and machine", in *Multinational Business* (London), No. 1, 1989, p. 2: "Consider two examples of high technology implementation. First, GM's car plant at Lordstown, Ohio. Opened with fanfares in 1972, this brand new automated plant was an expensive disaster. It suffered from the start from absenteeism, high labour turnover, disappointing productivity and all the other signs of chronic worker alienation. Now look at Nissan's plant in the UK. The first Japanese auto plant in Europe, it is also highly automated and quite different in structure and organization from any other car assembly site in the UK. Nissan Washington has met all its quality and productivity targets and with a $1,000 cost advantage per car is reportedly the lowest-cost car plant in Europe. ... Lordstown was a classic case of seduction by technology. In designing the plant for machines instead of humans, GM, like many other manufacturers, missed the opportunity to turn the workforce from part of the manufacturing problem (the implicit Western assumption) into part of the solution." For an extensive discussion of the productivity dilemma in the IT context, see T. Åstebro: *Information technology in the long wave perspective*, Paper presented at the first anniversary workshop of the IIASA CIM project, Stockholm-Helsinki, 25-27 June 1991.

4/ The growing doubts among manufacturers are illustrated by the fact that "the market for industrial robots lags far behind all predictions made in the late 70s"; that Volkswagen "has indicated that it will cut back its levels of factory automation for future projects"; and that in Germany "misinvestment in production planning and scheduling systems has been estimated at DM 100 million" (W. Wobbe: *Anthropocentric production systems: A strategic issue for Europe*, APS Research Paper Series (Commission of the European Communities, 1991), p. 2).

5/ A. Fiedler and U. Regenhard: *Mit CIM in die Fabrik der Zukunft? Probleme und Erfahrungen* (Opladen, Westdeutscher Verlag, 1991), p. 22.

6/ See, for instance, B. Haywood, P. Vuorinen and E. Tóth-Hizsnyik: *Automation and developing countries: With a specific focus on Africa, and the textile, clothing and footwear industries*, Joint IIASA-UNIDO research project, final report, 1991; J. Bessant and H. Rush: *Integrated manufacturing*, IPCT.70 (Vienna, UNIDO, 1988); and N. Hanna: "Informatics and the developing world", in *Finance & Development* (Washington, D.C., International Monetary Fund and World Bank), December 1991.

7/ M. Elmandjra: *Impact of the socio-cultural environment on the development of information technology*, paper presented to the Gottlieb Duttweiler Institute International Conference, Zurich, 5-6 December 1991.

8/ J. Meyer-Stamer *et al.*: *Comprehensive modernization on the shop floor: A case study on the Brazilian machinery industry* (Berlin, German Development Institute, 1991).

9/ G.K. Boon and A. Mercado (eds.): *Automatización flexible en la industria (Difusión y producción de máquinas-herramienta de control numérico en América Latina)* (Mexico, Editorial Limusa, 1990).

10/ Meyer-Stamer *et al.*, *op. cit.*

11/ M.E. Moustafa, *Management of technology transfer: Planning and controlling the implementation process in developing countries* (Geneva, ILO, 1990).

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