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MICRO-ELECTRONICS MONITOR

Issue No. 42 December 1992

This issue contains a special article by Professor Jun-Liang Chen of the Beijing University of Posts and Telecommunications. The article, "Software in Telecommunication Industries and its Cooperative Development", was presented at the Workshop for Asia and Pacific Region Representatives from the Telecommunication Industry, held at New Delhi (India), in September 1992

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I. NEWS AND EVENTS

Global telecommunication database

The International Telecommunication Union (ITU) has entered into a joint initiative with USA-based telecommunications company Lynx Technologies, Inc., under which Lynx has licensed ITU to provide dial access to a database of global telecommunication services and tariff information.

Under the agreement, Lynx will provide ITU with a copy of its global database of services and tariff information, which the ITU will place on a database server at its Geneva, Switzerland, headquarters. ITU has designed and programmed a system for access and use of the database at a special annual cost. The database will be updated by Lynx on a monthly basis.

The new service from ITU will be available to government telecommunication organizations, telecommunication operators and the United Nations and its specialized agencies. It will provide up-to-date information on global telecommunication tariffs and services to assist users in evaluating new markets and new strategies, to price services on a competitive basis, and for a wide range of other applications.

For the past 17 years Lynx has published *The World Telecommunications Tariff Directory*, a 10-volume compendium of information on telecommunication carriers, services, rates, regulations and policies. The company also provides some of the world's largest carriers with this information on a monthly updated basis, for their internal use. Recently, it launched its own dial access service known as the Lynx Global Telecom Database (LYNX GTD).

For more information: ITU member administrations, telecommunications operators and the United Nations and its specialized agencies should contact: Mr. L. Goelzer, Chief, Information Services Department, International Telecommunication Union, Place des Nations, 1211 Geneva 20, Switzerland. (TP 41 22 730 5333; Fax +41 22 730 5337). Other interested parties should contact Mr. H. Fromm, Vice President, Lynx Technologies Inc., P.O. Box 368, Little Falls, NJ 072424, USA. (TP: +1 201 256 7200; Fax: +1 201 882 3583.) (Source: *ACCIS Newsletter*, 10(3), September 1992, p. 2)

Providing information for sustainable development

In early 1991, the United Nations Development Programme (UNDP) launched a new program called the Sustainable Development Network (SDN), designed to provide an information-exchange link in the 115 developing countries where UNDP has offices. A workshop on the network was held in New York in September 1992.

Access to information and appropriate technologies is essential for developing countries to find effective ways of using their natural resources for sustainable development. In today's fast-paced world, research and technological innovations are creating new opportunities and opening viable alternative approaches to development. The SDN will build the capacity of countries to access and manage information.

Participating developing countries will have a national SDN Directorate linking non-governmental organizations, government agencies, the private sector and universities. It will focus on issues vital to the sustainability of natural resources management, urban and industrial programmes, environmental education and development policies.

Each national network will in turn be linked to a global computer network affording all members direct electronic access to a wide range of information.

An important goal of the international SDN is to increase North-South and South-South exchanges of technologies as well as exchanges of information and case-studies relevant to sustainable development.

For further information contact: Mr. C. Lankester, Director, Sustainable Development Network, United Nations Development Programme, One United Nations Plaza, Room FF-12108, New York, NY 10017, USA. (TP: +1 212/906 5862; Fax: +1 212/906 6350.) (Source: *ACCIS Newsletter* 10(3), September 1992)

UNCTAD joins forces in world-wide EDI push

Citing its potential to help build international trade in developing countries, the Electronic Data Interchange Association (EDIA) and the US State Department have joined efforts with the United Nations Conference on Trade and Development (UNCTAD) to expand the use of Electronic Data Interchange (EDI) worldwide.

EDI allows businesses and customs agencies to replace paper purchase orders and documents with computer-to-computer communications. Proponents of the system say that EDI is capable of cutting paper consumption, speeding orders and allowing inventories to be kept to a minimum. These are all advantages that can help developing countries overcome customs-clearance delays and other time-consuming bureaucracy.

EDIA and the US State Department, in association with UNCTAD, now have plans to sponsor a "travelling classroom" of EDI hardware and software, which will be used in regional training sessions in Latin America, Africa and Asia. (Source: *Communications Week International*, 22 June 1992)

Technological Information Pilot Systems (TIPS)

The Philippine Government and the United Nations Development Programme (UNDP) have signed an agreement that will see updated data-processing facilities in Manila host the regional headquarters of a $6 million, 10-country information service network for technology.

Named the Technological Information Pilot System (TIPS), the network links the developing countries of Brazil, Mexico, Peru, Egypt, Zimbabwe, Kenya, China, India, Pakistan and the Philippines. The 10-nation network's hub is located in Rome and accesses telecommunications facilities for linking geostationary satellites. The 10 national bureaux are equipped with a dedicated circuit on an Intelsat link for the transmission and reception of data to and from the international operating centre in Italy.

The information flow consists of, but is not limited to, summaries of technical reports, abstracts of techno-economic studies, executive summaries of feasibility studies, and technology trade offers and requests from 14 different industries such as agro-industries, biotechnology, chemicals, electronics and fisheries published either on a daily or weekly basis.

The network maintains a database with more than 40,000 records to date, expanding at a rate of 1,000 per month. The 10-country network will soon be increased to 30 to include first-world countries.

In the first year of the Pilot's operation, the value of commercial transactions is expected to amount to $8 million, with 47 per cent representing sales of products and 53 per cent representing technology transfer agreements. (Extracted from *Electronic News*, 25 May 1992)

INISTE

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has started a programme for the establishment of a computerized information network on world-wide developments in school science curricula and teacher training.

The programme is part of the International Network for Information in Science and Technology Education (INISTE), which was launched in 1984 to promote international exchange of information and experience on innovations in science and technology education. Two hundred and fifty-five institutions from 130 countries are members of INISTE.

The new UNESCO network will provide information on developments in science education curricula for primary and secondary schools and teacher training. Two databases are being established for this purpose, using mini-micro CDS/ISIS.

Selected INISTE members from six countries met with UNESCO staff in Paris in July 1991 to discuss the scope and coverage of these databases and the methods of data collection and information exchange among member institutions. The databases are expected to be ready for distribution on diskette by the end of 1992.

For further details on INISTE, contact: INISTE Secretariat, ED/STE, UNESCO, 7 place de Fontenoy, 75700 Paris, France. (Source: *UNISIST Newsletter*, No. 4, 1991)

A community of satellites

A landmark in the opening up of European telecommunications has been achieved. Eutelsat, the European satellite organization, decided to break the monopoly over access to satellites for telecommunications. Organizations can now book their satellite capacity through any member of Eutelsat according to which one offers the best service and price. Eutelsat, like other satellite operators, charges its members a flat rate, but the rates passed on to customers include mark-ups that can range from 7 per cent to more than 200 per cent, depending on the country. Satellite data networks have become a viable alternative to leased lines, mainly thanks to the advent of very small aperture terminal (VSAT) technology. VSATs are low-cost ground stations with dishes not much larger than those for domestic satellite television. Applications range from car manufacturers distributing price and part stock information to their dealers to soft drinks vending machines letting their owners know when they need to be refilled. The European Commission is planning to issue directives to member Governments which will push the issue. Within the next two years Europe should see its first privately owned satellites in orbit and publicly owned operators such as Eutelsat will be able to sell capacity directly to users rather than via the major European telephone operators and many business satellite networks will start to become the norm for data communications, and not the exception. (Source: *The Times*, 24 July 1992)

International team to develop 256 Mbit DRAM

An international team of some 200 semiconductor engineers gathered in East Fishkill (USA) to begin one of the most ambitious projects in the history of the chip industry. This group, drawn from the ranks of IBM, Toshiba and Siemens, is to develop a 256 Mbit dynamic random access memory (DRAM) - a data storage device for use in twenty-first century computers.

The 256 Mbit memory chip is the next grand challenge of semiconductor engineering. It represents a 16-fold increase in the storage capacity of memory chips

and promises to transform computers into talking, thinking, listening machines that are different from anything that has gone before.

However, several critical technology hurdles must first be overcome at an expected cost of $1 billion. Hence the decision announced by IBM, Toshiba and Siemens to share their expertise and divide the huge costs and very significant technological risks of this project.

The costs will be "generally shared" among the three partners, but there is far more than money at stake. For each of the participants, success is critical to their ability to remain leaders in the global electronics market.

Time to market is the key issue. These champions of the chip industry have entered a race against world-class competitors from the United States, Japan and Korea, and the company that brings 256 Mbit DRAM technology to market first stands to reap huge rewards. (Extracted from *Financial Times*, 17 July 1992)

Fifth generation project ends, another starts

Japan's much-publicized Fifth Generation Computer Systems Project has come to an end, without producing a machine that can think like a human being. None-the-less, the $427 million, 10-year project has caused Japan to take a closer look at its approach to Government-led basic research. Project participants and organizers agree that one change that needs to be made is to encourage more participation by Japanese scientists and foreign researchers. However, some observers wonder if the Government really needs to be involved at all, considering that Japanese manufacturers have developed first-class research capabilities of their own. Speakers at a Tokyo conference held recently to sum up the results of the Fifth Generation programme said that although no marketable product resulted, progress had been made in such key areas as parallel processing.

The Fifth Generation Computer Systems Project has, however, resulted in the Real-World Computing Program. This new effort will develop a computer able to process "real-world" information - sounds, images, spoken communications and the like.

The programme aims to improve analysis and forecast of the global environment. It expects to develop intelligent robots and enable machines to communicate using human language.

To achieve this goal, Japan's Ministry of International Trade and Industry will establish Real-World Computing Partnerships for research and development and will invite overseas partners in Europe and Asia to participate in the project.

One key to enable international cooperation on the project is the Real-World Computer (RWC) Network. It will give researchers all over the world the ability to access massively parallel computing resources on the network, remotely.

RWC will also give users remote access to research information of Japan's central laboratory, and there will be general exchange of R&D results among network users.

Whether RWC emerges from its cocoon will take 10 years to determine. (Extracted from *Nikkei Week*, 13 June 1992 and *Electronics*, 14 September 1992)

Chip defect experiments

Experiments to develop defect-free semiconductor crystals were undertaken on board the US space shuttle Columbia in October 1992.

Astronauts attempted to grow large crystals of cadmium telluride - a semiconductor material useful in optoelectronics - that are free from defects due to gravity-induced processes. The experiment, developed by Boeing, involves heating one end of a glass tube containing cadmium telluride to 850°C vaporizing the cadmium and tellurium. The gas mixture condenses into crystals of cadmium telluride the size of a large coin - up to ten times larger than Earth-grown crystals. (Source: *Electronics Weekly*, 14 October 1992)

Chip makers answer telecoms call

Europe's indigenous semiconductor manufacturers are making the most of their position at the centre of the world's most progressive telecommunications markets.

European standards such as GSM digital cellular, DECT cordless telephones, and ISDN and SDH (public telephone network protocols) promise high volume markets. Inevitably these attract major suppliers from Japan and the United States, but many European companies are capitalizing on their close relationships with systems houses and knowledge of the standards committees.

Knowledge of the European standards process is important. For that reason US chip maker Sierra Semiconductor has sited its world-wide telecommunications chip development in Europe.

Large suppliers Philips, Siemens and SGS-Thomson, which together account for over a quarter of the European semiconductor market, have the resources to compete with commodity chip suppliers from Japan and the United States.

These are the components being designed into cellular telephones, ISDN terminals and exchange line cards by the million. Europe also boasts a number of specialist suppliers such as GEC Plessey Semiconductors,

Matra MHS of France and Mietec of Belgium, which have been successful in developing highly sophisticated products in many cases for specific customers.

A presence on the standards committees has been vital for chip developers tracking the evolution of the GSM digital cellular telephone standard.

Plans for a fully integrated two-chip set are being stalled by the possibility of a new half rate speech coding specification.

Philips Semiconductors has the advantage that one of its sister companies played a role in designing the GSM speech coder algorithm. The company has taken a longer-term view of GSM and developed a programmable signal processor, which is optimized for the GSM algorithm. The device can implement the complete GSM baseband signal processing at 20 million instructions per second (Mips), compared to the 60 Mips processing speeds required by some DSP implementations. It will use Philips' proprietary self-aligned contact MOS (SACMOS), which supports low power operation.

The long-awaited market for public ISDN services and products has still to materialize. The uncertainty has prompted Philips to stop its ISDN chip development so it can concentrate on its mobile communications products.

Some companies have been looking for other applications for their digital telephony chips and believe they have found one in pair gain products, which can double the capacity of analog telephone lines.

The world market for pair gain systems is expected to be over 2 million lines next year and Mitel is generating some of the largest sales of ISDN chips.

The European market is not just about the new digital technologies; over 50 million analog telephones are sold each year, a market worth £2.5 billion, and predicted to continue into the next century.

The emphasis is on cost and size reduction. Companies offer highly integrated products combining the speech circuits, dialler and ringer functions into one or two IC's requiring fewer than 50 discrete components.

The European market offers volume, but component companies must be price competitive, which often means following telephone production to the Far East.

Future generations of broadband systems such as broadband-ISDN, SDH and ATM, and mobile communications systems operating at 2 GHz and above, will require the development of technologies such as submicron CMOS, high speed BiCMOS and GaAs.

Projects within Europe's Joint Submicron Silicon Initiative (JESSI) are helping specialist telecommunications chip companies develop a 0.5-micron CMOS process.

High-speed bipolar specialists GPS and Philips have identified new markets such as high-speed switching protocols like ATM and multigigahertz mobile communications such as DECT, PCN and Japan's personal handy phone (PHP). The new digital cordless telephone standards, CT-2, DECT and Japan's PHP, are important new markets for all European chip makers. Most companies have products for both RF and baseband signal processing. (Extracted from *Electronics Weekly*, 29 July 1992)

New EC health and safety law for VDU users

New health and safety legislation for those who work with visual display units (VDUs) is on its way from Brussels, but controversy still surrounds the practical implementation of many of the ideals.

The aim of the legislation is to ensure the adoption by European Community States of minimum standards of protection for workers' health and safety, while avoiding imposing administrative financial and legal constraints, which would hold back the creation and development of small and medium-sized businesses.

The EC health and safety law sets out legal principles to be adopted by EC States within certain time-limits. The regulations must be adhered to by 31 December 1992 for newly-installed kit. For computers already installed, these would not apply until 31 December 1996.

The directive was borne out of growing concern about the increasing number of injuries, including repetitive strain injury (RSI) suffered by computer operators. Muscular industrial injuries normally associated with blue-collar workers (such as chicken plucker's wrist) are now being experienced by those who operate computers for long periods of time.

Insurance companies confirm that claims for injuries at work associated with computers, such as RSI, backache and others, are increasing.

Employers will have no choice but to comply with the new legislation or face serious consequences. Health and Safety Officers have the power to carry out random checks and bring prosecutions. The courts have the power to award unlimited fines and to close operations which fail to comply with health and safety regulations.

Directors of companies could, in more serious or flagrant cases, find themselves personally liable to prosecution and fines and, conceivably, imprisonment.

For employees, the new law will make claiming compensation for injuries suffered as a result of their workplace environment easier.

One grey area in the law concerns exceptions to the equipment covered by the proposed legislation. While keyboards, chairs, desks, glare and heat from computer equipment are covered, there are no regulations for computer systems on board a means of transport, portable systems not in prolonged use at a workstation, calculators, cash registers and the typewriters known as "typewriter with window".

The definition of VDU users and associated equipment is also contentious. The provisions only apply to those defined as workers who habitually use display screen equipment as a significant part of their normal work. However, employers and employees are concerned about the accuracy of such a vague definition.

The provisions made in the directive to ensure employers take steps to protect users' eyes and eyesight are equally questionable. While the directive appears to include the provision of glasses and similar equipment, it does not mean employers are responsible for any corrections for near and distance vision defects, or for the provision of more than functional optical equipment.

Also, the regulations suggest sight tests every ten years. This has been criticized by many trade unions as being far too infrequent.

Another area of concern is computer users temporarily employed through agencies. It seems clear that the temporary employer will be responsible for ensuring their workstations and work practices comply with the provisions of the directive and regulations when in force. Similarly, the agency will be responsible for the employee's regular eye tests and the costs of providing any necessary "special corrective equipment".

But it is not clear who would be responsible for the training and information required about health and safety relating to workstations. While the directive is vague on this, the proposed regulations put the onus on the temporary employer.

Employers should also note that the EC legislation will cover software as well as hardware. When the legislation takes effect, an employer must, when selecting, commissioning and even modifying software, ensure it is suitable for its task, easy to use, provides performance feedback to workers, displays data in a format and at a pace adapted to the worker, and that principles of software ergonomics are applied.

There are obvious implications for software houses and system suppliers. "It may be necessary to modify existing software to enable it to be sold in the future. (Source: *Computer Weekly*, 13 August 1992)

II. NEW DEVELOPMENTS

New transmission electron microscope

A transmission electron microscope that can recognize an object as small as 0.11 nanometer, or the size of a hydrogen atom, had been developed by Hitachi, Ltd.

To be put on the commercial market in the near future, the microscope is able to irradiate an electron beam to an area as tiny as 0.7 nanometer, thus enabling elementary or ultimate analysis of a substance, the spokesman said.

The microscope has an accelerating voltage of 300 kilovolts, which compares with the previous limit of 200 kilovolts in Hitachi's HF-2000 model having a maximum resolution of 0.16 nanometer and an electron beam diameter of 1 nanometer.

Research on superconductors and advanced materials and development of super-high-speed operational elements for computers and other new electronic devices requires the ability for high precision evaluation of microstructures. There is a rapid increase in phenomena recently that cannot be analysed unless a defectiveness of an atom or an impurity is measured. Although analytical transmission electron microscopes equipped with high-performance electron discharging guns instead of thermo-electron guns have been developed, their capabilities are insufficient, limited to 0.16-nanometre resolution and an electron beam diameter of 1 nanometre. The accelerating voltage of 300 kilovolts was achieved by developing an electron accelerating tube with 10 steps instead of six and improving the tube's design to stabilize applied voltage. (Extracted from *American Material Market*, 12 August 1992)

New chip being developed

IBM and Siemens are developimg a CMOS-technology 64MB DRAM device and anticipate mass production of the chip by mid-decade. The device is 10.7 mm by 18.1 mm in size, and requires a 3.3 V power supply for operation. Memory cell areas are only 1.5 sq. microns, with interconnects as narrow as 0.4 micron. The chip also includes transistor gate insulators 10-nm in thickness. The use of borderless contacts is one factor in enabling small device size. (Extracted from *Semiconductor International*, August 1992)

Researchers design self-healing circuits

Fault tolerant chips capable of detecting and correcting their own internal errors have recently been developed by engineers at GE R&D Center in Schenectady, N.Y. Such chips should prove particularly beneficial for use in mission-critical applications, such as aboard satellites, where repairs are often impossible and faulty circuit elements could prove catastrophic.

The self-healing circuits are designed to detect and correct: intermittent faults caused by loose connections or marginal components; transient faults caused by electromagnetic interference; and permanent faults such as improperly grounded signals.

Dr. Abhijit Chatterjee and Dr. Manuel d'Abreu originally designed self-healing digital signal processing (DSP) devices. However, the methods may be applied to any DSP, ASP or control circuit whose behaviour is represented by a system of state variable equations.

The methodology, validated using both computer simulation and prototype testing, involves the use of checking circuits that are tied into the chip's primary circuitry. The checking circuits compute "checksum codes" - specifically weighted linear sums of the terms on both sides of the state equation. The circuits are implemented by adding extra rows to the chip's state equation matrix representation. Upon evaluation, the checking circuits execute corrective signals to the primary circuitry. Physically, the technique can be implemented inside the chip or as an add-on feature outside the chip.

Future work will include the development of computer tools to automate implementation of the technique in the design of DSP and ASP chips. The researchers estimate that self-healing ICs are approximately 2-3 years from commercial realization. (Reprinted with permission from *Semiconductor International Magazine*, August 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL., USA)

LEDs from polymers

Uniax (Santa Barbara, CA), a start-up company, has produced flexible light-emitting diodes (LEDs) from soluble, conducting polymers, providing "a very significant step forward" in future semiconductor technology based on organic materials, according to physicist Richard H. Friend of the University of Cambridge (England). The LEDs work even when sharply bent. Polymers are easier to process and fabricate into various shapes and offer mechanical properties (such as flexibility) that inorganic semiconductors do not. They should make it easier to produce large-area light-emitting displays.

In the Cambridge devices, a poly(para-phenylenevinylene) (PPV) film is sandwiched between a positive (hole-injecting) electrode, such as indium/tin oxide, and a negative (electron-injecting) electrode, such as aluminium. The application of voltage injects electrons and holes (vacancies in the valence band that act as positive charge carriers) into the polymer layer from opposite sides. When combined, light is emitted.

Uniax, working with the University of California (Santa Barbara) and led by physicist Alan J. Heeger, used a soluble PPV derivative, MEH-PPV, which simplified fabrication. In addition, the research found that using a negative electrode made of calcium gave a much higher quantum efficiency. Another group, at the University of Graz (Austria), led by Guenther Leising, made a poly(para-phenylene) LED that emits blue light, and the Cambridge group found that block copolymers derived from PPV cam be chemically "tuned" to emit light from green-blue to orange-red. (Extracted from *Chemical and Engineering News*, 29 June 1992, pp. 27-28)

Full colour LED display

Sanyo Electric Co. Ltd. said it has now developed a full-colour LED (light-emitting diode) dot matrix display module with a dense array of 16 by 16 full colour LED lamps.

No conventional flat display uses a blue LED because of the low brightness. Recently, the company developed a blue silicon carbide (SiC) LED which is bright and reliable. The new blue LED is combined with conventional red and green LEDs to make up the full-colour LED, which provides a flat full-colour LED (Source: *Electronics Weekly*, 12 August 1992)

Low voltage alternative for electron beam lithography

Engineering work at Stanford University has shown a practical low voltage alternative for mask making with electron beam lithography. The low voltage direct-write exposure work was done at 2 keV in test systems - a Hitachi scanning electron microscope connected to an Elphy I pattern generator.

Y. H. Lee explains that this work is being driven by the need to apply electron beam lithography for fabricating X-ray lithography masks and masks for advanced 1X optical lithography systems, such as proposed Markle-Dyson.

The Stanford engineers believe this work confirms predicted dramatic reduction in proximity effects. The work illustrates the high dose tolerance enjoyed at low voltages. In addition, electromagnetic interference and lower electron beam brightness are not limiting factors for the low voltage electrons. (Reprinted with permission from *Semiconductor International Magazine*, July 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL., USA)

Speed sensor debut

The world's first rotational speed/direction sensor to use a single sensing element has been developed by Philips Semiconductors. The sensor, which can contactlessly measure rotational speed and direction, uses only one sensing element. Furthermore, it requires no trimming or calibration and can be used with a variety of tachometer wheel tooth structures. Insensitive to

vibration and capable of operating over a temperature range of -40 to +150°C, the KM1110BH/31 device is suitable for use in a wide variety of automotive and industrial applications, including engine/gearbox managment, motor speed regulation and machinery control. (Source: *Electronics Weekly*, 23 September 1992)

Tubular carbon

The shape of things to come may well prove to be tubular, thanks to Thomas Ebbesen and P. Ajayan at NEC in Japan. They have found a way to mass-produce carbon nanotubes, a discovery which could have far-reaching implications for the manufacture of carbon fibres and semiconductors.

First found by Sumio Iijima last year, carbon nanotubes are needle-like tubes of graphitic carbon, sealed at each end. So far, detailed study of these molecules has been hampered by poor availability, but the new production method promises to relieve this shortage.

Ebbesen and Ajayan take two graphite rods and induce a plasma between them using a direct current. One rod is then slowly consumed giving rise to a new rod-shaped deposit on the other. Growing to about 8 mm in length, this new rod is hollow and hidden inside it is a host of nanotubes, some of which are up to 20 nm in diameter.

If done correctly the synthesis is remarkably quick and easy, Ebbesen claims. There appear to be two major keys to success. One, Ebbesen states, is knowing how to make a proper plasma. The other is the pressure under which the synthesis takes place. "The pressure is critical," he insists.

The researchers believe that, with sufficient nanotube samples available for study, the tubes could soon find applications in catalysis, composite materials and as nanowires. (Source: *Chemistry & Industry*, 3 August 1992)

Sandia develops CIVA to quickly locate metal "opens"

Researchers at Sandia National Laboratories have reduced the time needed to locate open metal conductor defects in ICs. Using charge-induced voltage alternation (CIVA), they can now do in hours what used to take weeks. Ed Cole and Richard Anderson in Sandia's Failure Analysis Department developed this technique.

CIVA is a highly selective imaging technique that uses a scanning electron microscope (SEM) to localize open conductors. The technique produces images by monitoring voltage fluctuations of a constant current power supply as it scans an electron beam over the surface of an IC. CIVA increases the beam energy until it just reaches the conductors of interest in the IC. It generates contrast variations in the images only from the electrically open part of the conductor.

CIVA is also more cost-effective than conventional IC diagnostic procedures. Besides a SEM, the constant current source for CIVA costs about $3,000 and the digital imaging systems about $20,000. Sandia has already transferred the technology to partners in private industry for use in their failure analysis laboratories. (Reprinted with permission from *Semiconductor International Magazine*, September 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL., USA)

"Breakthrough" positive photoresist for deep-UV

Officials at OCG Microelectronics Materials have what they are calling a "breakthrough in photoresist technology" for deep-UV lithography exposure: OCG's CAMP-6 chemically-amplified resist is a positive tone photoresist optimized for use with a deep-UV exposure source. CAMP-6 is said to feature excellent resolution, down to 0.25 μm, and a depth of focus of 1.0 μm at 0.35 μm. These results were obtained using a GCA XLS 0.48 NA KrF laser stepper system. OCG scientists developed CAMP-6 in collaboration with AT&T. (Reprinted with permission from *Semiconductor International Magazine*, September 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL., USA)

Holographic projection X-ray lithography

Lawrence Berkeley Laboratory researchers have developed a unique projection X-ray lithography technique for manufacturing ICs. They use a computer-generated hologram in-line to project the desired image onto a wafer. The hologram is the sole optical component; it replaces conventional masks and projection optics.

These researchers use an algorithm to create the hologram, eliminating unwanted signals normally present as systematic errors in holographic images. The holographic image is projected using a conventional X-ray source with a one-twentieth fractional bandwidth that is otherwise identical to sources for X-ray proximity printing.

The new lithography system is said to be relatively immune to contamination. Other characteristics that make holographic X-ray lithography attractive for semiconductor manufacturing include high resolution, wide process latitude, good depth of focus and high wafer throughput. This technology eliminates problems of diffraction blurring and contamination from a conventional mask. In addition, it is compatible with current proximity printing. (Reprinted with permission from *Semiconductor International Magazine*, September 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL., USA)

Wavelength extraction

Researchers at the Bellcore telecoms laboratory in the US have developed technology that allows users to extract different wavelengths carried on optical fibre networks. The experimental multiplexing device is described as an integrated acousto-optic filter and can be used to increase the speed and efficiency of optical fibre networks. The device can extract one or more wavelengths, allowing an optical fibre network to carry multiple information. By adding the extra dimension of wavelength to optical transmissions, phone companies can significantly increase the signal-carrying capacity beyond today's single-wavelength optical transmission systems. The Bellcore filter is 1,000 times faster than is possible with current multiplexing technology. (Source: *Electronics Weekly*, 30 September 1992)

Bacteria make good memories

The phrase "software bug" is set to take on a whole new meaning as a US firm works to develop computer storage using bacteria.

Researchers at Biological Components Corporation are creating high density memory from a species of bacteria found in San Francisco Bay.

Biological has already been able to create memory film that can be used in floppy discs and is now attempting to make three-dimensional memory cubes, a long sought after goal for virtual reality technologies as well as artifical intelligence.

The research has taken place in conjunction with the Center for Molecular Electronics at Syracuse University and involves a bacterium called *Halobacterium halobium* because of its ability to harvest light. When exposed, the bacteria creates a protein called bacteriorhodopsin, which releases a small electrical charge. Upon absorption of light, an instantaneous shift of electron density occurs with the negative charge moving along the protein chain towards the nitrogen atom. This shift in electron density interacts with nearby negatively charged residues and activates a rotation which is complete in less than one picosecond.

That rotation makes the being a biological analog of high electron mobility transistor devices. The bacteria also produce their own energy supply through photosynthesis.

This interaction with light means the bacteria are able to be flipped off and on - the foundation for a binary digital technology. The on/off function can be controlled, and information recorded, by stimulating the substance with a laser. This is the basis for the memory film. (Extracted from *Electronics Weekly*, 30 September 1992)

Cadence works faster with gridless circuit board router

Cadence, the US electronic design tool firm, has developed a novel circuit board router that works as fast as a gridded router yet can achieve route densities as high as a sophisticated gridless router.

Dubbed Warp-4 by Cadence, the new technique starts with a standard regular grid and deforms or warps it to make the most of the space between device pin contacts. The technology has been built into Cadence's new Prace-XL router for circuit boards, multi-chip modules and hybrids.

Gridded routers are faster than gridless ones by an order of magnitude or more, because the reference grid limits the amount of decision making that the router needs to perform. The problem is that the grid also limits the routing flexibility, imposing artificial constraints on where tracks can go.

Cadence has combined Warp-4 with the Allegro Correct-By-Design (CBD) constraints-driven system design technology announced earlier this year. This lets the designer set constraints such as on parameters including track lengths, the amount of parallelism, string order and stub lengths which the router then obeys automatically during routing. (Extracted from *Electronics Weekly*, 30 September 1992)

Fujitsu supercomputer is "world's most powerful"

Fujitsu has built what it claims is the world's most powerful supercomputer. The VPP 500 machine operates at 355 GFLOPS and implements the third strand of the company's stated intention to pursue three technologies in the area of supercomputing: vector, massively-parallel and vector-parallel processing.

At the moment, supercomputers are split into two types of machine: traditional vector-processing machines, where very powerful central processors perform matrix operations; and massively-parallel processing machines, where large numbers of small microprocessors operate in parallel on a particular application.

It has been the goal of parallel-processing machine designers to reduce the percentage of non-parallel tasks to about three per cent of the overall operation. This becomes accentuated when one manages to build a faster version of a parallel-processing machine, because if the parallel section becomes faster, the amount of time taken to process the non-parallel tasks increases as a proportion.

Fujitsu's solution has been to build processing elements so powerful that each one when acting alone on an operation that cannot be "parallelised" has about the same processing power as a standard-vector processing supercomputer. As such, the new machines can run

applications developed for both parallel and non-parallel architectures, thereby providing a degree of compatibility with existing supercomputer users.

The VP500 series can have up to 222 processing elements (PEs) each consisting of a scalar-processing unit and a vector-processing unit. The scalar unit is a long-instruction-word RISC processor which allows several instructions to be executed per clock cycle. The vector unit is a powerful vector processor with large-capacity vector registers and high-speed load and store pipelines.

Systems will cost between £5 million and £30 million depending on configuration. The first system sold in Europe will be installed in the Technical University in Darmstadt by September next year. (Extracted from *Electronics Weekly*, 16 September 1992)

College boffins make logical choice

Researchers at Napier University in Edinburgh have built a chip they claim is the first to make use of Reed-Muller logic. This represents logic functions in terms of Exclusive-OR operations and is reckoned to be more efficient than Boolean logic implemented in NAND or NOR gates for some functions, and also much easier to test.

According to Dr. Almaini, associate head of the Department of Electrical and Electronic Engineering at Napier, Reed-Muller logic can be more economical in terms of silicon area in about 50 per cent of cases, particularly in arithmetic functions such as encoders, decoders and parity checkers.

The circuitry is constructed using what are known as Exclusive Universal Logic Modules (EULMs). Each of these has c control inputs, 2^c data inputs and one output and can be abbreviated as $EULM_c$. An $EULM_c$ can implement any logic function of up to c+1 variables when expressed in Reed-Muller form.

The chip was built as a full-custom design by European Silicon Structures. Made in 1.5-micron CMOS, it comprises two $EULM_1$ blocks and two $EULM_2$ blocks. According to Almaini, blocks with greater numbers of input pins can be built but it is more practical to cascade smaller devices to build up the circuit.

Almaini also said that it was possible to include Reed-Muller logic sections on the same chip as conventional NAND/NOR gates.

The University is keen to license the technology to merchant chip makers. According to Almaini, there are no standard ICs of this type available and the department has already held discussions with one semiconductor supplier. (Source: *Electronics Weekly*, 9 September 1992)

0.5-micron gate arrays "imminent"

Toshiba has made its first low-power and high-speed gate arrays using its new 0.5-micron CMOS process technology and is on course to launch first products before the end of the year.

A company source said that the first 0.5-micron gate array products were "imminent" and standard cells were planned for early in the new year.

Toshiba is evaluating first silicon of its TC180G series sea-of-gates arrays, which will offer up to 600,000 usable gates and will almost double the speed of existing 3V arrays built on the company's 0.8-micron process.

As well as power savings and the speed improvement, the potential for smaller die sizes will benefit from Toshiba's new miniature packaging technology.

Size and power benefits of the 3V arrays are expected to find applications in battery operated systems such as palmtop computers, mobile phones and global positioning system (GPS) receivers. (Source: *Electronics Weekly*, 9 September 1992)

Japan feels way ahead in microscopes

Researchers in Japan are using a new type of microscope that feels its way through the atomic structures of materials. Because the atomic force microscope (AFM) probes the surface of materials it can be used by researchers to investigate the way materials interact with one another. At NTT's laboratories research has begun on how insulating layers of silicon dioxide form on silicon substrates. It is hoped these new devices will bring closer the day when electronic components can be formed from groups of atoms in molecular-scale devices. (Source: *Electronics Weekly*, 12 August 1992)

Superconducting transistor

A superconducting transistor using a barium potassium bismuth oxide high-temperature superconductor has been developed and tested for fundamental operation by Sanyo Electric. The new transistor has an emitter, a base and a collector. A prototype of the transistor was tested showing the current amplification factor as low as 0.2. Sanyo says the factor will exceed 0.9 in a few years when the structure and dimensional parameters including junction area are optimized. Applications include arithmetic and logic units in superconductors, analog amplifiers for high-speed signal processing and 3D graphics processing. (Source: *Electronics Weekly*, 12 August 1992)

0.72 μm^2 DRAM cell

Hitachi, Ltd. has announced it has developed a memory cell having the world's smallest area. The memory cell measures 0.72 μm^2 and was achieved by combining a 0.25 μm process with a levelling structure to overcome the depth of focus problem in optical lithography. Basic read-write operations with this cell have been confirmed. This technology should help promote the research and development of advanced DRAM VLSIs.

The company has also developed a new short-channel MOS (metal oxide semiconductor) transistor for use in peripheral circuits to control read signals. In addition, by controlling the amount of impurities in the channel region, leak current was reduced and stable operation at low voltage obtained.

A 2-kbit prototype DRAM circuit has been prepared using the above technology. The memory cells of this prototype are 0.6 by 1.2 μm in area, capacitance of its capacitor section is 25 femto-farads, and its operating voltages 1.5 V. This memory cell area is about half that of the 64 Mbit DRAM (1.28 μm^2) announced by the company. (Extracted from *JETRO*, September 1992)

New ultrahigh-density magnetic memory using self-organized cell

Hitachi, Ltd. has developed a new type of solid state magnetic memory, which can realize a storage density of more than 10 Gbit/cm^2. The information unit of this memory is a vertical Bloch line in the magnetic domain wall structure and magnetic garnet crystal is used for the storage medium. A fine magnetic stripe domain pattern generated naturally in a magnetic thin film is used for a memory cell so that the cell size can be reduced to as small as 0.05 μ without micro-processing technology. The storage density can be increased by over 10 times compared with the conventional memory. Therfore, the newly developed magnetic memory is possible to replace the floppy disk used in compact personal computers such as notebook-type personal computers.

The prototype memory cell is 0.7 μm and storage density is 36 Mbit/cm^2 in the test chip. By improving the conditions of permalloy deposition such as temperature, film thickness and growing speed, the width of stripe domain can be narrower than the Bloch line, enabling the cell size to be reduced to as fine as 0.05 μm to provide an ultrahigh-density memory of 10 Gbit/cm^2. Also, the memory operates with a power consumption of less than 1 W. (Extracted from *JETRO*, August 1992)

Magnetic head for directly sensing magnetic fields

Professor K. Mohri of the Faculty of Engineering, Nagoya University, and Unitika Ltd. have jointly developed a new type of magnetic head device based on a new principle of operation.

An amorphous material has been developed in which electromagnetic induction is changed considerably by the external magnetic field. This material is used for the new magnetic head device. This new device can measure the amplitude of the magnetic field generated by the disk. Since the magnetic field is measured directly, the stored information can be detected even if the magnetic disk is at rest during read-out.

The new device is made of an amorphous material consisting of iron, cobalt, silicon and boron. It is a magneto-inductive device capable of detecting the magnetic field created by the disk itself. The device is a wire with a diameter of 20-150 μm and 4-10 mm long folded into two. Conventional types of magnetic heads generally have a length and width of about 1 cm and thickness of about 5 mm, so the new device is more compact.

Experiments show the new magnetic head device enables waveforms with less noise to be obtained, and is highly promising for commercialization. (Source: *JETRO*, August 1992)

Technique for growing C_{60} crystals on Si surfaces

Professor T. Sakurai, leading a research team from Tohoku University, and Associate Professor H. Shinohara and a research team of Mie University, have jointly succeeded in growing C_{60} single-crystal thin films on the surface of a silicon substrate.

C_{60} fullerene represents a third unique crystal structure for the carbon element, in addition to the well-known planar graphite and tetrahedral diamond, and is itself unique in its structure and large unit size. Scientific interest was greatly aroused by the discovery that C_{60} becomes a superconductor with alkali metal doping. In principle, its electronic properties are expected to change from insulator to semiconductor, metal and to superconductor just by controlling the doping level of the alkali metal.

Various techniques such as scanning tunnelling microscopy (STM) have been used to investigate the morphology of C_{60} deposited on Au(111), HOPG(0001) and GaAs(110) surfaces. However, no report has been published in connection with Si surfaces, one of the most widely used and well characterized materials in the electronics industry.

The research group studied field ion-scanning tunnelling microscopy (FI-STM) of the adsorption of C_{60} molecules on the Si(100)2x1 surface. Au, HOPG and GaAs surfaces are rather inert and flat, preventing the investigation of interesting interactions between the substrate and the C_{60} overlayer. Each surface Si atom has

one dangling bond and significant amounts of charge transfer can be expected in the case of the Si(100)2x1 surface. The group has also been studying the C_{60} film growth on the Si surfaces upon alkali metal adsorption.

One of the well-known characteristics peculiar to C_{60} crystals is the fact that individual C_{60} molecules rotate at a high speed (10^9 rotations/s) at room temperature, but Profesor Sakurai and his research team have also reported that the C_{60} molecules adsorbed on the Si(100) and (111) surfaces are stably fixed in position. It is expected that this study will point out the way to answer the problems in this sector of research. (Extracted from *JETRO*, August 1992)

Nanometer scale intelligent memory formed using STM

Ion Engineering Research Institute Corp. and the University of Osaka Prefecture have jointly verified formation of a nanometer-scale memory by modification of amorphous As_2Se_3 film evaporated onto HOPG and Au using a scanning tunnelling microscope (STM).

Indentations formed by the STM are about 3.5 nm in diameter, so a high-density recording with a capacity of several tens of thousands times that of the optical disks can be achieved theoretically.

STMs developed for observing the surface of materials on a nanometer scale have recently been used to manipulate atoms to form various atomic scale structures. For instance, STM can produce nanometer scale patterns for memories. One method forms nanometer patterns on a highly oriented pyrolytic graphite (HOPG) surface using submicrosecond pulses up to 4 V applied to a tungsten tip in the presence of organic fluid. Structures formed on the surfaces of materials such as Ag_xSe and Au have also been reported using a similar technique.

The research group investigated the STM images of amorphous As_2Se_3 (a-As_2Se_3) films on a few substrates, and tried to form nanometer-sized structures applying a voltage pulse to the Pt-Ir tip of an STM.

The As_2Se_3 thin films used in this experiment were prepared by evaporation in a vacuum chamber onto an atomically flat cleaved surface of HOPG or onto gold substrates. The evaporated As_2Se_3 thin film was 10 nm in thickness. The STM was used as an electron source for microfabrication using a Pt-Ir tip.

The research group concludes that sufaces of a-As_2Se_3 on HOPG for a nanometer-scale memory are clearly useful, and considers that the mechanism of the indentation is due mainly to electric field induced spinodal decomposition of the material. (Source: *JETRO*, August 1992)

Transformer Coupled Plasma

Lam Research (Fremont, CA) has introduced new etch technology using low-pressure, high-density plasma. Called Transformer Coupled Plasma, the process is said to result in rapid etch rates as needed for volume production and allows independent control of ion density and ion energies. Achievement of etch uniformities of 5 per cent, 3-segma across 200-mm wafers is reported. The technology is said to be appropriate for use in etching in the 0.25-micron regime. Lam worked with Sematech and with IBM, one of its leading customers, in development of the technology. (Extracted from *Solid State*, June 1992)

Superconducting wire improved

High-temperature superconducting wire can be made stronger and simpler in a "tube-within-a-tube" engineering design by David Korzekwa, John Bingert and Haskell Sheinberg, researchers of the Metallurgy Group at Los Alamos National Laboratory's Los Alamos Materials Technology. The resulting wire conducts electricity more reliably than other designs under investigation, according to the researchers. With their design, a bismuth-based superconducting compound is sandwiched between concentric silver tubes. A layer of superconductor is deposited onto the outer surface of a silver tube and another tube is slipped over the bismuth layer. The three-layered structure is drawn down and heated. The wire is cooled by passing liquid nitrogen through the hollow core. (Extracted from *Chemical and Engineering News*, 6 July 1992, p. 29)

Key part of high-speed optical switch developed

A tiny prism that may become a key part of high-speed optical switches for future computers has been developed and patented by Dr. Robert R. Alfano, director of the Institute for Ultrafast Spectroscopy and Lasers at City College in New York, NY; Dr. Yao Li, a former associate professor, and P. L. Baldeck, a former graduate student. Scientists are working to develop high-speed computers that will work using optical signals instead of electricity, but a limiting factor in this pursuit is the need for optical gates and switches that can route billions of bits of light each second. Scientists at City College in New York are working on non-linear materials that bend the light in different ways depending on the way they are exposed to the light. A beam focused on the prism will cause it to bend light differently, creating a prism or lens within the cube-shaped circuit. The optical gate will open, close and redirect light signals with great flexibility and speed by using light to control the prism. Optical computing, when it is developed, is expected to yield enormous increases in processing power as against electrical systems. (Extracted from *New York Times*, 25 July 1992)

Low-temperature CMOS ring oscillator

Toshiba researchers have made a CMOS ring oscillator, using a 0.2 micron process, which can switch a 19.8 ps at liquid N(2) temperature with a 2V supply.

Toshiba says low-temperature devices are important because rules of scale do not apply to submicron miniaturization. If an existing sub-micron device runs at low temperature, the threshold voltage rises and the benefits of cold operation are lost.

To overcome this, Toshiba optimized the impurity profile in the source and drain regions, so reducing the surface concentration of the channel region. This cuts the threshold voltage of the 0.2 micron CMOS devices. It also used a self-aligned titanium silicide process to reduce the parasitic resistances of gate electrodes. (Extracted from *Electronics Times*, 12 October 1992)

Engineers get red light out of spongy silicon

With a novel patterning technique, researchers at Sandia National Laboratories in Albuquerque, New Mexico, can control the emission of red light from silicon semiconductor material. By irradiating portions of porous silicon wafers with an ion beam, the researchers manipulated both the location and intensity of photoluminescence.

This accomplishment is a significant step in the development of silicon light emitters that could be used in new types of flat panel displays, signal processors and optical communications. The ultimate goal is to use optical signals as a faster alternative to electrical connections. A significant advantage of using silicon for such signal transmission is that it could be easily combined with conventional circuit technology.

The Sandia discovery is one of many recent advances in work aimed at getting silicon to emit visible light. While researchers have been studying the problem for the past 40 years, major strides occurred last year. Investigators from laboratories in England, France, Germany, Japan and the United States described how they got porous silicon to emit red, orange, yellow and green light using lasers as an energy source. No one is quite sure what causes the light. (Reprinted with permission from *Semiconductor International Magazine*, August 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL, USA)

Laser particle buster

Susan Allen and her team of scientists at the University of Iowa have found a way to use lasers to get rid of contamination on semiconductors. The patented process, called laser-assisted particle removal (LAPR), is a result of research conducted at the University's Center for Laser Science and Engineering in Iowa City, Iowa.

The group attacked the problem by taking a second look at a different problem - water contamination on optical surfaces. They had found that water could be removed from cracks on surfaces by shining a laser on them. The process does not appear to harm surfaces being cleaned, since the laser frequency is chosen so that the energy is absorbed only by the water. Allen's team has a double goal - to both gain a more fundamental understanding of the science involved and to optimize the cleaning process for adaptation to commercial use. Since much of semiconductor manufacturing is done in vacuum, Allen says that future experiments will concentrate on using this type of environment rather than an air jet. (Reprinted with permission from *Semiconductor International Magazine*, September 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL, USA)

High-temperature superconductor via laser MBE

A high-temperature (high-Tc) superconductor has been achieved via the laser molecular beam expitaxy (MBE) technique by Professors S. Kawai and T. Kawai of the Institute of Scientific and Industrial Research, Osaka University. They demonstrated that it became superconductive at over -153° C (120 K). Laser MBE is a method in which an intense laser beam irradiates the raw material and atoms and molecules emitted from the surface are layered on a substrate to yield a new material. Because substances that are electrically neutral and stable can be stacked simply, this method is widely used in semiconductor manufacture. The method allows experiments to be performed at low pressure and temperature, making it appropriate for a variety of applications. (Extracted from *New Technology Japan*, August 1992)

Sony is closer to blue laser

Researchers at Sony in Japan claim to have made a semiconductor blue laser that will eventually allow the amount of data that can be usefully stored on optical discs to be greatly increased.

The density at which the data can be packed onto an optical disc is limited by the wavelength of the light in the reader mechanism. Lasers in currently available optical-disc readers use red or infrared light which has a longer wavelength than blue light. A blue light laser could allow up to three times as much data to be stored on a comparatively sized disc.

The laser was produced using a new material made up of magnesium and zinc selenide. A commercially viable product is still some years away because the laser can only operate at temperatures well below freezing. (Source: *Electronics Weekly*, 29 July 1992)

New green laser

Hitachi's central research laboratory has developed a second harmonic generation (SHG) green laser with an output of 5 milliwatts and an emission wavelength of 532 nm. The device will be used in CD players and optical storage systems for PCs.

The laser consists of a light source diode, convergence lens, neodymium-yttrium-vanadium oxide solid state laser crystal, titanium oxide-phosphoric acid-gallium nonlinear optical crystal and a resonator (output mirror).

The light-source diode emits 810 nm light, which is converted to 1064 nm by the time it reaches the solid-state crystal. The nonlinear optical crystal then divides the wavelength in half, enabling the emission of 532 nm green light from the resonator.

With the solid state crystal it is possible to obtain 5mW of green light with a light source diode output of 50 mW. This is one third of the output needed to produce similar levels in conventional SHG lasers. (Extracted from *Electronics Times*, 10 September 1992)

Squeezed light beam gives denser data

A laser light beam only 50 nm across can be produced by guiding the light down an aluminium coated optical fibre, drawn to a fine point, according to Eric Betzig of AT&T Bell Laboratories. The feat could allow packing 100 times more information onto computer disks than is now possible. Current lenses and mirrors can focus a beam of laser light to a point 500 nm across, for blue-green lasers, which operate at a wavelength of about 500 nm. The new technique has been used to put 400 dots in a grid 2.3 microns across on magneto-optical film. This is equivalent to 7 billion bits/sq. cm. Two copies of *War and Peace* could be stored on an area the size of a pinhead. The dots are made with changed magnetization when they are heated by the laser beam. The dots are read by a weak laser beam, which views the polarization of the light caused by the dot. Practical obstacles remain before the system can be commercialized. The platinum cobalt film surface must be perfectly clean, and tracking of the fibre tip 10 nm above the surface must be extremely accurate. (Extracted from *New Scientist*, 15 August 1992)

Chip contains four lasers

Enabling frequency-division multiplex communications, four variable-frequency lasers are integrated on a single chip. From Mitsubishi Electric, the Variable Frequency Semiconductor Laser Array features a 125μm separation between lasers and one built-in lens converging the beams of all four lasers into only one fibre. This light source permits frequency-division multiplex communications in which multiple laser beams are transmitted through one optical fibre. This means that existing optical fibres can now carry much larger quantities of information than before. The laser array also allows the oscillation frequency of each of the four lasers to be individually controlled and secures a frequency spacing of 10 GHz to prevent cross-talk. (Source: *AEU* No. 3, 1992)

Eye chip offers vision for the future

A team of researchers in the US has taken the first steps towards developing a light-sensitive chip that can be surgically implanted into the eye to restore basic sight to people suffering from certain forms of blindness.

The technique would be restricted to blind people with damaged photoreceptor cells in their retinas. An eye surgeon in Baltimore has shown that if the nerve cells behind the photoreceptors are still intact, the person can "see" when the nerve cells are electrically stimulated. Now, engineers in North Carolina are working with the surgeon on a chip that could be implanted into people's eyes, detecting light and transforming it into electrical impulses to stimulate the nerve cells.

Eugene de Juan, the surgeon at Johns Hopkins University in Baltimore has so far operated on four patients using a slender electrical probe to stimulate the ganglion cells that send impulses from the retina to the optic nerve. De Juan's team intend to conduct more tests using multiple and simultaneous pulses to study further the ganglion cells' responses to electrical stimulation.

De Juan emphasizes that this technique of generating sight would only benefit patients whose blindness is caused by the destruction of the photoreceptors, such as through retinitis pigmentosa and retinal detachments, and whose ganglion cells and optic nerve are still functioning. It would not help people suffering from glaucoma because this affects the ganglion cells and the optic nerve.

Tom Gray of North Carolina State University has made a prototype array of four phototransistors on a chip. This array will sense light reaching the back of the eye, transform the photons into electrical impulses, and transmit these to microstimulators near the retina. De Juan believes he could implant such chips into patients' eyes in ten years' time.

The main challenges will be packaging the chip so that it does not damage the eye, and keeping power levels down so the heat generated by the microstimulators does not burn this sensitive tissue. Other hurdles include attaching the chip to the retina, and providing electricity to power it.

While a 1024-photosensor array would provide enough vision for reading and moving around without bumping into things, it will be far from normal vision:

scientists estimate human eyes register roughly one million picture elements. (This first appeared in *New Scientist*, London, 24 October 1992, the weekly review of science and technology.)

DNA takes chip makers down a size

Makers of silicon chips may be able to push the physical limits to making smaller circuits with the help of DNA. Two European researchers claim they can grow DNA in a precise, controlled pattern on a flat surface. The DNA itself would not form part of a chip, but its pattern could be used in chip manufacture to make circuits many times smaller than those possible with conventional techniques.

The researchers, Cornelis Hollenberg of the Heinrich Heiner University in Düsseldorf and Ernesto diMauro of the La Sapienza University in Rome, chose to use DNA simply because it is a well-understood form of "molecular Lego" that is relatively easy to assemble in a regular pattern.

Details of the work are described in a European patent application (491 059) which the researchers filed in 1990 and which was recently published. The inventors are already negotiating the sale of a licence to a Japanese manufacturer. Hollenberg believes that chips could be made within "a couple of years". (Extracted from *New Scientist*, 17 October 1992)

Storage on plastic sheeting

A cheap way of storing analogue information optically using dye-carrying liquid crystal polymers has been developed by scientists working on a European Commission research project.

Scientists from GEC's Hirst Research Centre, together with researchers from the Universities of Leeds and Hull and Dutch chemical firm Akzo have found a way of storing pictures and graphics on flexible polymer coated plastic sheets.

The research has shown that high resolution, 5-micron line, graphics and greyscale images can be written and stored using this technique. (Extracted from *Electronics Weekly*, 27 May 1992)

Magnetic paper puts movable message on the cards

Three Japanese companies (Star Micronics, Victor and Dai Nippon) have developed plastic "paper" that can be written on with a magnet, erased again with a magnetic field and, the companies claim, reused more than 100,000 times.

The first product using the paper is a plastic card called the Display Card, which will carry a strip of the paper on the front with enough space for two rows of 18 Roman, Japanese Kanji or Chinese characters. On the back of the card is a magnetic strip identical to that on most credit cards.

The paper works on a similar principle to the liquid-crystal displays used in calculators and digital watches. The liquid crystal is sandwiched between a base material and a protective transparent cover. The particles of liquid crystal are normally arranged in an ordered fashion and so reflect light efficiently and appear light in colour. If a magnetic field is applied to a particular spot, however, it disorders the particles so that they reflect less well and appear grey, though not as dark as a conventional liquid-crystal display.

The paper on the Display Card is 0.2 mm thick and characters are written with a row of seven pins similar to those in an impact dot-matrix printer, except that they apply a magnetic field rather than hitting the paper. The pins produce letters 3.5 mm tall. The resolution of the paper is coarser - about 20 dots per centimetre - than that of conventional liquid-crystal displays, but the company says it may improve in future versions. The image can be erased simply by passing a magnet over the film.

The card will be launched together with a printer device that writes on the plastic paper and reads or writes on the magnetic strip at the same time. Its most likely first use will be in gaming machines. The paper could also be used on prepaid telephone cards or bus tickets to indicate how much credit remains on the card. Larger sheets of the paper could be used in office printers and fax machines, where they could be reused when the information printed on them is no longer needed. But the cost of making such large sheets is too high at the moment. (This first appeared in *New Scientist*, London, 24 October 1992, the weekly review of science and technology.)

Smallest motor yet

Toshiba (Japan) has developed the smallest electromagnetic motor in the world, according to the company. The 0.8 mm diameter motor can spin as fast as 10,000 revolutions/min. The motor is not powerful enough and is too small to have any practical application at this time. Such small motors may have future application in micro-machines that remove obstructions from tiny pipes or thread through the bloodstream or digestive tract to diagnose diseases, according to experts. (Extracted from *New York Times*, 25 September 1992)

Computer translates sign language

Hitachi (Japan) has developed a computer that translates sign language into data by means of a glove, according to a company spokesman. The glove, which was developed by VRL Research, can transmit data 30 times a second. The machine will be able to recognize

500-1,000 common signs and generate articles and prepositions within three years. (Extracted from *Asian Wall Street Journal*, 14 September 1992)

Uses for buckyballs

Scientists at the Dupont Experimental Station in Wilmington (Delaware) have found that buckminsterfullerenes are good electron acceptors, and that having accepted electrons, they are photoconductors. These discoveries point the way to the development of a variety of potential uses.

Buckminsterfullerenes are massive carbon molecules that are found in small quantities in such common materials as furnace soot. They comprise 60 carbon atoms arranged in a spherical shape, with each carbon atom covalently bonded to neighbouring carbon atoms; the bonding for each atom is identical to that of its neighbours. This is, chemically, a very stable structure, so the molecules do not react with the normal reagents of organic chemistry, although they will go into solution in solvents. Scientists are interested in fullerene because it is so new and its spherical shape gives it unusual properties. Some types of fullerenes have been shown to be superconductive. The molecules are named after Buckminster Fuller, inventor of the geodesic dome. But it has proved difficult to produce fullerene crystals perfect enough for practical use as semiconductors.

Initial research also shows that introducing other materials into the buckyballs seems to give them optical properties; frequency-doubling capabilities in the light region of the electromagnetic spectrum could make them useful for generating lasers of various colours, for instance. But their massiveness provides perhaps the most intriguing potential application. "If we can introduce all these extra electrons into such a massive molecule, and then heat the material into a gas, we have a plasma made up of very massive ions," said Steven Freilich, a research scientist at Dupont's Experimental Stations.

Microchips made from fullerenes may soon be possible. Japanese researchers have made thin films of fullerene crystals that show the electrical behaviour of semiconductors such as silicon. They have also been able to add slight impurities to the crystal to alter its behaviour in a predictable way. A team led by Satoru Isoda at Mitsubishi Electric overcame this problem by using an ionized cluster beam (ICB) to create the crystals. The process involves shooting fullerene molecules out of a nozzle and ionizing them. They are then accelerated by an electrical field onto a substrate, where they form a thin film.

The wafers produced in the experiments are around 1 mm in diameter, but Isoda hopes to increase the size to several inches - the same as silicon wafers, although he admits he is uncertain at this stage how fullerene will compare with silicon as a semiconducting material.

The next step of the research is to use fullerene semiconductors to make a p-n junction, a basic diode which will only let current flow in one direction. It is made from a piece of semiconductor doped to make it rich in electrons connected to a piece doped to be starved of electrons. (Extracted from *Electronic Buyer's News*, 15 June 1992 and *New Scientist*, 31 October 1992)

MPP companies vie for position

Parallel processing computers more powerful than supercomputers and built using conventional semiconductor technology were unveiled by MasPar of the US.

These 64-bit massively parallel processing (MPP) machines are built from arrays of between 1,000 and 16,000 32-bit reduced instruction set computing (Risc) technology processors implemented in standard 1-micron CMOS chips and can deliver up to 68,000 Mips and 6.3 Gflops of 32-bit processing; between three and five times the performance of the previous generation.

MasPar is one of a number of firms developing relatively cheap 64-bit high-performance computers around conventional chip technology.

Rival US MPP specialist Kendall Square Research (KSR) will shortly implement on a single chip all the elements of a proprietary full 64-bit processor specifically designed for parallel processing.

Details of a 64-bit parallel implementation of the Sparc merchant microprocessor will be unveiled by Silicon Valley start-up HaL Computer Systems - which is backed by Japanese computer giant Fujitsu. (Extracted from *Electronics Weekly*, 7 October 1992)

Photovoltaics more efficient than ever

Converting sunlight to electricity using silicon "solar cells" is a well-known research effort, but what about converting monochromatic *laser light* to electricity? That is an area that some researchers are very interested in, for applications such as transmission of power by line-of-sight or by fibre optics. It is also being considered for powering space missions or extraterrestrial bases.

Consider that energy conversion efficiencies of 45 per cent have already been demonstrated, close to double the 23 per cent efficiency achieved by today's best solar cells in converting sunlight to electricity. The cell structure that has produced the highest efficiency silicon solar cells is the passivated emitter, rear locally diffused cell (PERL cell). Under solar illumination, these cells demonstrate overall energy conversion efficiencies above 23 per cent.

Martin Green of the Centre for Photovoltaic Devices and Systems, University of New South Wales (Kensington, Australia) notes that several features of this device make it a particularly efficient converter of long-wavelength monochromatic light. For example, the textured top surface resulting from the "inverted pyramid" structure shown reduces reflection loss from the top surface by ensuring that light reflected at the first point of incidence is reflected downwards and so has a second chance of being coupled into the cell. Long-wavelength light is only weakly absorbed in silicon and a reasonable fraction will reach the rear of the cell. The rear reflector consists of aluminium displaced from the silicon interface by a layer of thermally grown silicon dioxide. Over 95 per cent of the light reaching this rear surface is reflected. Upon reaching the top surface, any remaining light strikes the inverted pyramids from within the semiconductor material. In this way, the effective path length of light in silicon is increased by about 26 times. (Reprinted with permission from *Semiconductor International Magazine*, August 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL, USA)

Low-cost photovoltaic cells

Texas Instruments has developed a low-cost method for making photovoltaic cells. The technique involves the alternate heating and cooling of an inexpensive grade of silicon, producing increasingly pure spheres that act as solar cells. The development is expected to make solar technology available to US households and industry at an affordable price. Texas Instruments expects to begin commercial production of the solar cell within a year, with full-scale manufacturing expected to commence in 1994. (Extracted from *JRL Communications*, 22 June 1992)

Hitachi makes flash on 0.5-micron process

The cost of solid state computer memory is being brought closer to that of magnetic drives by the semiconductor arm of Hitachi. A 64 Mbit flash memory chip that can be made on the same process as 16 Mbit DRAMs, which are now in mass production, has been developed by Hitachi. The firm is developing a new memory cell that will allow it to make a 64 Mbit flash memory on a 0.5-micron process. The cell has a NOR type structure that also gives high speed. The alternative NAND type cell is smaller than the NOR cell but has the disadvantage of being slow. Hitachi's solution of a small NOR cell would get the best of both worlds. (Extracted from *Electronics Weekly*, 14 October 1992)

Breakthrough in chip process technology

A breakthrough in semiconductor process technology that means 256 Mbit DRAM memory chips can be made using conventional optical lithographic techniques has been reported by scientists working for Japanese consumer electronics giant Matsushita.

Silicon features small enough for 256 Mbit DRAMs as well as a prototype 64 Mbit DRAM have been produced by combining excimer laser lithography with a new positive resist chemical developed by Matsushita. Scientists at Matsushita's Semiconductor Research Centre in Osaka, Japan, are now working to produce a prototype 256 Mbit DRAM chip using the technique.

Matsushita can achieve 0.25-micron processing using an excimer laser with chemically amplified resist means.

This means future memory chip generations up to, and possibly beyond, 256 Mbit can be made without going to esoteric new semiconductor process technologies such as X-ray lithography, which require hugely expensive superconducting synchrotron machines.

The key to the technique is a new resist developed by Matsushita, a positive chemical amplified resist called ALKA2 - for alkaline soluble kinematics using acid generating positive resist, version 2, containing a polymer, a photo acid generator (which produces acid when exposed to light) and an alkaline.

Excimer laser light triggers acid production, which makes the polyvinylphenol-type polymer dissolve into the alkaline. The acid generation only occurs during exposure to deep ultraviolet (UV) light of the kind produced by excimer lasers, while the alkaline soluble reaction takes place during the post-exposure baking process. (Source: *Electronics Weekly*, 14 October 1992)

Two into one

Two distinct optoelectronics or electronic devices can be integrated onto a single gallium arsenide (GaAs) or indium phosphide substrate using a technique developed by US defense contractor Litton. Dr. Yi Ching Pao, manager of the molecular beam epitaxial research at Litton's solid state division in Santa Clara, developed the high-level integration molecular beam epitaxial wafer to get round the problems associated with connecting high frequency components on different wafers. (Source: *Electronics Weekly*, 14 October 1992)

Silicon lightbulb

US researchers at the University of California in Berkeley have developed silicon chip lamps, according to a research paper to be presented at the International Electron Device Meeting in San Francisco during December. These "microfilaments" reach temperatures of between 1,200° K and 2,600° K and produce around 0.3 lumens of light, visible at 5 m, from a power input of

between 50 mW and 100 mW. The device in the scanning electron microscope image above uses a heated filament made from tungsten wire just 0.7 microns thick, 5 microns wide and 200 microns long. Such microdimension hot filament vacuum devices can be fabricated using standard chip-making techniques, according to the paper which is entitled: *IC-Processed Hot-Filament Vacuum Microdevices* by Kirt Williams *et al.* (Source: *Electronics Weekly*, 14 October 1992)

Microwave welding

Microwaves can provide a clean, high speed heat source for welding and cutting, according to researchers at the University of Liverpool's Electronics and Electrical Engineering Department. They claim microwave heating is cheaper and faster than current methods involving electric arcs. By using a tuned cavity, the Liverpool team has focused microwaves onto an ionizable gas - typically argon - to create a 4,000° C plasma concentrated into a beam only 2 mm in diameter. A 1 kW trial machine has successfully welded steel, stainless steel and titanium and the researchers have now set their sights on developing a 30 kW device. (Source: *Electronics Weekly*, 14 October 1992)

Supercomputer attains record throughput

With a 16 per cent improvement in performance compared with the present version, the SX-3 R supercomputer has the fastest vector throughput performance in the world at 25.6 G floating operations per second (FLOPS) with its multiprocessor system and a 6.4 G FLOPS with its single processor system. NEC has started selling the SX-3 R and will begin installations. The company expects to ship 80 systems in the next four years - 50 to its domestic market and 30 overseas. The supercomputer gets its fast speed from the improved circuit design of its super rapid arithmetic and logic unit. It adopts a 1 M-bit SRAM in its main storage and a 4 M-bit DRAM in its extended storage to attain a main storage capacity of 8 G-bits and a maximum storage capacity of 64 G-bits. (Source: *AEU*, No. 3, 1992)

New phone chip

The universal telephone could soon be a reality thanks to a new programmable line interface IC to be launched by Philips Semiconductors.

Designed by Faselec AG, Philips' partly owned Swiss subsidiary, the PCA 1070 is intended for use in telephones, fax machines and other equipment on the public switched telephone network. It can be programmed to meet the technical parameters for connection to any country's telephone system cutting the need for costly redesigns.

The chip would be sampled before the end of 1992. Projected price will be Fl 6.50 (£2.40) in quantities of 10,000. Transmission parameters for each country network are stored as values in EEPROM, and are downloaded into the chip by an associated microcontroller each time the phone goes off-hook.

Philips Semiconductor also launched three chips, which make up the baseband, audio and control circuits for cordless telephone conforming to the newly ratified Digital European Cordless Telecommunications standard (DECT).

Functions provided include an adaptive differential pulse code (ADPCM) coder-decoder, burst mode controller and a specialized microcontroller that handles power management, keyboard and display functions. (Source: *Electronics Weekly*, 7 October 1992)

Smallest transistor

Memory chips produced early in the next century will be able to store more than four billion bits of information - 250 times greater in storage capacity than today's biggest chips.

The sweeping pace of miniaturization, along with reductions in the cost of computer power, has led IBM research scientists in Yorktown Heights, New York, to build the world's smallest transistor. Using electron-beam nanolithography fabrication techniques the chip's active area measures just 1/75,000th of the cross-section of a human hair. Previously, the smallest transistor in existence was 20 times larger in area. According to the researchers, these new transistors can be reduced further in size by a factor of two. (Extracted from *Financial Times*, 12 June 1992)

Second SHG crystals

Salts of tartaric acid could be efficient second harmonic generation (SHG) crystals, according to researchers at the University of Sussex. Such materials would be useful in converting infrared light transmitted by fibre optics into visible frequencies used by optical devices. Existing SHG materials are either unstable at high temperatures, coloured, or expensive. The Sussex researchers have now made 12 salts of organic amines that function as SHGs. The crystals are tested with a pulsed neodymium laser at 1,064 nm. The crystals emit light at 532 nm. The tartrate of piperazine is three times as effective as alpha-quartz and the tartrate of 3-hydroxypyridine is 14 times as effective. The original acid must be asymmetric at the atomic level, and the crystal must be rich in hydrogen bonds. (Extracted from *New Scientist*, 23 May 1992)

HTSC research finding

The University of New South Wales (Australia), has developed silver-sheathed wires of bismuth which can conduct power currents at liquid nitrogen

temperature, a breakthrough in the research into high-temperature superconductors (HTSC's). This brings the University's scientists in line with Sumitomo's (Japan) researchers in the race to develop HTSCs suitable for power transmission, as both have now achieved HTSC power densities double those of US rivals. (Source: *Technology Update*, 22 June 1992)

Smallest memory cell

Hitachi (Japan) has developed what is reportedly the smallest memory cell ever, with a surface area of just 0.72 sq. micron. It could lead to the mass production of 256 M-bit DRAMs, perhaps by 1998. Hitachi successfully used optical lithography and ultraviolet light to produce a 0.25 micron circuit pattern. (Extracted from *Nikkei Week*, 13 June 1992)

NKK claims fastest mask ROM

NKK, the Japanese industrial giant, has intensified its challenge in the high-speed semiconductor market by unveiling what it claims is the world's fastest mask ROM series featuring an access speed of 25 ns. The device is six times faster than previous devices and comes in 1 Mbit and 2 Mbit versions, using a two-layer aluminium patch and 0.8-micron CMOS polyicide gate process. Both models require a 5 V power source and consume 550 mW in operation. Currently under development are 40 Mbit and 8 Mbit devices and lower-voltage products.

In addition NKK is setting up a chip research centre near Tokyo which will be capable of producing 6,000 eight-inch wafers a month. Manufacturing equipment will be installed by mid-August and test runs begin in October. (Source: *..lectronics Weekly*, 27 May 1992)

Marconi picks up dry joints

A fast and simple technique for picking up dry joints, one of the biggest manufacturing headaches for surface mount PCB asemblers, has been developed by UK test and measurement firm Marconi Instruments.

Marconi claims the patented technique, called Q-Test, can find open circuits with almost 100 per cent coverage on devices for which there is no detailed information available. The company has built the test into its new 4200 ICT Plus tester.

Unlike short circuits, open circuits can only be found by proving the connectivity of each lead of each device on the circuit. Q-Test does this by sending a test signal into the board pad connected to each pin of a device in turn, and looking for a current flowing in the earth bond wire of the device using a current-sensing probe.

The board power supply is switched off and the logic tester drives both the ground and Vcc to +5V.

The tester can now drive a signal negative with respect to ground into each pin, which forward biases the lower clamp diode on the pin and causes a current to flow in the earth bond wire if the pin is connected properly.

The current sensor is held above the device in a "top hat" frame. (Source: *Electronics Weekly*, 30 September 1992)

III. MARKET TRENDS AND COMPANY NEWS

Market trends

PC demand

The sharpest indictment of the computer industry's failure to persuade the broader business community of the value of its products, in Europe if not in the United States, is the widely held conviction that there is suppressed demand for PCs, which will only be released when prices fall to the "right" level. There is plenty of evidence from Amstrad's success with its word processors that people are prepared to experiment with an unfamiliar technology if the price is low enough.

Ordinary market economics dictate that price has a marked influence on demand. The volume of people taking intercontinental flights or package holidays abroad increases as air ticket prices fall; the number of car owners rises as prices fall within the reach of the average pocket, but the idea that the market for personal computers will explode when the price falls to, say £500, puts the most powerful business machines ever invented in the same category as expensive electronic consumer products, such as hi-fi sound systems or high-definition television.

Larger organizations purchasing hundreds, perhaps thousands, of personal computers a year are not part of this pattern, although lower PC prices do increase their flexibility, but for smaller businesses, the price/demand syndrome suggests that PCs are a "nice-to-have" rather than "have-to-have" option, unlike, say, a delivery truck or, perhaps, a portable telephone. No one questions the need a business has for a delivery truck. But the business benefits of PCs are by no means so obvious. (Extracted from *Financial Times*, 21 July 1992)

The microprocessor market

Two decades ago Intel's 4004 microprocessor contained 2,300 transistors. Its new Pentium microprocessor, to be launched in 1993, has 3.2 million. The firm's stranglehold on the supply of microprocessors for use in IBM-compatible personal computers - it has 80 per cent of the market - has proved lucrative. The firm's 486DX microprocessor, a chip found in the most powerful desktop PCs, sells for over $300, but costs about $20 to make. Such money-spinning devices account for over half of Intel's $4.8 billion annual sales (it also makes

less-profitable memory chips), helping it clear a hefty 17 per cent net profit margin. On that measure, Intel is the tenth most profitable big public company in the world. Those sort of numbers have attracted competitors into a market which, until 1990, Intel had to itself. While it ties up its rivals in the courts, Intel is also using the $750 million it will spend this year on R&D to race ahead of them. The firm's new Pentium chip - so called because names are easier to patent than numbers - will be three times faster than its predecessor, the 486. Intel has its eye on the growing market for PCs which can process video and sound, as well as text, numbers and graphics. To keep its technical edge, the company has two teams designing several generations of microprocessors in parallel; in the past it used only one. This has helped halve the time Intel takes to design each new generation to under three years. The company is already about halfway through the development of Pentium's successor, codenamed P6; it is likely to hit the market in late 1994. P7, which will contain 15 million transistors, will follow two years later.

The heart of Intel's strategy is to encourage personal computer-makers to take up each new generation of microprocessor as fast as possible; that competition-free zone is where the biggest profits are.

Even IBM, Intel's old ally, is a potential rival. IBM is not allowed to market its customized Intel chips to other manufacturers, but it can sell complete circuit-boards with the chips already fitted. That could hit Intel's sales. (Extracted from *The Economist*, 14 November 1992)

Market prediction for sub-laptops

The market for sub-laptop PCs and peripherals is expected to reach $10 billion in 1993 and $50 billion by 1998, according to a report issued by Market Intelligence Research Corp., Mountain View, California. The size of the market was $3.5 billion in 1991.

In the United States, sub-laptop sales, which totalled $2 billion in 1991, will reach $25 billion by 1998. But the US share of the world-wide market will fall to 52 per cent in 1998, from 64 per cent in 1991. Pen-based computers will be the fastest-growing segment, growing 85 per cent a year through 1998, according to the research firm's assessment.

Sub-laptop sales will be spurred by smaller machines with a longer battery life, making the devices more portable, but the main reason for the expected sales boom is that manufacturers (will) look for new ways to make these mobile, lightweight products more functional and easier for workers to use for a broader range of tasks. (Extracted from *Electronic Buyer's News*, 8 June 1992)

Cheaper chips to manage mainframe data

Using numerous inexpensive microprocessor chips in a mainframe to manage data a good deal quicker and cheaper is considered by computer engineers to be a new business opening resulting from a major technology shift. This would substitute for the past practice of using an individual, large, costly processor that executes the calculations within a mainframe. The benefits of the new approach are that using many microprocessors can supply computing power at a portion of the cost of mainframe processors, and the machines can be scaled up in size as needs increase. The new type of computing is expected to get into business gradually. (Extracted from *US News*, 8 June 1992)

Multimedia consumer electronics devices

Toshiba (Tokyo, Japan) and Apple Computer (Cupertino, California) will jointly develop multimedia consumer-electronics devices combining audio and video with computers. Toshiba will produce the first product for sale by both firms by mid-1993. Apple earlier teamed up with Sharp (Japan) to develop Newton, an electronic notebook, phone list and appointment calendar. Apple wants to link its expertise in software and product design with Japanese expertise in miniaturization, flat-panel display screens and semiconductors.

The project is another example of what many experts see as a trend - the blending of computers, communications, publishing and consumer electronics into one industry. According to Apple (Japan), "as multimedia grows, there will be greater fusion among these separate areas". Toshiba estimates that world-wide sales of such devices could reach 5 million units per year by 1995.

Apple and Toshiba are the first to license technology from Apple's Kaleida joint venture with IBM that was formed to develop multimedia software. The device, which may come with a liquid crystal display or be hooked up to a television set, would be able to display video, text and data. For example, repairmen could use a CD-ROM player to call up instructions from a repair manual and watch repairs being performed on the screen while a narrator explains it. (Extracted from *New York Times*, 24 June 1992)

Foreign chip share in Japan grows

The foreign share of the Japanese semiconductor market increased in the second quarter of 1992, bringing hope that Japan will further open up its market and honour a promise of a 20 per cent foreign share of its chip market.

The Semiconductor Industry Association (SIA) says that foreign market share in Japan increased by 1.4 per cent to reach 16 per cent in the second quarter of 1992.

The SIA has asked the US Government to step up pressure on Japan to fulfil its earlier commitment. It has asked for punitive import duties if Japan does not move quickly enough. (Source: *Electronics Weekly*, 7 October 1992)

Chip makers see the future in a flash

Sharp has announced that it plans to stop developing dynamic random-access memory (DRAM) chips, a move that may signal the end of an era for micro-electronics: for 20 years DRAMs have been the mainstay of the global electronics business. Other companies are also reducing their investment in DRAMs, and many are backing a rival technology known as flash memory.

The world-wide trade in DRAMs is worth $7 billion a year, and two thirds of it goes to Japanese companies. By the end of the 1980s, some of these companies were investing up to $500 million a year to bring new generations of chips, with ever-larger capacities, into production. Each generation in turn has become a commodity item, subject to the same cycles of boom and bust as copper or cocoa.

Today, companies that ploughed billions of dollars into setting up production lines for DRAMs are struggling to find customers. The price of 4-megabit DRAMs fell by 3 per cent in August 1992 alone, to about 1,300 yen (£6) apiece, one fifth of what they were fetching when they first appeared. The Electronics Industry Association of Japan announced that it expects the whole industry's production to fall by up to 8 per cent in 1992. By the time the business recovers the DRAM could be obsolete.

Sharp, a consumer electronics company at the leading edge of developing components such as liquid-crystal displays, never even bothered producing a 4-megabit chip. It has a prototype 16-megabit DRAM waiting in the wings, but it has now decided to stop developing DRAMs because of the widening gulf between the cost of developing new chips and the profits they generate.

Meanwhile, Fujitsu, Japan's largest computer maker and one of the world's biggest chip makers, is cutting its investment in electronics manufacturing by at least 20 per cent in a desperate attempt to make its chip business pay. It is the first of the giants to admit taking these measures. Analysts in Tokyo say that Fujitsu's rivals, Toshiba and NEC, will have to follow suit.

This year has also seen a rush of agreements to develop the flash memory chip. The capacity of flash memories has lagged behind that of DRAMs, but they are catching up: 4-megabit flash memories are beginning to be mass-produced. NEC, Japan's largest semiconductor maker, says it plans to send out samples of a 16-megabit chip in 1993 and to produce prototypes of a 64-megabit flash memory by late 1993. It expects the business to take off in 1995 or 1996. (This first appeared in *New Scientist*, London, 26 September 1992, the weekly review of science and technology.)

East European facilities may disappear

A report published by SEMI in May 1992, "Semiconductor Technology Capability in the Former Soviet Union and Eastern Europe", presents a bleak assessment of the chip-making capability of this region. It expects few, if any, of the 66 wafer fabrication facilities in this former communist bloc to survive the transition to market economics.

These facilities are some six years behind Western technology and are still producing 256 K DRAMS. They average an output of only $21 million per year. The report anticipates that various plants will close and that a pan-Eastern European chip-making combine will emerge that may have a structure similar to that of the SGS-Thomson Micro-Electronics Group. (Reprinted with permission from *Semiconductor International Magazine*, August 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL, USA)

Designers check out the chip library

In the electronics industry, last year's product is already a dinosaur. One bottleneck has been custom-built semiconductor chips to meet specifications for a product. Demand for such "mixed signal" chips is rising. Texas Instruments are devising a concept called Prism methodology, which is like a library that has integrated circuit elements on its shelves instead of books. When their engineers need it, they can go to the "library", find predefined modules and re-use them to meet customer needs. Another important feature is that it permits re-use of test programs, thereby reducing time required to get a new chip to market. (Source: *Financial Times*, 10 September 1992)

The soft sell with a hard centre

Cut-throat competition in the recession is sending computer prices tumbling, yet many customers are paying more for their software than the cost of their PCs. Computer manufacturers have been able to make their standardized equipment stand out only by offering increasingly sophisticated features at the same price, or less. For some time, software companies have realized that combining the cost of a computer with a popular software package is one way to bestow a certain "uniqueness" on the computer being sold. By selling directly to the computer manufacturers, the software companies have been able to distribute large volumes of software for a fraction of the normal cost. However, there are dangers with this kind of purchasing approach. Software sold cheaply without the appropriate support

from a dealer can turn a purchase into a disaster. Buying the wrong type of software for the business, just because it is part of a low-cost package, can often turn out to be a costly error. Unlike the professional systems market, which survives by its ability to offer extensive after-sales support to often experienced, computer-literate customers, consumers at the less expensive end of the market are often new to computing and need more hands-on help from the suppliers. The only people who will be able to sell inexpensive software in the volumes necessary to make some kind of profit will be the computer supermarkets, now gaining a foothold in the United Kingdom. The success of mail order and other direct sales approaches - exemplified in companies such as Dell, which sells computers, software and support by telephone - is putting the conventional dealer channel under even more pressure. Many corporate deals are now being negotiated at heavily discounted rates, sometimes as much as 80 to 85 per cent of the original list price. Once registered as a *bona fide* user with the package supplier, the customer can upgrade the software at a fraction of the original price. For many software packages, the price bears little relation to cost but is what suppliers think the market will bear. (Source: *The Times*, 28 August 1992)

Fibre market to grow

The European market for optical fibre communications hardware is expected to double in value over the next five years, according to market researchers, Frost & Sullivan.

The biggest growth will be in optoelectronic components, couplers, connectors and both multi-mode and single-mode fibre cable.

The report predicts sales of transmitters/receivers rising from $181 to $402 million, connectors from $64 to $133 million and single-mode cables from $404 to $754 million in five years. The growing use of optical fibre in local area networks will swell the multi-mode fibre cable market from $102 to $228 million by 1997.

The total market value is predicted to reach $1.7 billion by 1997 with the United Kingdom just squeezing ahead of Germany and France as the largest national market with $830 million sales. (Source: *Electronics Weekly*, 9 September 1992)

GaAs ignites technology of the future

"Gallium arsenide is the technology of the future and always will be". Such is the belief of many who have grown sceptical about the prospects of GaAs ever competing with high-performance silicon as a general-purpose semiconductor material.

The advantages of GaAs: high speed, high density and radiation hardness, have traditionally granted it a niche in some applications in the military, satellite and some supercomputer areas where its great disadvantage, namely its cost, has not been a critical issue.

However, for non-specific applications the speed advantage has usually been offset by ever-improving silicon technologies such as ECL and BiCMOS, which have provided comparable speeds more cost-effectively.

However, the largest supplier of Asics in the world, Fujitsu of Japan, is confident that a new dawn is about to break for custom chips built on GaAs, claiming that the present world-wide market for GaAs devices is worth about $150-200 million.

Fujitsu expects the emerging market for digital mobile telephones will bring with it a requirement for devices that can best be made using GaAs, citing market research reports that show a growth in the world-wide GaAs market to $600-700 million by 1995 and $1 billion by 1997.

Fujitsu has invested $200 million in a plant at Yamanishi, Japan dedicated to producing GaAs parts on 4 in. wafers. GEC-Marconi is in the process of upgrading its GaAs MIMIC (monolithic microwave ICs) manufacturing line from 3 in. to 4 in. wafers, and to make it pay will have to find markets outside its traditional space/defence-dominated sphere and expects a growth in demand for GaAs coming in personal communications and wireless LANs, and that will result in lower-cost GaAs devices.

However, LSI Logic, Fujitsu's main rival for the title of leading Asic supplier, does not have a GaAs capability and is sceptical about the necessity to move away from silicon. (Extracted from *Electronics Weekly*, 29 July 1992)

Fuzzy logic in consumer articles

Industry giants want to have a second chance at selling the public on fuzzy logic. In 1990, when "fuaji riron" became linked to the hottest marketing label around, consumers were not aware that the products advertised as having fuzzy technology built into them were not what they claimed to be. According to sources at Fujitsu (Tokyo, Japan), the software in those products was nothing more than look-up tables. In this second attempt, fuzzy logic will be built into the hardware of consumer products. Fujitsu states that consumers now have real fuzzy logic control at work in air conditioning, heating and refrigeration units, washing machines, microwave ovens, vending machines and automated currency exchange machines. Applications have spread to industrial equipment. Togai InfraLogic is co-developing a fuzzy automatic transmission with Honda Motor. (Extracted from *Machine Design*, 10 September 1992)

Company news

Sematech spends on safety

US chip research consortium Sematech is being forced by the US Government to spend at least 10 per cent of its future funding on developing environmentally safer methods of chip production.

In a military authorization bill passed recently, Sematech is instructed to spend $10 million in 1993 to develop a "pollution-preventing, environmentally safe microchip manufacturing process".

Sematech has been receiving $100 million from the US Defense Department to help maintain US competitiveness in the semiconductor industry. Now that semiconductor production is no longer as cruciai to US defence plans, the US Congress wants Sematech to redefine its mission and help reduce the level of pollution caused by chip manufacturing plants.

Silicon Valley is one of the most polluted areas in the world with the largest number of Superfund sites, sites with very high levels of contamination, in the United States.

Environmental groups have also protested over Sematech's exemption from strict environmental regulations that cover other semiconductor operations because of its status as a Defense Department-funded organization.

Now that many large and expensive military defence projects have been cut, Sematech may face loss of members and a reluctance to continue funding at present levels. Unless it can maintain adequate funding, it will not be able to finish many of its research and development projects. (Source: *Electronics Weekly*, 14 October 1992)

Philips in Chinese venture

The Philips group (based in Eindhoven, the Netherlands) has opened a new IC factory in Shanghai, China. Construction began in 1989 and was completed in 1991, with full commercial production levels being reached in May/June 1992. The plant is claimed to be the most advanced bipolar wafer fabrication in the region and will eventually employ some 500 people.

It uses bipolar technology and the low power, low voltage SACMOS technology developed by Philips to produce ICs from 125 mm (5 in.) wafers. These products for the Chinese domestic market and for export to countries in South-East Asia will include devices for monochrome and colour television, telephony, remote control and radio applications.

The new plant is a joint venture between Philips Electronics Southeast Asia Holding BV, which has 51 per cent of the shares, and the Shanghai Number 7 Radio Factory, with a 49 per cent share holding. (Reprinted with permission from *Semiconductor International Magazine*, June 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL, USA)

Disk-drive alliances

As storage technologies diversify and push toward ever higher performance, disk-drive makers are realizing they cannot do everything alone. Their response has been a spurt of disk-drive alliances over the past 10 months. The partnership trend represents a philosophical departure for the disk-drive industry. While other segments have eagerly embraced alliances, drive makers have historically been reluctant to forge arrangements within their highly competitive circle or even to team up with outsiders.

Another factor prompting disk-drive makers to seek partners in related fields has been the increasingly competitive nature of the drive industry. Rampant price-cutting made many balance sheets run red through much of 1991. Meanwhile, drive makers have found they must offer ever-larger product portfolios to meet a growing range of customer needs.

On the technology front, Maxtor has teamed up with Censtor Corp. (San Jose) to develop heads for contact recording. Fujitsu Ltd. is widely rumoured to be another Censtor partner. Conner Peripherals (San Jose) has teamed up with Intel Corp. to develop solid-state memory cards. (Extracted from *Electronic Engineering Times*, 18 May 1992)

Philips and Motorola enter joint Malaysian venture

Construction of a factory at Seremban, Malaysia will start as a joint and equal venture between Philips Semiconductors International of the Netherlands and Motorola Semiconductor Products of the United States of America. The facility is scheduled for initial production in late 1993 with the assembly of small signal surface mount transistors and diodes. The initial workforce will be about 100 people, but is expected to rise to about 500 by 1997 when production will be some billions of devices per year.

The joint project will be known as Surface Mount Products Malaysia Sdn. Bhd. and will be funded by the two companies to about US$ 50 million over the next five years. The joint venture represents an opportunity for both companies to more effectively expand production and to achieve greater manufacturing efficiencies than either would expect to achieve independently. The agreement is for assembly requirements only and does not

include wafer production, marketing or sales. (Reprinted with permission from *Semiconductor International Magazine*, September 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL, USA)

National Semiconductor shares its Israeli facility

National Semiconductor has agreed to give up the major part of its ownership of the wafer fabrication facility at Migdal Haemek in Israel. The facility will be taken over by a collaborative venture comprising a consortium of Israeli companies, the Israeli Government, and National Semiconductor.

This fabrication facility opened in 1986 and produces 1.0 µm CMOS devices using 150 mm (6 in.) wafers. It produces ICs for PCs, LANs and office automation applications. The change will enable better use to be made of the facilities at Migdal Haemek with a sharing of manufacturing costs between the three partners. (Reprinted with permission from *Semiconductor International Magazine*, September 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL, USA)

New alliances: IBM, Toshiba and Siemens; AMD and Fujitsu

In two separate announcements, five of the world's leading semiconductor companies announced major alliances that span the United States of America, Europe and Japan.

First, IBM Corp., Siemens AG and Toshiba Corp. announced an alliance to develop a 256 Mb DRAM chip and its process. Then, in an unrelated but similar announcement, Advanced Micro Devices and Fujitsu announced plans to collaborate on the development, manufacturing and sale of EPROM and flash memories, including the construction of a new $700 million fabrication facility in Japan.

These announcements are significant for two reasons: they may help to somewhat ease international tensions in the semiconductor arena and they clearly illustrate the escalating costs of developing new, leading-edge semiconductor technologies.

In the IBM/Siemens/Toshiba alliance, teams of developers will begin work at IBM's Advanced Semiconductor Technology Center (ASTC), north of New York City. Siemens and Toshiba will also conduct project-related activities at their own facilities. At the peak of the development phase, more than 200 researchers from the three companies will support the effort. By teaming up, the three firms aim to speed up the multi-year development process and be first with a 0.25 µm 256 Mb DRAM technology.

The AMD/Fujitsu agreement is somewhat further-reaching in that in addition to development it includes manufacturing and sales. Also, the two companies intend to establish a $700 million wafer fabrication facility to produce the devices.

The new facility, to be located in Japan, is expected to be operational in 1994 and will use 8 in. wafers and process technologies capable of producing products with geometries of 0.5 µm and smaller. (Reprinted with permission from *Semiconductor International Magazine*, September 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL, USA)

Mainframe trio Sparc component link-up

Radical new ideas about mainframe architectures are being developed by Japanese giant Fujitsu and related companies ICL of the United Kingdom and Amdahl of the United States.

The three firms are collaborating to cut the costs of future mainframe machines by developing common "components and subcomponents", according to industry sources.

These may include mainframe processors built from gallium arsenide (GaAs) chips and massively parallel computers built from the arrays of Sparc reduced instruction set computing (Risc) technology processors.

The architecture of mainframes may change as the GaAs-based central processors and parallel machines are merged into hybrid servers hooked together on optical networks.

Some of the technology could be incorporated in the next generation of mainframes from the three firms which will start appearing from 1995.

The idea of hooking mainframe processor nodes together over optical fibre networks has already been implemented by ICL in its latest generation of mainframes - the SX family.

One model for future mainframes involves the central processor acting as a database manager while the high-performance parallel machines handle specialized tasks such as transaction processing, database serving and engineering simulation. (Source: *Electronics Weekly*, 30 September 1992)

Three join forces for European EDI

BT, AT&T and IBM have announced plans to link their Europe-wide electronic data interchange networks. This will give individual customers a single point of contact for all three and only one subscription charge.

Messages will be transferred using the Odette file transfer protocol and will eventually be upgraded to the International X.435 standard. (Source: *Computer Weekly*, 8 October 1992)

Microprocessor prototype

IBM and Motorola have produced a microprocessor prototype. The device is the initial product from the sweeping link-up with Apple Computer made in 1991. The new chip continues to undergo tests and will not become the "brain" of IBM computers until late 1993, when it is scheduled to supplant the microprocessor in low-cost workstation computers produced by IBM. Known as the PowerPC 601, the chip is then set to become part of the 1994 Apple Macintosh line of computers. Machines Bull and Thomson-CSF, both of France, will also see the device become part of their machines. (Extracted from *Wall Street Journal*, 2 October 1992)

IV. APPLICATIONS

Nitrogen-cooled Squids move toward medical applications

Using nitrogen-cooled Squid (supereconducting quantum interference device) technology, experts at the Research Centre Jülich in Jülich, Germany, have taken a major step in developing supersensitive magnetic sensors based on high-temperature superconductors.

By drastically reducing intrinsic noise signals, the Jülich devices become so sensitive that they can measure magnetic induction values of less than 0.2 picotesla - 100 million times less the value of the earth's magnetic field and about 200 times less the peak value of the magnetic field emanating from the human heart.

The research recently led to a breakthrough involving a considerable increase in the sensitivity of Squids based on high-temperature superconductors for the low frequencies of biomagnetic signals. The sensitivity increase is achieved by reducing the disturbance signals, the so-called Squid noise, by more than one order of magnitude.

The chief consequence of the Jülich development will be that in the near future practically all measuring tasks up to a resolution of 0.2 picotesla, which previously was the domain of helium-cooled Squids, will be taken over by their nitrogen-cooled, thin-layer rivals made from high-temperature superconductors. (Extracted from *Electronics*, 24 August 1992)

Electric wind extinguishes fires

Spectronix (Israel) is developing an "electric wind" to blow out fires on any flat surface. The device is based on work by Eran Sher of Ben Gurion University (Beer-Sheva). The electric wind is produced when a flat electrode and a sharp electrode are used to create an electric field. The field is much denser near the sharp electrode. If it is dense enough, atoms are ionized. Positive ions are propelled away, creating an electric wind. In the new system, the flat burning surface acts as the flat electrode. A wire about one metre long, suspended on a frame, is used as the sharp electrode. The sharp electrode is moved by hand 10 cm over the surface on fire. This cools the burning material to below its ignition temperature, putting the fire out. A direct current of only 20 kV is needed. (Extracted from *New Scientist*, 15 August 1992)

New technique directs light through silicon chip

Light emitting silicon can be used as a holographic surface, perhaps paving the way for denser storage of data on silicon chips, according to researchers at the University of California (San Diego). The new technique could allow porous silicon layers thin enough to direct light through a silicon computer chip. Diffraction gratings can be produced to let the silicon surface act as a hologram. A black and white picture projected onto the silicon wafer produces different etch rates, depending on the light intensity at any particular point on the image. This allows reproduction of the gray scale of the image. The etching process used at UCSD makes the silicon porous in a controlled fashion, so the porous silicon does not become grainy. (Extracted from *Science News*, 27 June 1992)

New storage method

Scientists at AT&T's Bell Laboratories have developed a magneto-optic storage method that may yield a hundred-fold improvement over today's most capacious products.

By stretching a fibre-optic thread to a fine point and coating it with aluminium, researchers have produced a laser device that can read and write data that is much denser than today's lens-focused lasers can handle. That method allows the scientists to pack data at 45 billion bits per square inch - close enough to allow two copies of War and Peace to fit on the head of a pin.

Bell Laboratories researcher Eric Betzig says that while a lot of work remains to translate the development into commercial products, it is not just a pie-in-the-sky breakthrough.

As it stands now, researchers can pack a lot of data in a given space but can only read a fraction of it. Betzig believes the development could translate into products ranging from better storage tools for traditional computer applications to consumer electronics. Patty Chang, an analyst at Dataquest Inc. in San Jose, believes the latter area is the likely beneficiary. (Extracted from *Information Week*, 10 August 1992)

Sony produces blue laser

Sony (Japan) has successfully produced a blue laser that could make it possible to triple the amount of information on a compact disc. At a temperature of -196° C it has a wavelength of 447 nm. The red laser used with existing CDs has a wavelength of 640-680 nm, and the CDs themselves (with a diameter of 12 cm), can store approximately 75 minutes of information. With blue laser technology, a CD could be made to store over three hours of information. (Extracted from *Nikkei Week*, 1 August 1992)

Neural computer for photocopiers

A computer that does not need software to tell it how to perform a task appears to be a contradiction in terms, but that is what Ricoh, the Japanese office equipment company has developed.

Do not start erasing software files from your computer just yet. Ricoh's experimental neural computer can only learn 16 characters at a time, even though it is put together with microchips that are blazingly fast. This is indeed a primitive performaance for a computer that is 500 times faster than the typical workstation, and four times faster than supercomputers. Ricoh's neural computer is none the less a tantalising hint of things to come. In a year or so Ricoh hopes to install a small neural computer in its office photocopiers - one that will learn by itself, without software that sets parameters, how to adjust all of the interrelated variables that determine whether a copy comes out with even tone.

Morio Onoe, professor emeritus at Tokyo University and general manager of Ricoh's R&D group, says that existing neural computers have combined the traditional central processing unit with software that imitates the functions of neurons of the human brain. (Extracted from *Financial Times*, 19 June 1992)

Fibre optic development

Kokusai Denshin Denwa and AT&T are collaborating on development of fibre-optic undersea cable technology and have achieved 5-Gb/s optical signal transmission in tests. The system, employing erbium-doped fibre-optic amplifiers, is said to be the first of its kind, and has been demonstrated at speeds almost 10 times that of a transatlantic cable that went into operation in March 1992. Capacity for the new system is as much as 500,000 simultaneous calls. Plans have been made to use the technology in the TPC-5 transpacific cable in 1994. AT&T intends to build a similar system to span the Atlantic. (Extracted from *Telephony*, 15 June 1992)

Smart power finds home in cars

A goal of integrated circuit manufacturers is to build logic circuits that can also control real-world functions - drive motors, neon lights and the like. This new generation smart power IC will find application in automobiles, appliances and industrial controls.

Already, the devices are finding their way into upscale automobiles, i.e. in anti-lock brakes, air bag controls, and many electric motors.

With smart power ICs manufacturers can use smaller motors, which means less weight and drag on an engine, and thus higher fuel efficiency.

Moreover, government regulations, especially in Europe, are compelling car makers to use smart power ICs to achieve pollution reduction goals.

In the US the electric car, being mandated in California, has smart power IC manufacturers excited.

To address this need, Ixys Corporation of San Jose has a line of smart power chips called IGBT (insulated gate bipolar transistor) MOS gate input with a bipolar transistor output.

Their uniqueness is that they switch faster and need less switching power. These IGBTs have continuous currents of 20 amps to 600 amps in a module with transistors tied in parallel to drive the motors used in electric cards. (Extracted from *Electronics*, 26 October 1992)

Fujitsu unveils world's fastest 3-D graphics system

A new 3-D graphic system from Fujitsu Ltd. of Tokyo utilizes a new design called reconfigurable parallel processing architecture to realize a processing speed of one million polygons per second per unit, and up to five million polygons per second when using a five-processor configuration. Fujitsu researchers stress that this speed, which they describe as a world record, will usher in the age of computer-generated television and movie images. (Source: *Electronics*, 26 October 1992)

Novel hard drive

Hewlett-Packard has launched a 1.3-in form factor 20-Mbyte hard drive for use in handheld and other small computers. The drive weighs about 1-oz and has dimensions 0.4-in by 2-in by 1.44-in. Industry observers say the device puts the firm far in advance of others, many of whom are working on 1.8-in size drives. The company's new Kittyhawk Personal Storage Module is

positioned as a lower-priced competitor to flash memory cards. It has 18-msec average access time and mean time between failures of 300,000-hrs. The company expects to be able to develop the technology further to increase the capacity eventually to hundreds of megabytes. (Extracted from *Information World*, 15 June 1992)

Virtual reality applications

"Virtual reality" is becoming a reality for chemists and biologists, who are using computer simulation techniques to "see" and "feel" how molecules react with each other. The University of North Carolina (Chapel Hill) has a molecular docking "virtual reality" system in its computer science department. Scientists can literally "feel" the attraction or repulsion between atoms or molecules by holding the grip of a robotic arm. Representations of compounds and proteins are projected onto a 4' x 5' screen and can be moved around in space. When the "molecules" approach each other, the electrostatic force between them is calculated by the computer and the information is programmed into the robotic arm. If it becomes harder to move the grip, the molecules are repelling each other or the bond is not favourable, but if it is easy to move the grip, the molecules attract one another. More and more scientists are applying virtual reality techniques to molecular modeling and other types of biological research. Virtual reality has been used for about 10 years in flight simulation, but is now expanding to encompass other fields of science. In the future, it could be used by the pharmaceutical and biotechnology industries.

Other kinds of virtual reality systems allow participants to enter a 3-dimensional world that changes perspective as the viewer "moves" through it. For example, one type of system uses head-mounted displays consisting of small liquid-crystal television screens. TV screens are played before the eyes of the viewer and images are displayed on them. Lycra gloves containing sensors connected to the computer are worn by the viewer, who through the use of hand movements, gives commands to the computer. Another kind of system known as BOOM (binocular omni-orientation monitors) contains a CRT-based stereoscopic viewing device resembling a pair of binoculars. The BOOM is a free-standing instrument that moves around, unlike the head-mounted display system. (Extracted from *Genetic Engineering News*, 15 May 1992)

Picture clears for future of European TV

Breakthroughs made public recently will change the face of home entertainment in Europe. In five years' time, Europeans could be watching the superior quality of digital television and recording the programmes digitally.

Conventional VCRs and tapes cannot record digital signals so the potential market for new recording equipment is huge. BASF, whose engineers invented magnetic recording tape in the 1930s, hopes to secure a share of the new market for Europe.

Until now European broadcasters have remained silent on digital TV. They know it spells death for the analogue HD-MAC high definition TV system the European electronics industry has spent five years and several billion dollars developing as a Eureka project.

But with the European Commission expected soon to admit defeat on its plans to impose HD-MAC as a standard, broadcasters' digital experiments are rapidly becoming public. In October the BBC successfully broadcast a digital HDTV programme using just one conventional TV channel from the Crystal Palace transmitter in London.

In Japan, electronics companies Sony and Matsushita are also working on a digital VCR. It will record all the data broadcast in a single channel and then leave viewers to choose which of the programmes on the data stream they want to watch.

The digital VCR will work on the helical scan principle, like an analogue VCR, with a rapidly rotating head scanning oblique tracks across slowly moving tape. The digital VCR will need more, and smaller, heads to pack the recorded signals more tightly because the data rate of the received signal will range up to 100 megabits a second.

The key factor is ability of the tape coating to resolve individual digital bits in a small area, while retaining enough magnetism for the readout heads to detect. Existing VHS tape is coated with relatively coarse magnetic oxide particles, and needs 25 square micrometres of coating area to resolve each digital bit.

The most efficient video cassettes currently available use tape coated with a thin film of cobalt and nickel oxides. This can squeeze one bit into 5.5 square micrometres. BASF's tests show that the practical limit for cobalt-nickel-oxide tape is two square micrometres per bit. But to record digital TV signals, the tape must break the one bit per square micrometre barrier.

Says Wilhelm Andriessen, director of technical applications at BASF "We now know it is all feasible, although it will take five or six years to move into manufacture." (This first appeared in *New Scientist*, London, 7 November 1992, the weekly review of science and technology).

Parking with precision

Those who have trouble parking their cars in tight spaces will welcome the news that one of Europe's major car makers is working on a personal-computer-based system that enables a car to park itself automatically at the push of a button.

The Integrated Research division of Volkswagen has built the system into its Futura "concept car" that will eventually be included in mass-production models to help drivers manoeuvre into difficult parking places.

The car's PC, located in the boot, can control functions such as front and rear wheel steering, acceleration and braking. The computer gathers data by using a narrow-beam infrared laser sensor to scan the distance to vehicles in front and back, and ultrasonic sensors that can measure the angles of obstacles in front of, or behind the vehicle, or on the kerb.

The computer checks the data relevant to the parking space, determining whether the vehicle is adjacent to the spot, how long it is and whether it is in front of or behind the vehicle. The vehicle then chooses one of several possible parking manoeuvres, and the driver confirms whether or not to begin to park by pressing a button. The driver always has the option to interrupt the process if the traffic conditions warrant it. (Source: *Electronics Weekly*, 14 October 1992)

Multibus group boosts Mips power

The Multibus Manufacturer's Group (MMG) has demonstrated the possibility of using Multibus II technology to build what it calls a "2000 Mips PC".

Using standard commercially available microprocessor boards based on 486s, i860s and i960s connected together via a Multibus II backplane, a powerful system can be built up enabling theoretical peak performances in excess of 2000 Mips.

Furthermore, such a system can make use of the communications facilities of Multibus II to enable software scalability, that is running software intended for single-processor computers on multiprocessor systems, so that it gains the full benefit of multiprocessing without having to be rewritten. According to the MMG, software accounts for between 80 and 90 per cent of the engineering cost in products using Multibus.

Among those planning products that make use of software scalability on the Multibus are French telecommunications giant Alcatel and SAT, a company that makes products for telemetry and process control. (Extracted from *Electronics Weekly*, 14 October 1992)

Coming soon - the folding screen

Shrinking a computer is easy. Chips can be packed closer together, bulky disk drives can be swapped for integrated circuit cards, even the keyboard can be replaced with a writing tablet. The only snag is the display; nobody enjoys squinting at tiny letters on a miniature screen.

A solution may have been found by Japanese manufacturers, Casio Co.; liquid crystal displays on ultra-thin, flexible film. Fashioned from a new engineering plastic just a quarter of the thickness of today's thinnest LCDs, the new screens are also 10 times lighter and more resistant to bumps and jolts.

Further refinements, say Casio, could yield screens that can be folded in half to fit the tiniest palmtop computers.

The company's first black-and-white film LCDs should go into mass production in March 1993. They will measure 3x5 inches, and the image quality will be slightly worse than that of existing LCDs. Initial prices will also be high - around 50 per cent higher than those of other types of screen. Plans are in the pipeline for colour screens, in larger sizes, and at competitive prices. (Source: *Business Week*, 6 July 1992)

How good is your printer?

The chances are it would take a lot longer to print the Bible (all seven-hundred-and-seventy-three thousand, six-hundred-and-ninety-two words of it) than the 65 seconds boasted by what is said to be the world's fastest printer.

The mind-boggling machine is an electro-sensitive system made by Radiation, Inc., at the Lawrence Radiation Laboratory in California. High-speed recording of up to 30,000 lines per minute, each containing 120 alphanumeric characters, is attained by controlling electronic pulses through chemically-impregnated recording paper, which moves rapidly beneath closely spaced, fixed styluses.

Impressive as that might sound, most of us will have to make do for some time yet with printers of somewhat less capacity. Just how much less, and under what circumstances, are questions currently being asked by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

The proliferation of different brands from a variety of manufacturers in virtually every corner of the globe can mean confusion for the consumer about how

good his/her printer really is. ISO and IEC are ideally situated to work through such problems within the joint technical committee, ISO/IEC JTC 1, Information Technology. (Source: *ISO Bulletin*, June 1992. For more information, contact ISO Secretariat, Case Postale 56, 1211 Geneva 20, Switzerland. Tel: +41 22 34 12 40; Fax: +41 22 33 34 30)

New fibre-optics transmission system

Northern Telecom's (Canada) Bell-Northern Research unit has developed a new fibre-optics transmission system that promises to sharply reduce the cost of fibre-optics installations. Current fibre-optics systems require that a tiny laser beam be aimed precisely into a small fibre-optic filament. The alignment must be precise to within 0.1 micron. However, Northern Telecom's light source only has to be aligned within 10-20 microns or 100-200 times less precisely. This is possible because it uses a circular-grating, surface-emitting laser that is easier to aim at the fibre-optic filament but is also much more wasteful of light energy. Fibre optics lines transmit hugh quantitites of data with extremely quick pulses of light. Because Northern Telecom's light source has a very low coupling efficiency, less information in the form of emitted light is able to pass through the fibre. The new fibre-optics transmission system has a coupling efficiency of only several per cent, against 70 per cent or more for the best commercial fibre-optics system (Extracted from *New York Times*, 22 June 1992)

CFC-less detection of residual solder-flux

NEC has developed a method for detecting solder flux residue on printed circuit boards without the use of chlorofluorocarbons. Residual solder flux is the most common cause of short circuits on printed circuit boards. It must be removed, otherwise the board must be scrapped. NEC has pledged to eliminate the use of CFC gases in its semiconductor operations by 1995. This latest development may accelerate that timetable. (Extracted from *Asian Wall Street Journal*, 8 June 1992)

Digitizer converts laptops to pen-based systems

Arthur Dent Associates (Tewksbury, MA) has launched a digitizer that is designed to be added to the screen of a laptop computer, converting the machine to a pen-based system. WriteAway includes the transparent digitizer, a controller card that fits into the modem slot, tethered pen and software including the Windows for Pen Computing environment. The first version of WriteAway is designed to be used with the Zeos 386+ computer, and future versions will be offered for Compaq LTE Lite and Toshiba machines. The company hopes to interest original equipment manufacturers in the product also. (Extracted from *Information World*, 22 June 1992)

Low cost LAN server carries out many functions

NEC America has unveiled a low cost LAN server that can carry out the functions of a router, modem, terminal server and hub. Developed at NEC's Data and Video Communications Division, Bandwidth-on-Demand (BonD), can dial-up links to remote sites, route and prioritize traffic. It can also serve as a dial-up backup unit. BonD works with Ethernet local-area networks running on Transmission Control Protocol/ Internet Protocol or Novell's NetWare. BonD will be available in three models, S, ST and B in early 1993. (Extracted from *Network World*, 14 September 1992)

Power PC switches on

IBM and Motorola have produced the first single-chip Risc microprocessor developed as a result of their collaboration. The 601 is the first of four microprocessors in the PowerPC range that will be built into computers from IBM, Apple and Bull. PowerPC microprocessors are single-chip devices based around IBM's RS/6000 Risc architecture. Some changes have been made to the instruction set, and binary compatibility with earlier microprocessors will be achieved by trapping unimplemented instructions. The 601 also contains the same bus as Motorola's 88110 Risc processor, which will allow it to be built into systems designed for the 88110. The 601 has 2.8 million transistors and is built in 0.6-micron COS process. The other three Power chips; the low-power 603 for portables, the 604 for mainstream desktops, and the 620 for high-end workstations and servers are under joint development now and silicon should be ready by the end of 1993. (Source: *Electronics Weekly*, 7 October 1992)

Neural networks put super into desktops

Neural network desktop computers that rival the processing power of supercomputers will appear "in the near future", according to researchers at US telecommunications giant AT&T's Bell Laboratories. They will deliver "several billion connections per second", according to a paper delivered at the European Solid State Circuits Conference in Copenhagen.

Connections per second (CPS) is a measure of neural performance such that a million CPS is roughly equivalent to 2.5 MIPS.

Conventional computers running neural network software would have to run at 10 billion instructions per second (10 GIPS) to match the power of forthcoming desktop neural computers.

Neural network chips with a speed of up to four orders of magnitude higher than general purpose microprocessors have already been demonstrated.

The paper concludes that over 50 different circuits were built in North America over the last two years ranging from digital emulators to fully analogue CMOS networks.

Analogue computation is used to some extent in 40 of the devices, and only 8 are exclusively digital. Several are now commercially available. Most were built in standard CMOS technology except for a few which use charge coupled devices.

Digital designs offer the most flexible and mature neural net implementations but analogue circuits can deliver higher performance.

Analogue chips are limited in computational resolution and are less flexible. But they are useful in signal processing, particularly pattern recognition. (Source: *Electronics Weekly*, 30 September 1992)

National develops radio modem for notebooks

Radio modems integrated in the PCMCIA low profile expansion card format for notebook computers will be available from National Semiconductor in 1993.

National Semiconductor has collaborated with IBM in the development of PCMCIA format interface cards for both Ethernet and Token Ring local area network (LAN) protocols. A 1Mbit/s radio modem chipset is already being developed to connect PCMCIA adaptors to 2GHz wireless LANs.

National Semiconductor has already developed the PCMCIA interface Asic with IBM. This is used with National's ST-NIC Ethernet controller or IBM's Tropic Token Ring controller in PCMCIA release 2.0 notebook PC cards launched this week.

National Semiconductor is also talking with potential partners about the PCMCIA radio LAN card.

The NIC8/16-bit Ethernet controller core has also been integrated with a 10Base-T transceiver. The AT-Lantic will support both the NE2000 and WD8013 shared memories interface architectures.

The integration of existing Ethernet chip products has continued with a combined 32-bit high-end controller and a 10Base-T transceiver. It is claimed to be the first fully integrated Ethernet interface on the market.

Called the Sonic-T, it supports a shared memory architecture and is compatible with 32-bit buses such as EISA and IBM's Microchannel. It is designed for motherboard applications running at 20, 25 and 33MHz. It uses high speed, interruptible DMA to avoid tying up the CPU.

Perhaps more important to National Semiconductor than offering highly integrated designs as the only option is the plan to offer full software driven on-board configuration, and automatic media selection.

National Semiconductor has also reduced the chip count and the cost of its fibre distributed data interface (FDDI) chipset from five to two devices. (Source: *Electronics Weekly*, 30 September 1992)

Computer linguist

Whenever two people speak to each other in a foreign language, there are often long pauses since they cannot find the right words and no interpreter is on hand. A computer has now been devised for such cases which can easily be carried around and is meant to get the conversation moving again at the press of a button. Verbmobil is the name of this Federal Research Ministry project on which scientists at various German universities, research institutes and companies are working as well as a research team at Stanford University. The aim of the project: when a Japanese and a German, for example, are talking to one another in English and one of them cannot think of the right words, he carries on talking in his native language. The automatic translator then supplies the English version. However, at the moment the computer's vocabulary is very limited. At most it can understand a thousand words, and then only if they are clearly pronounced. So it is unlikely that Verbmobil will be marketed before the year 2000. On the phone, too, when pauses can be particularly unpleasant, you will soon be able to do without foreign languages. At the Siemens Research Centre in Munich, scientists from leading research institutes and companies in the USA, Japan and Germany are working on a "telephone with integrated translator". In the first phase the computer of this novel phone system is to be fed short dialogues involving a vocabulary of around 500 words. (Source: *Scala*, October 1992)

Tiny motor clears way for microsurgery

Japanese researchers have built what they believe is the world's smallest electromagnetic motor - it has an outside diameter of just 0.8 millimetres. Its developers at the electronics company Toshiba are aiming to make a motor small enough for use in surgery inside the human body.

Motors driven by electrostatic forces have been built less than one-tenth the size of Toshiba's motor, but they have a much lower power-to-size ratio.

The new motor runs on a 1.7-volt power supply and weighs 4 milligrams. The difficulty with making a motor this small, says Makoto Ueda of Toshiba, lies in winding small enough coils of wire in the motor. The

three electromagnetic coils in Toshiba's motors are each 0.25 millimetres in diameter and are wound with wire 0.03 millimetres thick. Toshiba has developed automatic winding machines to make the coils for the recording heads of video recorders. Using the same principles, they built one that would wind coils for the motor.

The motors could be used in machines to scour away plaque from the inside of clogged arteries near the heart, or to power miniature probes for inspecting narrow pipes and tubes in manufacturing plants.

Toshiba's problem now is to slow down the electromagnetic motor, which runs at speeds of up to 10,000 revolutions per minute. Slower speeds would increase its torque: without gears, the torque of the motor is far too weak - at $5x10^{-8}$ newton metres - to power a micro-machine. By fitting the motor with a miniature gear system, Toshiba hopes to increase the torque up to 50 times. (This first appeared in *New Scientist*, London, 10 October 1992, the weekly review of science and technology.)

The listening bank that talks

High-street cash dispensers were not designed for blind or visually impaired people, who have problems knowing when screen messages are prompting them to do something, like request an account balance or cash withdrawal, and knowing which buttons to press. But blind people in Tokyo will soon be able to use a "talking cash dispenser", designed by the computer company Fujitsu, which gives spoken instructions and verbal confirmation when buttons are pressed.

The dispenser comprises a telephone and a recorded voice instruction unit that can be fitted to existing automated teller machines. The system is standard in the company's latest ATM machines, which it says are the first in the world to have no screen.

After inserting their cash card, users pick up the telephone and are prompted by recorded voice commands to key in their PIN number on the phone's keypad. The voice unit repeats every key depression to the user so they know they have pressed the right one, with the option to go back and make corrections. (This first appeared in *New Scientist*, London, 12 September 1992, the weekly review of science and technology.)

Lighting a path for lightning

Lasers could improve protection against lightning strikes by guiding the discharge down to static lighting conductors, say Japanese scientists. The researchers succeeded in using a laser to redirect artificial lightning in a laboratory.

Their device makes use of the fact that high-energy laser beams create a region of ionised gas, or plasma, along their path that is an excellent conductor of electricity. By directing the beam close to a generator of static electricity, the team induced an electrical discharge similar to a bolt of lightning. The discharge followed the plasma channel created by the laser beam and struck an electrode several metres from where it would have struck naturally.

Zen Kawasaki, a lightning expert, worked on the project with engineers from the Kansai Electric Power Company and the Institute for Laser Technology. Other researchers have been working on the same phenomenon, but the Japanese team believes it succeeded in diverting the discharge a record 8.5 metres partly because it used a focusing mirror called MACH (multi-active channel). This is a combination mirror with multiple focal lengths that produces a longer plasma channel.

In the experiment, a beam from a powerful carbon dioxide laser was reflected off the MACH mirror along a sloping path passing close to both a copper electrode and an impulse voltage generator. Inside the generator powerful capacitors are used to build up static electricity to a voltage of 1.2 megavolts.

Although there was an electrode directly below the impulse generator, the discharge from the generator followed the laser beam down to another electrode about 8.5 metres away. (This first appeared in *New Scientist*, London, 12 September 1992, the weekly review of science and technology.)

Tune in with a new-look Elvis

Video cards - printed circuit boards that can be plugged into spare slots in the back of a personal computer - are available now for less than £500; a price that puts them within reach of the mass personal computer. The cards allow integration of live television, prerecorded material or home video with computer-processing power. Computer databases of digitized moving pictures are being experimented with, as also is scanning of news programmes on TV and recording items of interest to create an educational database - a small step towards "intelligent" television. As television moves to higher definitions, its receivers will have to become computers to decode and unravel highly compressed signals transmitted. There are immediate advantages to watching TV through a video card on your PC rather than TV monitor - you can cut your least favourite politician down to size by letting them drone on in a postage stamp-sized window while you are getting on with something more useful. (Source: *The Independent*, 6 July 1992)

Hey presto for business

From invoices and shipping advices to remittances and banker's orders, the problems are the same: paper can be slow, unwieldy and prone to errors. A new

technology in computerized trading technique known as electronic data interchange (EDI) is emerging. This is faster, cheaper and much more accurate. Another gain claimed for electronic trading is the ability to slim down inventories. Supermarkets and industries dealing with high volumes and low profit margins are exploiting the potential savings of quick response and just-in-time manufacturing. EDI is now conducted through a third-party network service. (Source: *The Times*, 18 September 1992)

Looking-glass fantasy

Walt Disney's fantasy of the talking mirror which flattered Snow White's stepmother and gave her a beautiful reflection has come a step closer. An Anglo-German team has developed an electronic mirror. When a person is present, it displays three-dimensional messages, images, advertisements, accompanied by a soundtrack. Developed by EC Tronics, Brighton, it works on the principle of infrared beam which detects the presence of a person and triggers a sequence of images and soundtrack. It could be used by a company advertising its products, a hotel - its services, a club - its facilities, if in a factory a person is entering a hazardous area - the mirror alerts him to the dangers, a railway station - its timetable. The applications are limitless, says John Shouler, director of the company. (Source: *The Times*, 18 September 1992)

Keep in touch, electronically

E-mail is slowly replacing the office memo. Psychologists report that E-mail flattens office hierarchy by making communication between levels of management easier. On the negative side non-computer-literate users are sometimes put off by the abstract nature of sending messages via computer, and use is limited by the need to have access to a computer. Suppliers are adopting a messaging standard known as X400, by which disparate E-mail systems can be interconnected without losing functions. Use of this standard has previously been restricted to larger companies with the required technical expertise. Now X400 is becoming accessible to smaller operations with software packages that make connection to networks that use it cheaper and simpler to arrange. (Source: *The Times*, 14 August 1992)

15cm^2 solar cell offers 16.4 per cent conversion efficiency

Thanks to a special structure and a thicker-than-standard electrode, a 15 cm^2 polycrystal silicon solar cell achieves a photoelectric conversion efficiency of 16.4 per cent. To reach that level, Kyocera adopts a structure that inhibits light reflection to improve the conversion efficiency 0.5 per cent. The thick electrode raises the current value for a 0.3 per cent improvement in conversion efficiency. Previously, Sharp attained a 17.1 per cent conversion efficiency with its 10 cm^2 polycrystal silicon solar cell. Kyocera's cell measures 15 x 15 cm x 270 µm, provides a maximum output power of 3.7 W and optimum voltage of 0.502 V, features 7.37 A optimum current and has an open voltage of 0.611 V. (Source: *AEU*, May 1992)

New circuit quickly updates handwritten images

Researchers at a NY State University (Buffalo) Center for Excellence have copyrighted an integrated circuit design capable of reading handwritten images well enough to update information in under 50 nanoseconds. The chip could lead to the development of an image-processing system advanced enough to allow the US Post Office (which funded the development work) to sort hand-addressed letters by machine. (Source: *Computerworld*, 1 June 1992)

Marketing of 1.5 V dry cells begins

Featuring long life, light weight, excellent power and a non-polluting composition compared with R6P manganese or alkaline dry cells, an R6P lithium dry cell battery is on the market. Fuji Photo Film sells the battery for Y400. In equipment such as an 8 mm camcorder, the battery's life is nine times longer than a manganese dry cell and three times as long as an alkaline dry cell. The 14.6 g battery is one third the weight of an alkaline dry cell and stores for more than ten years with very little discharge. The unit exhibits outstanding power in low temperatures. (Source: *AEU*, May 1992)

Novel light bulb

Intersource Technologies has developed a light bulb that uses high-frequency radio waves instead of a filament to generate light. The bulb would be more energy efficient than existing bulbs, and could last 14 years in normal household use of 4 hours/day. A 25-watt version of the new bulb would give of as much light as a 100-watt incandescent bulb, but would cost only 9 cents/week to buy and operate, as against 30 cents/week for the incandescent. Most incandescents last 750-1,000 hours. The new bulb would last 20,000 hours. Compact fluorescents last 7,000-10,000 hours. The new bulb will be available in 1993. First applications will be in spotlights or commercial applications where changing the bulb is a major expense. A version for home use will be introduced somewhat later. The E-Lamp (for electronic lamp) will cost $12-15 apiece initially, but volume production could reduce this cost. The lamp was developed in cooperation with American Electric Power (Columbus, Ohio), the second largest electric utility company in the US.

The E-Lamp works by generating radio waves that excite gases in the bulb. The gases give off electromagnetic waves that strike a phosphor coating on the inside of the glass, producing visible light. The new bulb can be used with dimmer switches, unlike compact

fluorescents. It can be used in any light socket, and can even be used outside. It will come on or off in less than one second, with no flicker. Karl F. Johnson of the Electric Power Research Institute says that previous efforts along this line have been unsuccessful in preventing the radio waves from leaking out of the bulb, so if the E-Lamp has solved this problem (as claimed), it is a major advance. (Extracted from *New York Times*, 1 June 1992)

V. SOFTWARE

New UNDP computer system offers external aid information

The Development Cooperation Analysis System (DCAS) is a new software package developed for UNDP field offices. DCAS stores information on all external assistance activities in countries where UNDP is present. The main objective of DCAS is to provide aid information to the development community in each country, particularly to governments and to bilateral, multilateral and non-governmental donors.

The data can be used for many purposes including aid mobilization and coordination meetings, sector-specific studies and programming and evaluation missions. The information on annual development assistance disbursements can be extracted in a variety of categories such as sector, type of assistance, donor, and beneficiary institution. The computerized system also provides detailed inventories of ongoing projects and proposed projects in each country.

The information from DCAS is the data used for the annual UNDP Development Cooperation Reports (DCRS). These published documents are issued in the second half of each year for every country where UNDP is active. The DCRs list all externally financed projects in the country and give summary tables on all flows of Official Development Assistance and aid from external non-governmental organizations. These are the only publications in the world containing detailed data on total external assistance flows to a country.

For information about DCRs and DCAS in general, please contact: Chief, Documentation and Statistics Office, Bureau for Programme Policy and Evaluation, UNDP-20th floor, 1 United Nations Plaza, New York, NY 10017, USA. To obtain individual developing country data, please contact the UNDP Resident Representative in the capital city of the country of interest to you. (Source: *UNDP Update*, Vol. 5, No. 21, 19 October 1992)

Database on expertise in electronic information services

The European Commission is compiling a database of expertise in the area of information services and information technology. To be known as the Experts Guide, this directory of names, addresses, contact coordinates and areas of specialization will be used not only for internal use by the Commission in the context of calls for tenders, but also as a means of informing the market at large about available experts in specific fields.

A detailed classification scheme has been adopted for compiling the database, which enables organizations and individuals to identify the categories in which they are proficient.

The database is expected to be available online from the middle of 1992. For information, contact: Axel Szauer, CEC DGXIII/B, L-2920 Luxembourg. TP+352/4301 3526; Fax+352/4301 2847. (Source: *XIII Magazine, News Review*, Issue No. 1, 1992)

Development activities CD-ROM published

Sharing information about their activities is likely to mean that development agencies can improve the effectiveness of their contributions to economic and social development. In a collaborative effort with other development organizations, Canada's International Development Research Centre (IDRC) has produced the first edition of a CD-ROM that could provide a forum for development information exchange.

The Development Activity Information (DAI) CD-ROM contains information on development activities run by United Nations agencies, other international organizations and bilateral donors.

One component of the disc is the data contributed by ACCIS, which was derived from the *Register of development activities of the United Nations system*. The *Register* reports annually on approximately 24,000 development activities of the United Nations, its specialized agencies, and the IAEA.

The CD-ROM project originated from a 1991 meeting of the Informal Study Group on the Exchange of Development Information. The Study Group, an informal association of organizations in the development community, was formed to encourage close cooperation between donor agencies in order to prevent duplication of effort and waste of resources.

A Common Exchange Format for Development Activity Information (CEFDA) was designed to be used by organizations contributing data for use on the CD-ROM. This first prototype edition of the CD-ROM is designed to evaluate the practicality of distributing development activity information on CD-ROM and in the CEFDA format.

Data was contributed by 11 organizations, representing the development activities of more than 230 funding agencies working in the field of international

development. They are: ACCIS; the Canadian International Development Agency; the Export-Import Bank of Korea; the Inter-American Development Bank; the International Centre for Ocean Development; IDRC; the Japan International Cooperation Agency (JICA); Kreditanstalt für Wiederaufbau (the German Federal Government's development bank); the Organization for Economic Cooperation and Development (OECD); the Special Programme for African Agricultural Research (SPAAR) and the United States Agency for International Development (USAID).

The DAI CD-ROM comes complete with its own software. For more information, contact: Mary Campbell, Coordinating Unit for the Exchange of Development Activity Information, International Development Research Centre, PO Box 8500, Ottawa, Canada, K1G 3H9. Tel: +613 236 6163; Fax: +613 238 7230. (Source: *ACCIS Newsletter*, 10(3), September 1992, p. 3)

Pesticides database

A project to expand a database on pesticides and the environment has been approved by the European Community. The project document was developed jointly by ARSAP (Agricultural Requisites Scheme for Asia and the Pacific), part of the UN's Economic and Social Commission for Asia and the Pacific, and the French International Cooperation Centre of Agricultural Research for Development (CIRAD).

The objective of the project is to expand the database begun by ARSAP on pesticides used in the region, their effects on humans, animals and the environment in general. In its first phase, the project will concentrate on the six member countries of ASEAN.

The project will bring together European experts on pesticide poisoning and medical, veterinary and environmental protection authorities from ASEAN countries to compare and adjust findings on pesticide effects under different climatic conditions.

As a result of this cooperation, a database is expected to be established that gives medical and veterinary centres, departments of agriculture and environmental agencies access to information on pesticides, their effects and recommended countermeasures in cases of poisoning. (Source: *Agro-chemicals News in Brief*, April-June 1992)

Speaking the same language

After creating a program for the Apple Macintosh, software writers often spend months rewriting it for IBM-compatible PCs - and vice versa. A way out of this expensive tedium now seems to be offered by Apple Computer Inc., and software maker Symantec Corp.

The two companies have been working on Bedrock, a programming system due to hit the marketplace in early 1993. It will let engineers create a program once that will work on the Macintosh and with Microsoft's Windows NT.

Bedrock's power stems from a set of more than 150 prewritten chunks, or "objects" of software, that work on many different brands of computer. They will perform frequently used functions such as scrolling text. If the system works as advertised, software developers' programs will be relatively small, simply calling the necessary objects into play as needed. (Source: *Business Week*, 13 July 1992)

Evaluating software for information storage and retrieval

The Netherlands Association of Users of Online Information Systems (VOGIN) recently conducted a software evaluation project, in the course of which the following categories of microcomputer software for information storage and retrieval were distinguished and characterized:

- Classical retrieval systems;
- End-user software;
- Indexing programs;
- Full-text retrieval programs; and
- Personal information managers.

The project also examined the special retrieval techniques of hypertext and best-match searching. The text included approximately 20 programs, including UNESCO's CDS/ISIS.

Results of the project are published, in three parts, in *Electronic Library* (ISSN 0264-0473); part 1, Vol. 9, No. 3, June 1991, pp. 145-153; part 2, Vol. 9, No. 6, December 1991, pp. 301-317; part 3, Vol. 10, No. 1, February 1992, pp. 5-19. (Source: *ACCIS Newsletter*, 10(3), September 1992, p. 5)

Fractal mathematics for HDTV signals

Iterated Systems has received a $2 million grant to develop a chip to use fractal mathematics to encode and decode HDTV signals from the National Institute of Standards and Technology (NIST). The FCC, however, has set a deadline of 1993 to decide on which of five competing HDTV technologies it will authorize for use in the US. Switching to fractal data compression would delay this decision. All the technologies now being considered use discrete cosine transform (DCT) to compress data. DCT is also used to compress images on video on computers and compact discs. Fractal transformation is being used in some applications by Microsoft and Racal Radio. (Extracted from *New Scientist*, 6 June 1992)

Graphical interface for the blind

IBM will soon introduce a new type of software that allows blind users to make use of the graphical user interface included with the OS/2 operating system. The graphical interface lets users issue commands to the computer by using a mouse device instead of typing in the commands. Blind users were formerly unable to use a "mouse", but the new Screen Reader/2 program will include a special Braille-based keypad. The software reads aloud the messages that appear on the screen as the user moves a highlighted bar up and down. (Extracted from *New York Times*, 22 June 1992)

Satellite accelerates early warning system

The Food and Agriculture Organization (FAO) is speeding up the flow of early warning data from its headquarters in Rome to beleaguered African agriculturists. For several years now FAO has been monitoring crop prospects in Africa with two satellites - Meteosat and Noah - that cover most of Africa and parts of Asia. The system, called ARTEMIS, which stands for Africa Real Time Environmental Monitoring Information System, receives information about the condition of crops and weather prospects and feeds it back to FAO headquarters in Rome for processing and analysis.

Because of continuing unstable climatic conditions throughout much of Africa, FAO sought to overcome the critical delay in getting the information from FAO in Rome back down to the affected countries so action could be taken in time.

FAO has now implemented a satellite telecommunications system known as DIANA (Direct Information Access Network for Africa), which makes use of a satellite to connect FAO in Rome with its regional centres in Africa.

The DIANA system will make it possible to transmit the high volumes of data from a micro-computer terminal at FAO headquarters to microcomputer terminals in Nairobi, Harare and Accra within a matter of minutes. At present, using a conventional system, it takes between 10 and 20 days to get the information down to regional and national levels.

The advantage of the DIANA system is that national Governments and regional organizations can now very rapidly be informed of climate trends that affect agricultural and livestock production.

Thus, in December, four months ahead of the normal harvest, FAO was able to predict the current disastrous drought in southern Africa, which is now spreading to eastern Africa. Early indications of crop failure were confirmed in January and February, but on the basis of the ARTEMIS data, analysts were able to build up a detailed forecast during January of how widespread the drought was and at what level it would hit the agricultural economies of the countries.

FAO hopes to extend ARTEMIS to the whole of Asia, parts of China and South America, thereby allowing it soon to be able to monitor the food situation across the world. (Source: *Development Forum*, September/October 1992)

Cheque-recognition system for banks

The most revolutionary technology in banking since the introduction three decades ago of magnetic ink character recognition (MICR), which laid the basis for high-speed cheque processing, may finally be coming of age.

IBM, which has been working with a group of nearly 20 banks for the past five years, says it is ready to introduce a cheque-recognition system that can read the handwritten amount on at least half of all cheques - an industry benchmark for minimal acceptance.

Today, most cheques are run through an MICR reader that sorts them at high speeds, but the dollar amounts on each item must then be encoded by hand. The big banks are hungry for a cheque-recognition system that would allow them to automate what is still a highly labour-intensive process and thereby sharply pare their workforces. For the past decade or so, building a technology that can read the dollar amount on a cheque has become something akin to banking's Holy Grail - much desired and sought after but impossible to find.

Current technology can record the visual image of a cheque for later display but cannot read the dollar value, or "courtesy amount", of the cheque. (Extracted from *Information Week*, 14 September 1992)

NSL speeds data access

US researchers hope to break the data bottleneck that slows computer performance by overhauling the way data is stored.

A new model for data interaction on large computer networks is being developed as part of the three-year effort by the National Storage Laboratory (NSL), which combines teams from leading research institutions and major companies, including IBM and Ampex.

The aim is to increase the speed at which workers can get at stored data, by as much as 50 per cent, while making storage systems ten times less expensive, which amounts to savings of "hundreds of thousands of dollars", officials say.

Retrieving large files using the current approach can take hours because of the way data moves through

the system. A supercomputer user sitting at a workstation, for example, typically requests data or files from a file server, usually a mainframe computer. The server fetches the file from a storage device, and routes it back to the user's workstation.

In contrast, the NSL model recasts the server from its role as a data "turnstile" to a master control switch. Data will then travel directly between storage devices to computers on a high-speed network, allowing the mainframe to be replaced with a less costly workstation.

High-performance computer systems, from workstations to supercomputers, are set to benefit first from this research, although participants say that the scheme will provide technology that will eventually benefit the rest of the commercial sector. (Source: *Electronics Weekly*, 7 October 1992)

Moving data mountains made easy

Computers are now part of the fabric of our society, and many people find themselves having to move enormous files of data from one computer to another. But transferring files any bigger than the largest capacity floppy disc becomes tedious. In the past year, an American hard disc manufacturer has perfected a 2.5 inch hard disc drive and Jilutech has bundled it into a small black box complete with a rechargeable battery and necessary electronics. The whole thing measures 12.5 centimetres square and 4 centimetres deep, about the size of a personal stereo.

The Jilutech Drive 25 plugs into the back of any PC and is very easy to set up. It comes in storage capacities ranging from 21 megabytes to a huge 130 megabytes. The 21 megabyte version costs £295, and takes a lot of the pain out of backing up and transferring copious amounts of data. It is also a useful addition to any laptop computer without a hard disc drive. Further information from Jilutech, 23 Metro Centre, Brittania Way, Park Royal, London NW10 7PE. Tel.: 081 965-9494. (This first appeared in *New Scientist*, London, 29 August 1992, the weekly review of science and technology.)

Advanced software project

Sun Microsystems will jointly develop advanced software for use in its workstations with a team of Russian computer experts. The agreement follows a joint research project with Russian researchers that led to the formation of the Moscow Center for Sparc Technology research centre. Sparc is the microprocessor chip technology on which Sun's workstations are based. The new agreement, with Sun's Sunpro subsidiary, involves 33 Russian software engineers, including computer designer Dr. Boris Babayan, who is known as the father of supercomputing in the former USSR. The scientists said that while significant progress had been made, various obstacles, including US export control regulations and high Russian taxes, are still hampering the operation. (Extracted from *New York Times*, 2 September 1992)

Digitizing information

The conversion of all sorts of information to digital bits that can be manipulated by computers will change lifestyles and industries, particularly computer, consumer electronics, entertainment and information businesses. Local phone companies, cable-TV networks, direct-satellite broadcasts, cellular-phone companies, utilities, publishers and movie studios will all be affected by digitization. To fully develop the technology, certain technical and marketing barriers must first be cleared. For one, there is yet no standard format for digitizing and manipulating data. There are also basic questions as to who the customer base will be, by what date and at what price. At home, the digital revolution will result in such things as interactive television, flat-panel displays that can show artworks or photos, personal digital assistants that act as electronic diaries and also communicate with computers and fax machines from any location, surround-sound stereo systems, home computers that can read handwriting or understand verbal commands, videophones and remote control centres. (Extracted from *Business Week*, 7 September 1992)

Snake worms its way into reactor's heart

Software originally developed for the Apollo space programme is helping a multi-jointed arm called the Snake to check crucial welds in one of the world's oldest civil nuclear reactors.

The software has allowed engineers to locate and remotely inspect welds on the two steel pressure vessels at the heart of the Bradwell power station on the south-east coast of England.

Engineers sit with their computer control system 10 metres above the top of the pressure vessel, watching on their screens a computer simulation of what is happening inside the pressure vessel. The software, initially developed for moon landings, helps them position the Snake and its probes with pinpoint accuracy. (Extracted from *New Scientist*, 15 August 1992)

BT takes the lead in dial-a-video technology

BT researchers are taking a lead in the development of new image processing technology which will enable users to dial up video pictures from databases holding over one million hours of video footage.

The project, which is being carried out in collaboration with the Massachusetts Institute of Technology, called image understanding, is still "ten years away from implementation and very blue sky research"

according to Mike Carr, head of video communications research at BT Laboratories.

The spread of affordable video telephony in the office and at home will require new video services. One service will be the accessing of video information from databases that could hold literally millions of hours of video footage.

The system under development, according to Carr, will be able to search such a database and select specific programmes, individual video frames and even parts of each video picture. (Source: *Electronics Weekly*, 9 September 1992)

Nuggets of information

Vast amounts of data are generated every day in a variety of areas including retailing, financial systems, and scientific applications. In 1989, it was estimated that there were five million databases in the world, ranging from small microcomputer applications to large-scale distributed databases used by multinational companies and government departments.

Moreover, the number of databases is estimated to double every 20 months. These data are being recognized as a valuable resource if only the useful knowledge that is embedded within it can be extracted. Electronic point-of-sale information, for example, has brought dramatic improvements in productivity and efficiency to the retail checkout while generating information that can be exploited to aid business performance at a higher level.

Data mining involves the application of artificial intelligence, genetic algorithm and neural networks to discover patterns and regularities that are concealed in company databases. Applications include discovering rules to classify consumer spending patterns and finding patterns that can be used to predict stock market movements.

The move to scanning prices from bar-codes in supermarkets and other retail outlets is established and gathering momentum. Querying the accumulated data in attempts to discover buying patterns or make stocking decisions demands significant resources.

However, as the ratio of disk space to cost increases, greater amounts of this historical data will be available, allowing these buying patterns and stocking decisions to be made with far greater accuracy. A trivial example is finding that people buy items such as wine and cheese on the same food bill. By placing wine and cheese close together, people can be encouraged to buy one when they buy the other, even if they had not done so before. In this way, trends in buying habits are exploited, and the organization of shelf space is optimized to sell more goods.

The data accumulated permits far stronger analyses than this - providing detailed information of individual products on a store-by-store basis over different periods of time, so that demographic and seasonal variations in these trends can be discovered, and solutions tailored to accommodate them.

A neural network can be trained to recognize patterns from an historical database of customer information, for example, and customer responses predicted. The trained network can then be used to select individual customers who are likely to respond positively to particular marketing campaigns. The main barrier to overcome for effective data mining is the problem of selecting the most responsive customers. Although companies may maintain marketing databases, detailed information about customers may only be available for a small percentage of the base. The records for some customers may not contain details of age, marital status and other important marketing information.

Greater accuracy can be achieved by using a limited number of complete records obtained through surveys, for example, relationships between variables can be discovered and used to interpolate the relevant information across the entire database.

Moreover, not only can the most responsive customers be picked, but other groups of best-risk customers for credit and insurance can be identified. While neural networks offer one route to data mining, it can be very difficult to understand the reasoning that is going on.

Much of the knowledge that can be discovered is strongly structured, but neural networks do not reveal this. Other artificial intelligence approaches can provide the visibility of reasoning that shows the structure in the data and may consequently give a better view of the reasoning process. (Extracted from *Computing*, 22 October 1992)

Reinforced Windows

By the end of the year Microsoft will have launched a new operating system called Windows NT. Although not designed to replace DOS or the current DOS-based version of Windows, at least in the short term, Microsoft is pitching it as "the operating system for the 1990s" and the next step is evolution of the microcomputer. Operating system OS/2 is powerful, useful, does most of what is claimed for it, and may have a respectable future.

Two main versions of Windows NT are supplied on a pre-release version CD-ROM: one for Intel-based PCs and the other for ACE specification machines built around the Mips RS4000. A key feature is its design as a portable operating system that can be carried over to a

new processor with the minimum rewriting of code. The NT installed on a CompuAdd 450 uses a 50 MHz 486 processor. The CD-ROM player used was a Pioneer DRM-600, which has the advantage of handling a cartridge containing a six CD-ROM disc as if each is a separate drive. The adaptor card to connect the CD-ROM was an Adaptec 1540 SCSI. The software will run on any 386 or higher processor, but a 486 processor is preferable.

A system that runs NT can also be preloaded with DOS or Unix. The NT installation can set up the system with a short initiating sequence which, when switched on, asks you whether you want to run NT or the alternative operating system. On choosing NT a short loading sequence scrolls technical messages up the screen as the various NT layers are slotted into place. Then the screen clears and the messages are replaced with the same bit-map "wallpaper" used by Windows for DOS. A prompt invites you to hit Control-Alt-Del in order to bring up the sign-on screen. The point of using this particular key sequence which causes a reboot under DOS and closes down the current application under Windows for DOS is that it would be relatively easy for a casual programmer to create a DOS or Windows program that looked like the Windows NT sign-on screen, but collect user names and passwords into a secret file before passing them on to NT and opening the operating system. Inspection of the secret file would then allow unauthorized entry. By insisting on the Control-Alt-Del key combination the Windows NT sign-on offers some security against this kind of trickery. A program designed to fool the user like this is called a "Trojan" after the horse of the same name. In a sense Windows NT itself is a kind of "Trojan" - a way for Microsoft to smuggle in a new, very different and much more powerful operating system under the guise of the familiar Windows front end.

The marketing message is that there is only one environment called "Windows" which is scalable across a range of hardware from small palm-top machines to high-end workstations and servers. But internally Windows NT is as different from Windows for DOS as it is possible to imagine. Its closest relative on the desktop is OS/2.

The greatly enhanced power of the NT operating system should allow Microsoft to do much more with the user interface. NT has a theoretical memory capacity of four gigabytes of RAM, and can handle a virtually unlimited amount of hard disk and optical storage. Windows NT allows you to call up a "DOS box", which offers the DOS operating system command line and runs DOS applications. The NT version of the DOS box can either be shown in a window which can be resized or occupy the whole screen. But the NT DOS box is not actually DOS; it is a sophisticated 32-bit server subsystem that emulates DOS and uses the same command line syntax. In fact it behaves more like the command line interface to NT, equivalent to the character-based command line interface of OS/2. Within this richer environment it is possible for users to launch Windows, OS/2 or NT applications directly. The final version of Windows NT should also be able to launch POSIX-compliant programs directly from this command line. POSIX stands for portable operating system interface for Unix, and is an international standard designed to ensure compatibility between versions of Unix-like operating systems. The NT DOS boxes cannot be individually adapted, whereas OS/2 lets its DOS sessions emulate various versions of DOS and be tailored in a dozen other ways to suit the applications you need to run. Whether this means that NT's DOS emulation will not be able to cope with certain DOS applications is difficult to judge until a final version is available on the market. Until 32-bit applications written especially for NT begin to appear, users should be able to run all their existing 16-bit Windows and DOS applications with no change. Versions had a bit of trouble running some of the DOS and Windows applications, particularly those like LapLink Professional that have to communicate with the outside world. There were also some problems with Lotus 1-2-3 for Windows, which appeared to run normally but presented dialogue boxes that did not respond to the mouse or keystrokes. However, minor problems like this are only to be expected with early software versions. Experiments which ran Microsoft's own application software, Excel and Word for Windows, worked without a hitch.

Conclusion

The Windows NT operating system is still in development, but this early version is certainly encouraging. It is a major venture for Microsoft, and the first operating system that the company has developed using solely its own resources. Customers who use the operating system over the next few years will be relying on it for vital computing activities, so it will need to fulfil all its promises of security and reliability. Microsoft has already pulled off a remarkable coup in moving more than 10 million customers from DOS to Windows. However, the change was largely cosmetic and DOS stayed behind the mask. It is trying to reverse the trick with Windows NT: although the mask is the same, the underlying operating system is radically different. This presents a technical challenge to the designers (which they show every sign of being able to solve) but protects customers from revolutionary change. If this migration is successful, Windows NT offers almost limitless room for evolution. (Source: *Which Computer*, September 1992, pp. 58 and 61)

Fuzzy logic and data retrieval

One drawback to our ability to gather and store masses of data on systems is that accessing only relevant items for specific queries is not only time-consuming but also a drain on back office database engine power. The cost of searching for such data goes hand-in-hand with

the length of the search and the subsequent sorting process.

So if IT managers could speed up search time and limit back-end engine data manipulation, then they would save money and get their management reports done in time for that vital boardroom presentation. One development which is helping to speed up and enhance database searches is fuzzy logic, which was first incorporated into chipsets in microwave ovens, dishwashers and vacuum cleaners.

Fuzzy logic is a rule-based system for specifying variables that are by nature indistinct and are best represented within an agreed range, rather than by precise individual numerical values. It emerged largely from the work of a California-based Iranian, Professor Zadah, in the late 1950s.

"Fuzziness" describes the degree of difference in a description of, say, what constitutes hot or cold, just as a pain threshold will differ from person to person - for example, two people tapped by a rubber hammer might differ in their description of the level of pain they experience, but both would probably agree on the level of pain felt after a similar blow from a monkey-wrench.

The rules governing action are represented as a series of probabilities, and a computer than acts on a codified fuzzy logic method based on them.

The exposure control on an automatic camera, for instance, can assess picture content, gathering data on the fuzzy variables, programming the exposure to reflect, say, the "bright" snow and "dark" figures, calculating the number of pixels (minute units that make up the picture on a cathode-ray tube) involved at different exposure levels. It aims to mimic in logic what an expert would choose looking at the same scene given the same camera. Where a rule-of-thumb, rather than a rule of mathematics applies, fuzzy logic can assist the designer and programmer to produce devices and systems with pseudo-human responses.

So how great is the IT manager's problem of accessing specific data cost-effectively? Today's relational database management systems (RDBMS) are asked to tackle a wide range of applications, from on-line transaction processing, such as payroll, to ad hoc management inquiries. This is common to most corporations with staff to manage and products or services to market.

The trend towards open systems has exacerbated the problem of designing a satisfactory client server architecture, and the situation has been made even worse by the recession, which has caused employers to cut the numbers of their skilled staff to a minimum.

The result in many organizations is that the back office database engine lacks skilled support, and lengthy sessions such as invoicing are constantly interrupted by ad hoc inquiries. The solution prior to fuzzy logic was to encode a database exclusively into numerics, so speeding up operations. But the problem with this is that most users want inquiries back in text. The translation from numerics at the user end simply slows things down again.

One supplier which has moved on from the numerical solution to embrace fuzzy logic technology is ICL. The company has re-engineered its mainframe database engine to run under Unix. Its Scafs RDBMS accelerator uses fuzzy logic to intercept the mass of data pulled off a disk to answer an inquiry, after which it discards irrelevant data and passes back through the processor the small percentage of relevant information. This process reduces back-end engine data manipulation by over 95 per cent and the data stays in alphanumeric form.

Initially Scafs is available on the DRS6000 and DRS3000, but ICL is currently in discussions with other manufacturers in an effort to make it vendor-independent technology. An extension of fuzzy searching currently under development at ICL is fuzzy image searching. This is where actual stored images are examined, not just their descriptive file names. This means that pictures containing specific characteristics are traceable.

Neural networks are more suitable for advanced pattern recognition tasks, such as handwriting identification and forecasting. However, in mimicking the brain they do not show how they arrived at their conclusion, just as we may recognize a face but cannot say exactly how we do it.

A sister concept of fuzzy logic, constraint-based programming, is also making headway in applications. For example, at Charles de Gaulle airport, a real-time aircraft scheduling application, Apache, allocates aircraft to particular gates. By giving a value to one variable, such as a plane to a specific gate, it limits the values for other variables - no other plane can use that gate for the present.

This type of programming is ideal for production line activities such as building cars. Other applications include locating warehouses for optimum distribution and assigning missile launchers to attacking planes.

So, after being popularized by the Japanese in domestic appliances, fuzzy logic technology looks set to break ground in regular computing applications. Some would say that there are programmers who have been employing the technique for years. (Source: *Computer Weekly*, 25 June 1992)

Getting results from simulation

Checking that a hardware design does what it is supposed to do is a notoriously difficult job.

Academics have worked hard on developing formal methods for "proving" a design, such as theorem proving and state machine equivalence, but so far no usable tools have emerged. In any case, formal verification merely proves the design agrees with the specification. More often than not the problem lies in the specification itself.

Software simulation is the only practical solution at present. But browsing through simulation results can be enormously time-consuming.

A DAC paper by Benoit Gennart of NTT's LSI laboratories in Japan and David Luckham of Stanford University, shortlisted for a DAC award, suggests a way out of the dilemma. They have come up with a new simulation methodology that helps a designer handle the complexity of simulation results, speed up the validation of a simulation and cut error detection time.

The technique, called Event Pattern Mapping, involves structuring the results from a simulation into a series of hierarchies, where each simulation event in a higher level maps to a series of events in the level below. Levels of hierarchy are built up one upon the other, until the top level contains a small enough number of events to handle with ease.

With the simulation results structured in this way, tracing errors is simply a matter of looking for faults in the top level and then tracing them down through intermediate levels to the lowest simulation level. This is a much simpler and faster job than hunting through the low-level simulation results for errors.

Event pattern mappings can handle synchronous as well as asynchronous behaviour (unlike comparative simulation techniques), they work equally well from gate level up to any level of abstraction and as a side benefit they form a formal documentation of the entire design process, structured in a way that makes the specification much easier to read. A big bonus for the hard-pressed design engineer is that the technique requires no change in design methodology. It just automates part of the normal simulation-based validation process.

Gennart and Luckham have developed a language called VAL+ to define event pattern mappings in simulation results. VAL+ is an annotation language for the VHDL hardware description language, which is rapidly establishing itself as the standard in digital design. Using VAL+ the designer specifies sets of event patterns, allocating to each set a higher-level mapping consisting of a name and a set of parameters. These VAL+ annotations are inserted into the VHDL specification as formal comments, preceded by the symbol - -|.

The next step is to detect all the occurrences of each pattern in the low-level simulation, and in each case generate the corresponding higher-level mapping, with the correct parameter values. The set of higher-level mappings form a new, high-level simulation. The high-level mappings are appended to the original simulation, without modifying any of the original events in the process.

Gennart and Luckham have written a clever algorithm to do this pattern recognition and mapping generation. For a hierarchical VHDL specification, the debugger starts from the bottom level, looking for patterns of events and replacing them with their mappings to generate a higher-level simulation. The algorithm then moves up one level at a time, repeating the process at each stage. Mappings generated from lower level patterns form new events in the higher level which the algorithm then studies looking for patterns to create higher-still mappings.

According to Gennart and Luckham, moving up each level of abstraction cuts the number of events by a factor of about ten. In a real test carried out by the two researchers, a 10,000-event gate-level simulation was reduced in three stages of mapping to a five-event instruction-level simulation.

It is a simple matter to check the correctness of this high-level simulation, and hence the low-level simulation underneath. Any errors in the top level can be traced quickly through the hierarchy to errors in the lowest level. The hierarchical structure eliminates most of the simulation from the error search. (Source: *Electronics Weekly*, 10 June 1992)

VI. COUNTRY REPORTS

European Community

New Eureka project will boost European GaAs work

All of the seven European producers of GaAs devices have expressed strong interest in a new Eureka initiative that is designed to promote European work on gallium arsenide. This initiative, which was approved for funding from the European Commission (EC) at a Eureka Ministerial Conference at Tampere in Finland in May 1992, is the result of detailed talks between the participating companies and a working party of government officials from the UK, France, Germany, the Netherlands and Italy, as well as from the EC. A total funding of between $27 and $37 million per year will be required from the participants, their respective governments, and the EC.

The work is to be led by GEC Marconi Materials Technology Ltd. of Caswell, Northamptonshire, England. The other participants are Daimler Benz and Siemens in Germany, Thomson TCM in France, Philips Microwave in the UK and France, and Alcatel Telettra and Alenia in Italy.

The discussions, which also took into account user views, held last year, were initiated by a report commissioned by the British Government's Department of Trade and Industry on the technical and commercial capabilities of the European gallium arsenide electronics companies. This report argued that GaAs, with its distinct advantages over silicon in a number of areas, is likely to form the basis of many highly specialized components in a range of applications ranging from personnel communications to collision warning products.

The Eureka project is aimed at identifying a number of perceived weaknesses within the European industry and at improving links between equipment, materials and user companies. (Reprinted with permission from *Semiconductor International Magazine*, August 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL, USA)

EC boosts R&D IT budget

The European Commission is to more than double its research spending between 1994 and 1998, giving a substantial boost to computer projects. Approval has been given for a Fourth Framework budget of 14.7 billion Ecus, compared with the 7.5 billion Ecus being spent between 1990 and 1994. (Source: *Computer Weekly*, 8 October 1992)

R&D programmes proposed by the EC Research Commission

1. **Key elements for information technology systems:** to enable European industry to produce and use electronic systems competitively. This programme will bring together key component technologies (CMOS), system elements (microprocessors and microsystems) and basic IT research.

2. **Software engineering and best practice:** to support the development of productivity-enhancing software methods and tools and ensure the best use of these methods and tools by users, who account for 70 per cent of all software produced.

3. **High-performance computing and networking:** to meet the increasingly demanding user requirements.

4. **Image technologies:** to advance the chain of technologies required to improve the process of digitizing images for several types of applications - such as high-definition television, office, automotive and avionics - and integrating the applications with other media.

5. **Electronic networks and linguistics:** to facilitate the flow of information among entities providing services of public interest.

6. **Information and communication-based techniques (ICT) support for function integration in manufacturing:** to develop advanced ICT, tools and equipment having a broad applicability across a range of industrial sectors.

7. **Advanced communications:** to develop flexible and robust network services allowing ease of use, multi-standard support and low costs.

8. **Information exchange between administrations:** to fulfil the needs of information interchange among administrations, firms and the public at large.

9. **Technologies for integrated and optimized transport systems:** to sustain mobility of freight and passengers through the optimization of network exploration under the best environmental, energy-efficient and social conditions. (Source: *Electronics*, 26 October 1992)

France

French to make vacuum array displays

The French venture capital-backed group Pixel International is to commercialize field emission vacuum displays. The technology employs arrays of micron-sized vacuum devices manufactured in silicon to form flat panel colour displays. The technique was demonstrated some two years ago by the French Leti company, part of the French nuclear centre. Leti has been seeking a partner from Europe or from the Far East to develop the technology.

Pixel is led by Jean-Luc Grand-Clement, formerly chairman and chief executive officer of European Silicon Structures. It will develop the technology. The Pixel consortium is expected to make the displays in small volumes for prototyping and small quantity requirements and to license companies around the world for large volume production. (Reprinted with permission from *Semiconductor International Magazine*, September 1992. Copyright 1992 by Cahners Publishing Co., Des Plaines, IL, USA)

Germany

Semiconductor research boost

The German Government plans to fund a new semiconductor research centre in eastern Germany.

Under Bonn's scheme to retain several former East German research institutions, Bonn and the state of Brandenburg will provide a combined DM23 million to fund the Academy of Science near Berlin.

Research at the academy will focus on nano electronics in cooperation with work being done at other research centres in western Germany, including the German Research Federation and the Julich Research Institute. (Source: *Electronics*, 28 September 1992)

Greece

STET to create cellular networks

Italian telecommunications provider STET has the first of two concessions for the creation of cellular networks in Greece. The second will be a joint venture between a variety of European companies, including the Paris-based France Telecom; the London-based Vodaphone; the German-based Databank and the Athens-based Intrakom.

The new network will operate on the pan-European GSM (Global System for Mobile Communications) standard, which is to be the basis for all European cellular networks from 1993 on.

STET will face formidable difficulties in Greece, analysts say. (Source: *Electronics*, August 1992)

Hungary

Safe: on its guard

From the centre of breeding viruses, Hungary may be set on becoming the main virus destruction agency. Safe, a small start-up company in Budapest, claims that its Top Guard system not only protects against all known viruses, but will act against future infections as well.

The virus-busting system sits on an expansion card with its own RAM, and monitors the operation of the computer from the moment it is switched on, to ensure that viruses residing in the operating system are spotted as it boots. Placing the system on an expansion board isolates it from the PC, preventing any virus corrupting the virus killer itself. All operations are monitored for signs of known viruses - that includes common methodologies as well - so new viruses based on old tricks will be spotted.

Once a virus has been identified, the infection is isolated and prevented from multiplying. "The term virus killer is not really accurate as we do not kill it - simply prevent it from replicating," says Szagadi. "This allows the program to continue to run as normal, with the virus ineffective." The company is already exporting Top Guard to Germany and Switzerland, where it is selling well - at a price of around $250 (£148) including installation. (Source: *Computing*, 22 October 1992)

IQsoft: expert advice

Oracle's distributor in Hungary, IQsoft, is a spin-off from the Computer Research and Innovation Centre, SzKI, of the Karl Marx University in Budapest.

SzKI seems to be turning into an infant version of MIT, in its role in begetting high-technology companies. The essential difference is that, whereas in the West a high-tech company concentrates on its own goods, in the East it must also deal in more merchant produce to make enough money to survive.

IQsoft has taken over the marketing of one of SzKI's most successful products - Mprolog - a logical programming language that has been selling in 25 countries since the early 1980s. It has developed an expert system shell called Expert, originally devised for banks. One application offers advice to customers applying for mortgages, because it can assess many different loan options with many different conditions and rates.

"Expert systems are frozen worldwide, but we are expecting an export boom in the next decade, so we are looking for other areas where we can earn a living," says Dr. Julia Sipka, one of IQsoft's founders and sales director. "To survive we are importing software packages, localizing them and offering them with training and support." Oracle is an essential part of the strategy, not only forming a ready-made way of making money but also providing a basis for new products - including an information system to support brokering activities between banks, and electronic archiving systems based on the package. (Source: *Computing*, 22 October 1992)

Hungary for change

Hungary is one of the bright spots in the former Soviet empire, especially compared to its neighbours, Yugoslavia, Romania and Czechoslovakia. The country was designated one of the providers of IT under the old, centrally directed Comecon system, so it is less backward in computer science than those areas which were cut off from progress by the Iron Curtain.

The communist system failed to produce a viable computer industry, but it did produce first-rate programs, according to Attila Szabo of the computer bureau of the Hungarian Chamber of Commerce.

The old State system produced, for example, large numbers of programmers who became very proficient at getting the best out of inadequate hardware. Unfortunately, they also got bored and frustrated working for subsistence wages on unrewarding projects in a repressive atmosphere, and many turned to

developing what are generally credited as some of the most creative and lethal viruses in the PC world.

This dubious claim to fame is being turned to advantage by one of the new software start-ups. Safe was set up by Imre Szagadi two years ago to exploit Hungary's expertise in the area. Safe also sells a SCSI interface and a portable guard disk unit.

Szagadi originally developed the system to combat software bombs connected with blackmail attempts - a problem endemic in the decaying Hungarian economy, where the bosses knew nothing of computers. He reckons that around three or four viruses a month emanate from Hungary alone. They are sent out on bulletin boards and networks, he says. (Source: *Computing*, 22 October 1992)

India

Soft bytes and hard battles

The Indian information technology market is a buyers' market. Much of the buying is done by computer illiterates and the selling by marketers who treat computers like soap or chocolates. This is at the root of all difficulties and inadequacies that hound the Indian computer business - mediocre hardware, indifferent software and a general lack of quality-consciousness. The survey carried out by Business India attempted to analyse some of the cross-currents in the computer industry. The domestic hardware market is in a state of flux. Reduced government spending, high exchange rates, the Gulf War and the arrival of multinationals, including the re-entry of IBM, have contributed to a pervasive feeling of despair. By and large, the Indian commercial computing market has still not accepted mainframes, but this is changing slowly as applications demanding large-scale transaction processing - like on-line reservation systems and traffic control, railway wagon monitoring, stock exchange trading, retail banking and money transfers - necessarily require mainframes. Today, the Indian mainframe industry is unlikely to be able to meet this demand. The future of the hardware industry will be determined by collaborations between Indian manufacturers and the multinationals. (Extracted from *Business India*, 31 August - 13 September 1992, pp. 126-141)

Japan

Atomically sculptured materials in Japan

Two atomically sculptured materials that may have electronic applications will be investigated over the next three years by Japanese researchers.

The materials will be developed as part of four advanced materials research programmes that have been given funding for three years by Japan's Agency of Industrial Science and Technology in Tokyo - part of the MITI trade ministry.

One involves developing microscopically sculptured surfaces for future thin film superconductor materials and catalysts being developed by researchers at the National Chemical Laboratory for Industry in Osaka. The aim is to develop accurately controlled ultrafine particles, measuring just a few tens of atoms across, that can be used to help prepare highly controlled thin film materials.

The other programme involves developing a new "nano-composite" material based on the graphite form of carbon, which sandwiches atomic layers of graphite with other materials, either individual atoms, clusters of atoms or fine particles. The aim of this project, to be undertaken by the Government Industrial Research Institute in Osaka, is to generate a multi-layer graphite structure - with each layer a third of a nanometre thick. (Source: *Electronics Weekly*, 14 October 1992)

MITI launches programme to promote "green" technologies

Motivated by both necessity and the promise of profits, and fuelled by its desire to be seen as politically correct in the eyes of the world, Japan's Ministry of International Trade and Industry (MITI) is renewing its efforts to promote the development of environmentally sound and resource-efficient "green" technologies.

The new effort is scheduled to begin in 1993 with a research budget of $446 million. The Global Environmental Technology Programme will promote:

1. The Innovative R&D Programme, focusing on global warming and running until the year 2000 when it aims to stabilize per capita CO_2 emissions at 1990 levels;

2. The International Collaboration Programme for Large R&D Projects, a long-term programme (1993-2020) which will seek to restore the Earth over future decades by reducing greenhouse gases; and

3. The Cooperative R&D Programme on Appropriate Technologies (1993-2010) that will develop and assimilate appropriate technologies in neighbouring developing countries.

Examples of projects to be undertaken include dispersed battery power storage, ceramic gas turbines, superconductive electric power technologies, fuel cells, clean power, and CO_2 fixation, absorption and storage. (Extracted from *Electronics*, 28 September 1992)

New project to develop self-repairing machines

A five-year project aimed at developing machines that can repair themselves will soon be launched by the

Education Ministry. The project will be based at a new University of Tokyo facility called the Research into Artifacts Centre for Engineering. In the current fiscal year the Education Ministry will spend ¥180 million ($1.4 million) to help the centre obtain the necessary parts, production equipment and computer systems. Some 50 researchers - university personnel and non-university personnel - will be involved. They will be split up into nine groups, each of which will focus on a particular problem - micromachine production technologies, autonomous distributed intelligence systems, intelligent computer-aided design systems, etc.

Mita Industrial and Tokyo University researchers have already developed a self-repairing photocopier that incorporates a computer, various electrical systems and optical sensors. The computer can identify operational problems and adjust the functioning of the photocopier to compensate for damaged parts. It can also direct the replacement of those parts. (Extracted from *Nikkei Week*, 20 June 1992)

Korea, Republic of

New intellectual property rights legislation

The Semiconductor Chip Mask Design Protection Law is the latest in a long line of intellectual property rights protection legislation passed in Korea in the past six years. Similar legislation is already enforced in the USA, Japan and Europe. Database protection is likely to be next on the agenda.

From 1986, Korea passed and began enforcing laws governing copyright, computer programs and chemical compound protection. Most recently, early in 1992, they passed the Trade Secret Protection Law.

Noteworthy in the draft bill is the expanded scope of protection, which includes not only those chips using the design, but also the electronic products that use the chips. As a result, set makers who use semiconductor chips in their products are expected to pay royalties on semiconductor chip mask design. The new draft also provides a 10-year protection term and restrictions on the right of reverse engineering. (Extracted from *Electronics*, 28 September 1992)

VII. STANDARDIZATION AND LEGISLATION

Standardization

IBM to link standards for update of AD/Cycle

IBM is hoping to bring together two international computer-aided software engineering standards to support its revised AD/Cycle case strategy.

The company has chosen the European Portable Common Tools Environment (PCTE) as the central data repository for AD/Cycle. The repository is the hub of AD/Cycle into which third-party suppliers plug proprietary case tools. PCTE is primarily a vendor-independent data repository and lacks the in-built information model needed to exchange data between the different tools.

IBM will announce plans to link PCTE with the Case Data Interchange Format (CDIF), a US-based initiative which tackles the data integration problem, using software from UK developer Software One.

Software One's Exchange case gateway product will be embedded in PCTE and given an interface to the US group's format. AD/Cycle-compliant tool vendors will be able to link into PCTE and CDIF without reconfiguring their tools. (Source: *Computing*, 20 August 1992)

US group aims ASCII alternative at Europe

A US consortium developing a standard to replace ASCII has turned its attention to Europe.

The Unicode consortium, formed by Microsoft and IBM-owned Metaphor Computer Systems, wants to capitalize on Eastern European markets with their different languages and alphabets.

Unicode will have up to 64,000 characters compared with the 172 offered by the 29-year-old ASCII standard.

Unicode has the backing of Novell, Apple, DEC, IBM, Sun, Hewlett-Packard and Unisys. But despite having a membership that spans the industry's largest hardware and software companies, the consortium does not have a date when Unicode will become the norm.

Unicode addresses modern 16- or 32-bit software and offers essential support for additional spoken languages and networking. Unicode expands the character set to which operating systems and applications have access, so allowing several languages, such as Latin, Greek, Hebrew, Arabic and Cyrillic, to be transparently supported when writing applications. (Source: *Computer Weekly*, 1 October 1992)

Big boost for ISO standards predicted

Internationally recognized standards from the ISO will double their share of the US computer market by 1996, according to a survey by Frost & Sullivan. The market research company predicts that by 1996 open systems products will make up 36 per cent of total sales (£49 billion) and exert a strong influence over

development in proprietary systems. It also predicts that ISO will gradually take over from functionally limited standards, such as TCP/IP, and that the use of "middleware", multilingual software that opens up proprietary systems, will become commonplace. (Source: *Computer Weekly*, 1 October 1992)

Software standard for parallel processing

Computer firms involved in parallel processing will attempt to develop standards so that software can be interchangeable. Meetings have been held in the US and Germany. Major areas that need to be standardized are how computers pass messages between processors and how memory is accessed, according to Tony Hey of the University of Southampton. The Genesis project in the EC has already developed software to control processor communication on a variety of computers. Hey says that the meetings have at least started major firms like IBM, Fujitsu and Cray discussing the problems. He thinks some major agreements can be reached within a year. Greg Wilson of the University of Edinburgh is less hopeful, and thinks that one of the major firms will simply dictate the standard to the rest of the industry. (Extracted from *New Scientist*, 9 May 1992)

European Commission EMC initiative

Like many things to do with the European Commission its EMC initiative is a bit of a dog's breakfast. It is late, the standards are not defined and support from member States is uncertain.

The EC's Directive on EMI (No. 89/336), originally intended to bring into operation standards for permissible levels of EMI emissions and for adequate immunity from EMI interference on 1 January 1992, has been put back to 1 January 1996. In the meantime, producers and sellers of electrical goods in the EC must either comply with whatever national EMC regulations are in force inside the country in which the goods are sold, or must conform to the EC standards set out in the Directive and carry the EC's mark of approval - "CE".

It is up to the manufacturer or importer to self-certify the goods he is placing on the market and to label them with the "CE" mark. Once they are approved by one EC country they are approved for every EC country.

If a piece of equipment is found not to comply with the standards then a country is obliged to "take all appropriate measures to withdraw the apparatus from the market". If a manufacturer has falsely certified non-compliant equipment then further action is allowed. Failure to comply is to be made a criminal offence.

EC countries have been given until the end of October 1992 to have the regulations in place to implement the Directive. However, Germany and Denmark are the only countries to have passed the EC regulations into domestic law. The UK is the only country to have said it aims to pass it into law by October 1992. All other EC countries are either still drafting legislation or have made no statement as to their intentions towards it.

At the moment, the EC has not defined the standards required to immunize equipment from EMI or prevent equipment from emitting EMI. Nor have any tests been defined to determine whether or not a piece of equipment meets EMC standards. All the Directive refers to are "acceptable" levels of emission and "adequate" levels of immunity.

European standards are supposed to be established with which manufacturers of electrical equipment will be able to show compliance by two means: either by manufacturing to the relevant standard or, where relevant standards have not yet been determined, by producing a "technical construction file", which describes the apparatus, sets out the procedures used to ensure that the apparatus conforms with the protection requirements and must include a technical report or certificate from a "competent body".

The body with the main responsibility for drawing up most of the standards is CENELEC, which has drawn up a hierarchy of standards: Generic, Product and Basic.

Generic Standards are the most comprehensive and apply where specific Product Standards have not been formulated. Product Standards will cover a specific type of apparatus (e.g. information technology equipment, medical equipment etc.) and will take precedence over Generic Standards. Basic Standards describe the details of test methods.

Manufacturers are required to give a functional description and definition of performance criteria established by EMC testing. To comply with the standard, the apparatus must continue to operate within those performance criteria. Manufacturers' test specifications have to be made available on request.

Once it has been established that the equipment does comply with the manufacturers' specification and all relevant European directives then the manufacturer can label the equipment with the "CE" mark.

It is hoped that test houses will become a source of expert knowledge and advice on EMC problems - able to advise on design to avoid EMC problems and able to diagnose sources of problems, suggest solutions and have to hand the relevant materials and tools to fix offending apparatus.

Complete texts of the 89/336 Directive and amendments have been published in the Official Journal

of the European Communities (No. L139 of 23 May 1989, pages 19-26 and L126 of 12 May 1992, page 11). (Source: *Electronics Weekly*, 30 September 1992)

Phone companies put standards to the test

International ISDN and videotelephone standards are to be given exhaustive testing in a nine-month live trial mounted by six European telecommunications network operators and a score of multinational user organizations.

Known as EVE-2 - the second phase of the European Videotelephone Experiment - the project involves the use of 100 desktop videoconference terminals sourced from ten British, German, Norwegian and French manufacturers.

The trial is intended to "reveal any rough edges in the CCITT H.320 group of recommendations". H.320 is an umbrella standard covering video telecoms processing and transmission. Its main objective is to ensure connectivity of terminals from different manufacturers.

Standards covered by H.320 are H.261, H.221 and H.242, which relate to the coding, decoding, control and synchronization of the video elements of a multi-media transmission, and three standards defining the audio path at various data rates: G.728, G.722 and G.711. It also refers to CCIR 601 which defines standards for broadcast quality digital television. (Extracted from *Electronics Weekly*, 14 October 1992)

Mobile phone standards

Mobile telephone makers could face the prospect of conflicting standards for the next generation of pocket telephone if the US Government is forced to abandon plans for personal communications systems (PCSs) in the 1.9GHZ band. A powerful microwave user group is lobbying Congress that the 1850-1990MHz was not suitable for the new mass market PCS services. This band has been the front runner for the US system, in part due to its similarity to the DCS1800 system being proposed in Europe. Despite plans by the authorities to accommodate existing uses of the band pressure is growing to look to higher frequencies for the PCS services which will be introduced by 1995. (Source: *Electronics Weekly*, 12 August 1992)

Legislation

EC copyright law

The UK Department of Trade and Industry (DTI) is set to substantially redraft proposed legislation on software protection.

The DTI is trying to clarify the complex terms of the controversial European Community (EC) directive. It wants to know what part of a software program or interface can be reverse engineered or decompiled.

The legislation is due to reach the statute book in January 1993 but critics say the DTI should leave well alone.

Concern is that in the UK draft the language of the directive has been rewritten and consequently the sense of important parts of the directive's text has been lost.

Bob Hay, chief executive of Federation Against Software Theft, argued that the issue of software decompilation is so technically complex and commercially sensitive that any rewording of the EC directive could introduce dangerous deviations.

The heart of the problem is that the controversial compromise on decompilation in the directive is considered to be ambiguous. National governments must choose either to copy the EC directive exactly, and repeat its ambiguity in national laws, or, like the DTI, try to clarify the ambiguity. Inevitably, this will introduce different interpretations of the directive across member States. (Extracted from *Computer Weekly*, 22 October 1992)

VIII. AUTOMATION

Robot checks nuclear reactors

A multi-footed pneumatically actuated robot designed to carry out safety checks inside nuclear reactors has been built by researchers at Portsmouth University (UK). Called Nero, the robot can cope with smooth and rough surfaces, carry a load greater than its own weight and also climb walls thanks to vacuum suckers integrated into its feet. (Source: *Electronics Weekly*, 14 October 1992)

Robot milkmaid

A fully automatic milking machine that cows could attend when they wanted would be a boon to farmers, and potentially a huge earner for its inventor. Compared to the cost of labour, it could be made profitable even for a herd of 60 cows. It is also important that the animals themselves benefit: cows that are milked more frequently produce more milk and are less susceptible to infection of the udder (mastitis). John Webster, professor of animal husbandry at the University of Bristol, also suggests that a system which cows attended voluntarily "would be better suited to the physiological needs and passing whims of the dairy cow".

For several years commercial companies and research institutes in Europe have been trying to automate the whole milking process. Much of the research has concentrated on developing methods of locating the cow's teats and attaching the cups using a sensor-guided robot arm.

But the difficulty for anyone designing a milking robot is that most industrial robots work on inanimate, rigid objects that have a defined shape, orientation and velocity; they usually blindly follow preprogrammed paths, grasp something well defined and move it to a predetermined location. However, animals are soft, and move and change their shape unpredictably. An effective robot needs to be "soft" too, but softness is not in great demand among industrially made robots. Spring-operated mechanisms on or near the gripping end offer one solution, while air-driven systems let the whole robot yield under excess forces.

With funding from the Agriculture and Food Research Council, the Silsoe Research Institute based near Bedford has developed a robot that uses pressurized air to control rapid response to movements. The prototype takes a maximum of 100 milliseconds to react to the cow's movement. Pressurized air is a very good medium for driving a low-cost system using simple cylinders and pistons, but makes exact positioning more difficult than for hydraulic or electrical systems. However, the components of the drive are cheaper; as a milking robot will inevitably suffer collisions and kicks, softness minimizes damage to both robot and cow, while careful design ensures that sensors are only an irritation to the cow. It is made of aluminium and stainless steel so that the system can be washed; the electronic systems are tightly sealed to withstand high-pressure cleaning needed for hygienic reasons.

In the Silsoe prototype, passive methods (such as the shape of the stall, with food at the front) encourage the cow to adopt a milking posture. Many cows now wear a transponder that identifies them, so the positions of the teats on the udder can be stored and retrieved using a database. A robot arm with a positional accuracy of ± 2 millimetres holds the cup, and when that is within 20 millimetres of a teat's estimated position, a local sensor comprising a matrix of light beams provides correction data - based on which beams are blocked off by the teat - to guide the cup directly beneath it. If the teat enters the cup, the suction of the milking machine ensures that it becomes attached. When all four cups are on, the robot withdraws. As attachment now takes just over 1 minute while milking takes 4 to 7 minutes, future robots could service more than one stall.

In a trial last November, the Silsoe system milked 10 cows three times a day for 12 days and achieved an 85 per cent attachment rate. Some industry sources reckon 90 per cent would be good enough for a commercial product.

Work has also begun on automatic techniques to inspect the udders for lesions or dirt, and if necessary to clean them or divert the cow to a "sickbay" for human attention. Software is being developed so the robot can identify and recover from situations such as the cow standing on the milking vacuum pipe. But mechanizing the complete process requires a knowledge both of engineering and of how cows behave. Experience so far suggests that cows have little fear of robots. In fact, they enter the milking stall more readily - probably for food - than they leave it.

Another benefit of automatic milking is its possible use in monitoring the health and welfare of cows. A lot of information about individual dairy cows is already gathered manually by the farmer or farmhand and then fed into a computer to determine an animal's health, production efficiency and breeding status. It is essential in herd management to identify the short period when the cow is fertile. Monitoring milk yield and appetite helps determine the cow's health, while unusual changes in the milk's conductivity can indicate mastitis, while its temperature helps indicate changes in body temperature. Automatic milking systems will inevitably provide more data on individual animals, so processing of sensor information will enable the early identification and treatment of many subclinical ailments. The result should be better animal health, higher milk quality - and of course more time for herders to do other tasks.

Farmers and milking machine engineers say that there will be a ready market for this technology when it becomes reliable. But it may be up to five years before any is viable. However, with potentially enormous sales world wide, a system costing a few tens of thousands of pounds would be a small addition to a typical milking parlour, which already costs between £80,000 and £90,000 to equip. Previous revolutions in agriculture have begun with engineering developments - think of the steel plough and the tractor. The robot may well initiate another. (This first appeared in *New Scientist*, London, 10 October 1992, the weekly review of science and technology.

IX. RECENT PUBLICATIONS

Issues for electronic records management

In recent years, the computer and communication industries have seen the emergence of a new and powerful force - the Open Systems Interconnection (OSI) movement. United Nations organizations, argues a new ACCIS publication, must now begin to migrate towards open systems, as ambitious worldwide new applications are still at the design stage. At the same time, it asserts, continuing disregard of the developing OSI environment will make electronic records management within the UN system extremely difficult, if not impossible, in the years ahead.

While organizations need to start planning to use OSI systems for communication and electronic records management, they need to take into account both the *current* set of open system standards and where they are leading.

Strategic issues for electronic records management: towards open systems interconnection, a study prepared by the ACCIS Working Group on Electronic Records Management Issues and Standards (WG/ERMIS) at the request of ACCIS, attempts to provide that information and to highlight the functional requirements of electronic records management.

The report contains: an overview of electronic records management requirements and OSI; a detailed review of the current set of OSI standards relevant to electronic records management; a summary of the interrelationships of electronic records management and the standards, and a summary of the information support requirements.

Strategic issues for electronic records management: towards open systems interconnection (UN Sales No. GV.E.92.0.13, ISBN 92-1-100374-1) has 126 pages and is available, price $32, from UN Sales Sections in Geneva and New York.

ACCIS produces curriculum materials

ACCIS has just published a manual of the curriculum materials on electronic records management produced by the ACCIS Working Group on Electronic Records Management Issues and Standards (WG/ERMIS).

The manual is intended to equip practitioners in the records management field with the necessary tools to put into practice the ACCIS guidelines on electronic records management. The teaching materials were devised for presentation at a series of workshops of UN system communications, data processing and information management staff.

With the publication of the manual, ACCIS is seeking to make the curriculum and teaching materials available to a wider audience, and to facilitate future presentations. It is hoped that the availability of these materials will stimulate interest in the subject matter, and promote electronic records management within organizations of the United Nations system and Member States.

The manual (ISBN 92-1-100376-8; UN Sales No. GV.E.92.0.15) is available from UN Sales Sections in Geneva and New York, price $15.

X. SPECIAL ARTICLE

SOFTWARE IN TELECOMMUNICATION INDUSTRIES AND ITS COOPERATIVE DEVELOPMENT

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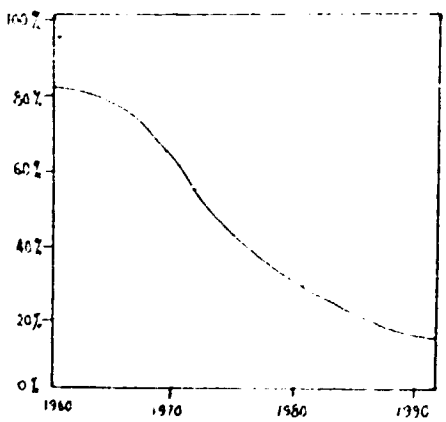
Presented at the Workshop for Asia and Pacific Region Representatives from the Telecommunication Industry
New Delhi, India
24-27 September, 1992
Organized by the
United Nations Industrial Development Organization
(UNIDO)

1. Importance of Software in Telecommunications

According to [1], the cost of software was estimated to be $130 billion in 1980 and it was likely to double by 1990 in the United States. Software costs amount to about 85 per cent of all computer expenditures in 1990. Figure 1 shows the changing ratios of expenditures for hardware and software.

Figure 1. Hardware vs. Software



Cost: Analysis of Typical Computer System.

Source: Electronic Design, January 1981

Though there are no statistics of software in telecommunications, the role of software is more important, since in modern telecommunication products,

either the complexity of the functions or the automation in operation is growing. As an example, in AT&T over 60 per cent of R&D employees were involved in software in 1989 and as a measure of the tremendous software workload, AT&T research and development delivered 20 million lines of new and changed code in 1987 on a base of 35 million lines of code. Finally, the size and complexity of software in telecommunication products continues to increase rapidly at an average compound annual growth rate, of delivered lines software, of about 25 per cent [2].

The reasons why software becomes so important may be analysed as follows:

- The rapid progress of IC (integrated circuit) technology decreases hardware cost steadily. Many hardware components that were developed several years ago may be replaced by off-the-shelf IC chips. Some components, which do not have off-the-shelf IC products are preferred to be implemented in the form of ASIC (Application Specific Integrated Circuit). These measures also greatly increase the hardware reliability.

- The wide application of various types of CPU (Central Processing Unit) chips simplifies the hardware design in the sense that the same hardware architecture can be used to fulfill different kinds of functions with different specialized implementations of software embedded in these CPU chips.

- Functions of telecommunication products are becoming more complex and sophisticated. Since the national communication network has to meet diversified needs and a changing environment, all major equipment in this network must satisfy these requirements. At the same time in order to decrease the labour and maintenance costs, some level of automation for telecommunication equipment is preferred. It is expected that the increase of functional complexity and automation will require more embedded software.

- Various forms of computer management, control and maintenance systems play important roles in operating and maintaining telecommunication companies. These systems are mainly software based. They perform complex functions and usually require a considerable amount of effort to be developed and implemented.

For developing countries software is the key point in imported technology absorption. If the software components of telecommunication equipment are not fully understood, it is almost impossible to modify or improve the equipment to meet the requirements of technological advances or specific application environment.

2. Major Software for Telecommunication Industries and Operating Companies

Major activities for a telecommunication company can be summarized as R&D for new telecommunication products, manufacturing, including quality control of produced equipment, and management. In this section we will briefly describe software functions performed in each of these activities.

(a) R&D of new telecommunication products

Basically, R&D activities for new telecommunication products can be divided into hardware and software, while initial steps such as requirement analysis and general design are usually performed by system analysts manually. Therefore, in supporting hardware and software R&D, software is also divided into corresponding parts.

The state-of-the-art hardware development methodology consists of the following closely related steps.

- General block design. The basic purpose is to partition a complex hardware equipment into several building blocks, each of which performs a relatively independent function. Few software tools are able to support this step of R&D. It mainly relies on the experience and creativity of the designer.

- Function block design. According to the functions performed by the building block, a hardware schematic design is carried out. This step of design can be done by automatic hardware synthesis software or through man-machine interactions.

- Function block simulation. A thorough simulation is necessary in order to verify the correctness of the designed schematic diagram.

- Test design. A set of hardware tests must be generated to examine the functional and electrical correctness of the product.

- Implementation. The designed circuits are implemented either using ASIC techniques or on printed circuit boards (PCB).

All the steps from function block design to implementation can be highly automated. The software packages performing the hardware designs are called computer-aided-design (CAD) or electronic-design-automation (EDA) system.

The R&D activities for the software of telecommunication equipment follow the software life cycle model. The main steps of software development steps are as follows:

- Requirement analysis. The software functions to be performed are clarified and analysed.
- Structural design. The structure of the whole software is determined, including the modules partitioned and the relationships among modules.
- Detail design. Data structure, algorithms and flow diagrams for each module are designed.
- Coding. The detail design is implemented in a high-level or assembler language.
- Testing. The purpose of testing is to verify the correctness of the design. It includes module (or unit) testing, integration testing and system testing. If errors are revealed, debugging is required in order to remove these errors.

Computer-aided software engineering or so-called CASE tools are available for each of the above mentioned steps. However, these tools are not able to take over all of the manual work in each of these steps. A reasonable approach is to combine these tools with manual work, so as to maximize efficiency and improve the design quality.

(b) Manufacturing

Modern manufacturing process of telecommunication equipment features the application of computer-aided-manufacturing (CAM) techniques particularly in assembling and quality control of the hardware products of the equipment, including the quality control of PCBs, chassis and the entire hardware system. CAM in assembling includes component-forming machinery, component insertion machinery, wave soldering machinery, etc. Although this equipment is complex and expensive, the software is relatively simple and the working principles and designs are different from one another. It is difficult to give a general description of the software used in the equipment for CAM in assembling, and it will therefore not be discussed in this article.

Quality control includes the testing of the products to detect any inconsistency between the product behaviour and requirements. If a discrepancy (or fault) is detected, the source of the fault must be located. This process is called fault diagnosis. The removal of the fault is usually performed manually. This process continues until the entire behaviour of the product meets the design requirements. Finally, the statistics of the discovered faults will be used to improve the manufacturing process. From this description, it is clear that the key points in quality control are testing and fault diagnosis, which are basically implemented through the use of software tools. These will be described in section 5.

(c) Management

Currently, no software is able to automate management. Only individual activities, such as financial analysis, inventory control, payroll systems, statistics collection, report generation, etc. can be supported by the corresponding software packages. These are relatively easy to design and will not be discussed in detail in this article.

The management of R&D activities is of great importance [3]. This includes the planning of a project, resource allocation and control over the whole process of R&D. Scientific management is a source of considerable efficiency and quality improvement [4]. However, in developing countries not enough experience and statistics have been accumulated, and the models used to estimate the duration of a project or allocation of manpower, which might be relevant to developed nations, are not applicable directly in the developing countries. The first priority is to gain experience and statistics from various R&D projects. Automation in this area does not appear to be an urgent task, or is at least not mature at the current stage. Therefore, this topic will also not be discussed in the later sections.

For telecommunication operating companies the following software systems are necessary:

(1) Network management system. The purpose of this system is to maximize the utilization of the network at all lines and under all circumstances. This is achieved by monitoring network performance and taking action to alleviate or circumvent the congested part of the network and prevent the congestion from spreading to other parts of the network.

(2) Billing and accounting. Billing refers to the calculation of charges and invoicing of subscribers by an administration for services provided. Accounting refers to the calculation of charges and the preparation of invoices for the settlement of accounts between administrations for the use of one another's networks or facilities.

(3) Planning. To minimize congestion due to under-provisioning, of either switching equipment or transmission plant, a continuing process of network planning is necessary. This depends on regular measurements of relevant parameters, such as the frequency of all routes to any destination being busy and the traffic loading throughout the day on each route. Such measurements are used to observe traffic profiles over a period of time, and thus determine when it is appropriate to increase the exchange equipment or

transmission plant. Planning also includes the optimal allocation of exchanges in a service area so as to minimize the overall investment in trunks, exchanges and subscriber lines.

(4) Operational system. This system is used for purposes such as the introduction of new equipment, the allocation or reallocation of terminations for subscribers or trunks and changing the facilities allowed to a given subscriber circuit. The system also includes the functions of providing telephone lines to new subscribers.

(5) Maintenance system. The system includes maintenance of a telecommunication centre, such as a switching exchange, and of a transmission system. The equipment in the centre and the transmission system is monitored. Faults are displayed or printed out. The system analyses and diagnoses faults using fault detection and location programs or specialized expert systems. Finally, faults are cleared manually.

3. CAD for Hardware

Sophisticated CAD (Computer-aided Design) systems for hardware R&D are available on the market. The block diagram of such a typical system is given in figure 2.

The system consists of six parts.

- Schematic input and logical synthesis. For digital circuits the designer may input his/her design idea using an HHDL (High-level Hardware Design Language) editor. Through an HHDL compiler, HHDL text is automatically transformed into a logical diagram. The designer may input the schematic diagram directly using the schematic diagram editor.

- Simulators. Three different kinds of simulators, including corresponding libraries, are provided so that different types of circuits can be simulated accordingly. The simulator inputs are given by the designer and the results of simulation are stored in the database in the form of wave diagram or text.

- Test design. A detailed description of a test design block is in section 5.

- PCB implementation. This software tool is able to do the IC chip placement, routing of connecting lines on two layer or multi-layer PCB according to some guidelines given by the designer. Sometimes, man-machine interactions are needed to help the routing and placement procedures. For densely packed PCBs, thermal analysis is needed to give a visual diagram of thermal distribution on the designed PCB under certain conditions of ventilation. If the thermal analysis does not meet the predetermined criteria, other placement variations need to be investigated.

- ASIC design tools. ASIC design tools include placement, routing and physical simulation to examine the electric specifications to be satisfied.

- Database. The database is the key component of the CAD system. All information put into and produced by the system, with important intermediate results, is stored in the database. The database keeps track of a product's evolution, including its specifications and all design details, so that the designer may easily understand the process of a product's modification. At the same time, the database plays a role of interfaces among different design tools. It is also a report generator. Any query about the designed product may be referred to the database.

4. CASE for Telecommunication Equipment

Basically, the control and operation of telecommunication equipment are state-transition oriented. Based on this, CCITT recommended a specification and description language (SDL) for telecommunication software. SDL has two basic forms: SDL/GR for graphical form and SDL/PR for textual form. These two forms are equivalent and can be transformed from one to another. There are several CASE systems based on SDL, but they are not as mature as CAD systems for hardware. We believe that a CASE system based on SDL is more suitable for telecommunication software applications. A relatively complete CASE system used in a telecommunication company is made up of several subsystems for designing testing, maintenance and production. The block diagram of a design subsystem is given in figure 3.

The upper part of figure 3 is the conventional design part of the subsystem. Three input means are provided: assembler language input, high-level language input and the SDL/GR input. Programs from the first two kinds of input through corresponding compilers are stored in the database. SDL/GR is more suitable for the designer's use. The input of SDL/GR is realized through an SDL/GR graphical editor. For computer processing SDL/PR is adequate. A GR to PR translator is provided. After SDL/GR is transformed into SDL/PR, a syntax analyser is used to check the correctness of the input SDL text. If errors exit, a PR to GR translator is used to indicate the location of errors in the SDL/GR form so that the designer may correct errors interactively. The checked format SDL/PR is then transformed into a high-level language program, which is correspondingly stored in the database. Currently, C and CHILL translators are

Figure 2

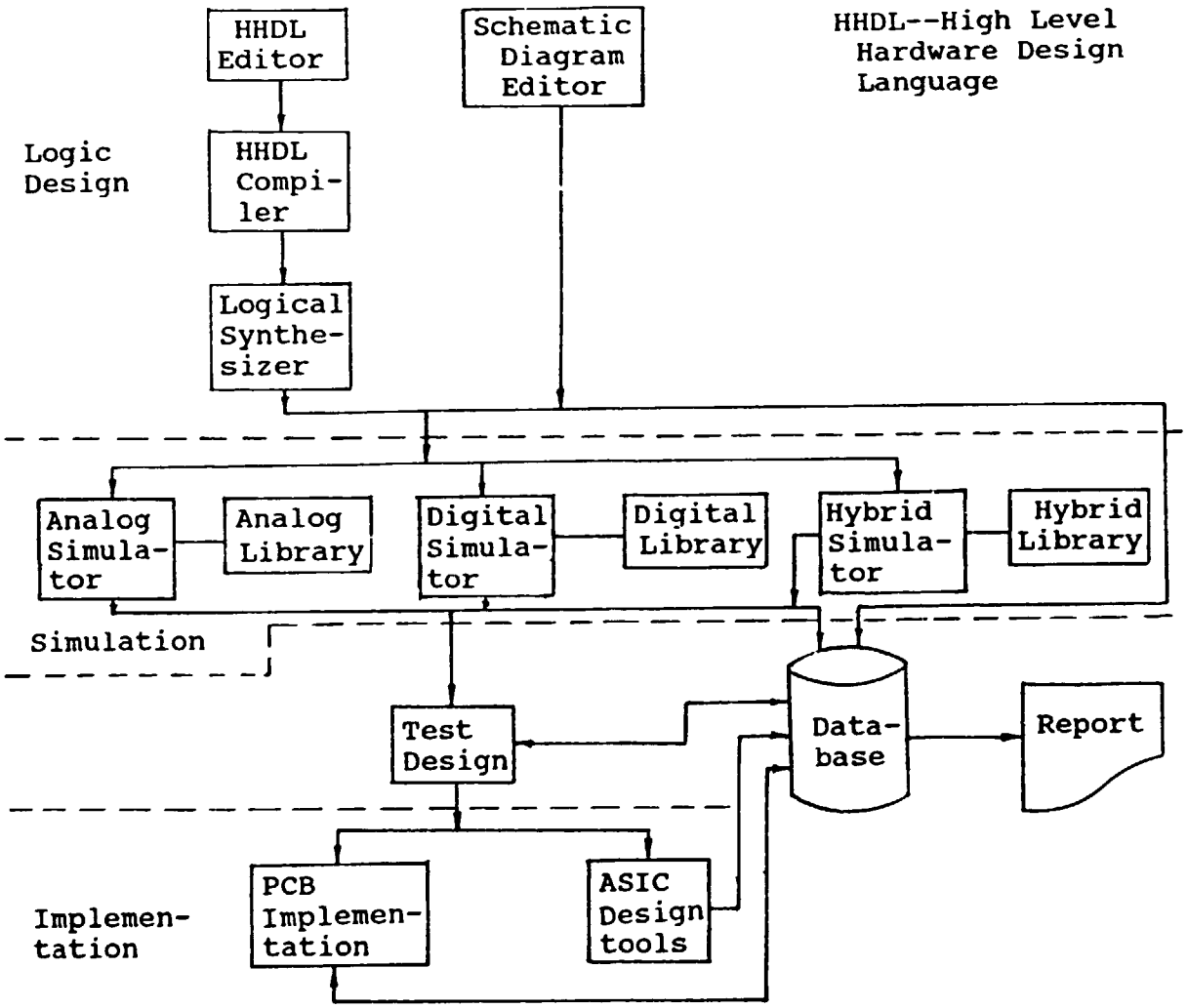
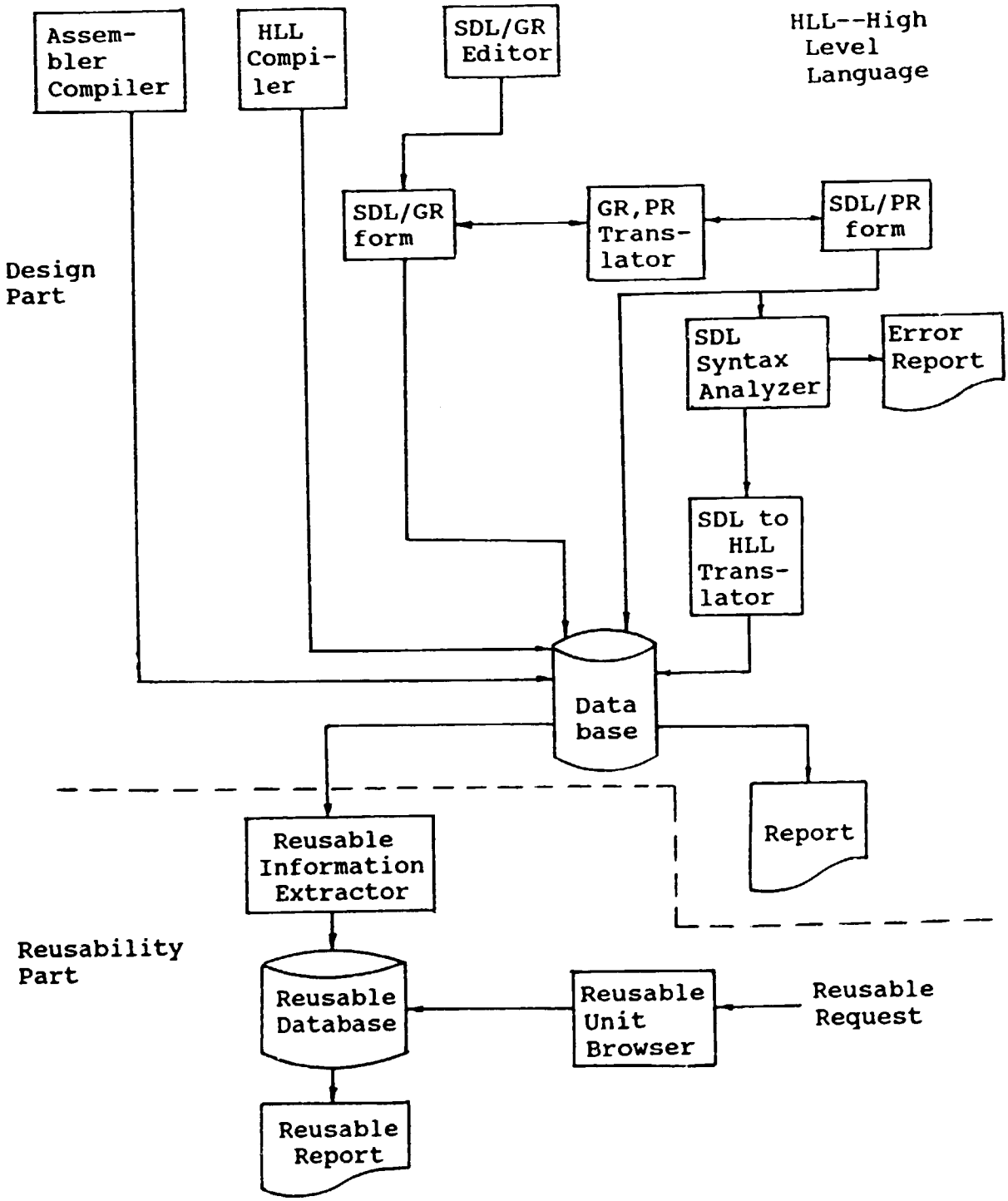

HHDL Editor
Schematic Diagram Editor
HHDL--High Level Hardware Design Language
Logic Design
HHDL Compi-ler
Logical Synthe-sizer
Analog Simula-tor
Analog Library
Digital Simula-tor
Digital Library
Hybrid Simula-tor
Hybrid Library
Simulation
Test Design
Data-base
Report
Implemen-tation
PCB Implemen-tation
ASIC Design tools

Figure 3


Assem-
bler
Compiler
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SDL/GR
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Design
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Syntax
Analyzer
Error
Report
SDL to
HLL
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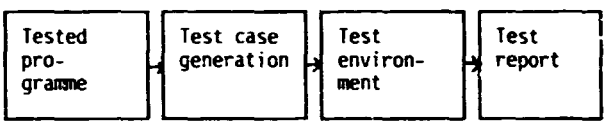
lator
Data
base
Report
Reusable
Information
Extractor
Reusability
Part
Reusable
Database
Reusable
Unit
Browser
Reusable
Request
Reusable
Report

available from the market, where CHILL is a CCITT recommended high-level language.

Reuse plays an important role in improving the efficiency and quality in developing software products. The lower part of figure 3 is dedicated to the reusability of software packages. Any designed software units, including their specifications and documentation, are stored in a reusable database through a block "Reusable Information Extractor". If a designer needs to design a new software unit, he/she may refer to the reusable database through the block "Reusable Unit Browser". Any possible reusable information, including source program, specification and documentation, can be printed out from the database.

The key part of a quality assurance subsystem is a software test system. The general block diagram of a test system is given in figure 4.

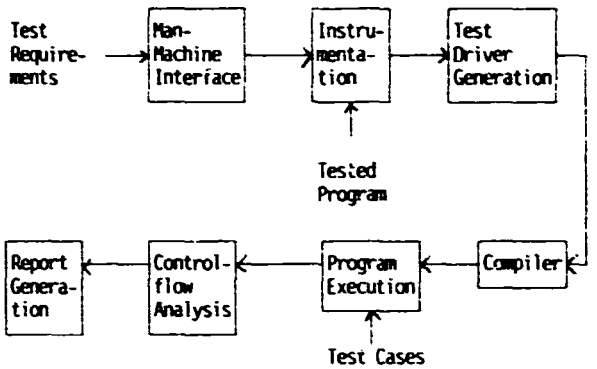
Figure 4



Many approaches exist for test case generation. The data-flow approach emphasizes the definition-usage relation in the program, while the control-flow approach examines the control structure of the program. Conventional test case generation methods are mainly based upon the tested program itself. We argue that since the correctness of the tested program is under examination, it seems more reasonable to derive test cases not from the tested program but from its specifications. As mentioned before, the specifications of telecommunication software are described by SDL. The derivation of test cases from an SDL description of the program is a reasonable way. The algorithms of deriving test cases from its SDL description may be referred to [5]. The block diagram of a test environment based on control-flow method is given in figure 5.

First, the test requirements are received through the "Man-machine Interface". According to the requirements the tested program is instrumented by inserting probes into the program. Usually, a tested program is only a software unit or module, with a superior or upper-level module. In order to simulate the software unit working in its real environment, an artificial superior module, called a "driver", must be generated in the system. This process is performed automatically. The augmented program is then compiled and executed with the test cases as inputs. The results are analysed according to the predefined test criteria. A report is finally generated [6].

Figure 5



Usually, the system described in figure 4 is applied to the module or unit, after which, system testing is needed to verify the quality of the whole software system. The methodology of system testing is quite different to that of unit testing. The test case derivation is based on a functional approach and the testing is performed in a real or simulated environment with the help of development systems in order to extract information during the execution of the software system [7].

A software production subsystem is needed to generate subscriber and office data files. The software subsystem must be configured according to the concrete specifications of the telecommunication equipment used, since some equipment, such as switching systems, is heavily dependent on its assigned roles in the network and user needs and requirements. In this case, software must be tailored both in its data and configuration for each particular application.

Maintenance is extremely important, because the cost of maintenance comprises the major part of investment in the whole life cycle of a software [8]. The maintenance subsystem provides management of any software maintenance activities, including program patches and software modifications.

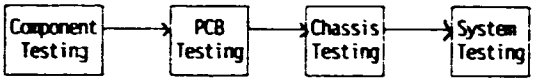
The structure of production and maintenance subsystems will not be described here and can be referred to in [9,10].

5. Hardware Testing System

A hardware testing system includes testing of components such as IC chips through to testing of the whole system, as shown in figure 6.

Component testing may be supported by a series of off-the-shelf equipment and is not discussed here.

Figure 6



Basically, PCB testing comprises bare board testing and PCB functional testing. Bare board testing uses a nail-bed facility to detect any defects in manufacturing PCB. This section discusses PCB functional testing and system testing.

The purpose of PCB functional testing is to verify the functional correctness of the PCB. Two basic approaches exist. One is the nail-bed approach. The basic idea of this approach is represented in figure 7.

Major pins of IC chips or components mounted on the PCB board are connected to the block "Cross Connection" through spring nails and connecting lines. Under instructions from the computer, the "Cross Connection" block connects the necessary component or part of the PCB to the measurement equipment or to the computer. The results of the measurement are also reported to the computer and compared with the preregistered standard values to determine the functional correctness.

The principle of the second approach is given in figure 8. In this approach only the terminal outlets of the PCB are connected to the block "Cross Connection". The computer sends test signals to the PCB and receives responses from the PCB through terminal outlets and the "Cross Connection". The responses are compared with the predefined values to verify the functions of the PCB.

At first glance, these two approaches are similar, although in fact they are quite different. For the first approach (figure 7), major points inside the PCB are "observable" by the computer through spring nails. The PCB is actually partitioned into small "modules", even to chips or components if sufficient spring nails are provided. In this case, the detection of internal faults and their location become easy and therefore efficiency and accuracy of fault location are guaranteed. In order to ensure the reliability of electrical contact of large numbers of spring nails with their corresponding soldered points of IC chips, a complex fixture with a vacuum pump is required. In addition, different PCBs require different distribution of spring nails, and therefore specialized design and processing of fixtures are needed for each PCB under testing.

Contrarily, the second approach simplifies the connection to the PCB considerably, because different PCBs use the same connection to the test equipment because the plug receptacle of the PCB remains unchanged. However, since the inner soldered points of

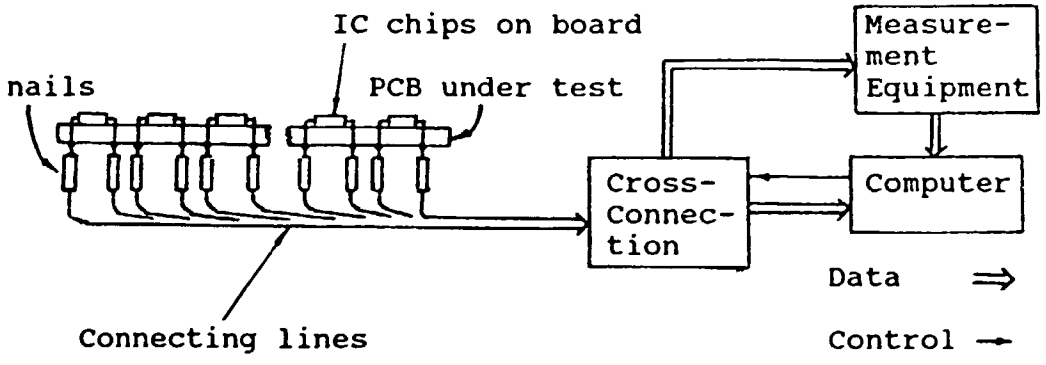


Figure 7

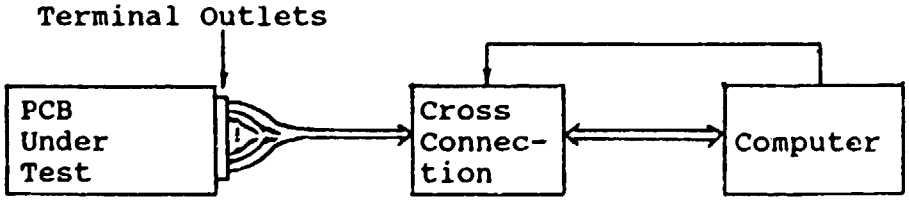
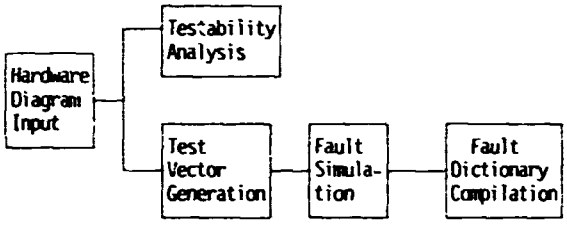


Figure 8

the PCB are not accessible to the test computer, it is more difficult to make thorough testing and to find out the locations of faults once such faults exist.

The software system used to perform PCB testing and diagnosing is given in figure 9.

Figure 9



The hardware schematic diagram must be first inputted. Then a "Testability Analysis" block examines the feasibility of generating test vectors to detect most faults in the PCB. If the analysis results indicate some portions of the PCB are difficult to test, either the original hardware design should be modified or additional outlets need to be placed; after that, test vectors are generated. Algorithms for test generation may be referred to [11].

A fault simulation program is invoked for each test vector. Fault simulation is a computing program to determine all faults to be detected by a given input test vector. The results of the fault simulation are used to calculate the fault coverage of the generated test vectors and to compile the fault dictionary, which is necessary for fault location. From an engineering point of view, 90 per cent of fault coverage is considered to be satisfactory. If the coverage is lower than 90 per cent, additional test vectors must be generated.

If the hardware is composed of analog circuits, the generation of test vectors is usually performed functionally, and the analog simulator in figure 2 used extensively, not only for normal working conditions, but also for all possible fault situations. These results are then compiled into a fault dictionary for fault location purposes.

The basic principle of chassis or system testing is the same as illustrated by figure 8. Only the PCB is replaced by a chassis or system. The software for chassis or system testing is the same as in figure 9 too, with the difference that in this case no testability analysis is usually necessary. Besides, the principle of test vector generation is functionally based, and in fault diagnosis the smallest unit to be located is the PCB in the chassis or system, instead of individual components or printed lines.

6. Network Management

As indicated in section 2, a series of software systems are necessary to increase efficiency and quality of administration, maintenance and planning of telecommunication operating companies. Since each of these software systems is different from another, whether in the use or design ideas and implementation and it is impossible to discuss all these systems in the article, we will only select the network management system as an example, and the rest of the systems may be referred to [12, 13].

Network management is carried out by network management centres (NMC), which are organized hierarchically. An NMC exchanges information with its superior NMC or subordinate NMC and monitors the grade of service of trunk groups of those switching exchanges which are under the management of this NMC. It also issues instructions to switching exchanges in cases of abnormal congestion. There are two basic ways to deal with this situation. One is to increase the facilities related to the congested trunk groups, such as increasing the number of trunks or provision of detour-routes. Another is to limit or totally block the traffic flowing to the congested exchange.

In order to store and analyse the various data received, a database is necessary. In addition, in many NMCs, a wall-sized display model is important. The model is computer-controlled, so that information on each route is automatically displayed. For example, congestion or traffic loading above a certain threshold may be shown by illuminations in different colours. Such a visual model assists network managers in an NMC to anticipate problems and preempt them by taking early action; it also enables staff to visualize the distribution and extent of congestion, thus helping them to detect a pattern or predict the likely course and speed of its spread. This is often useful when choosing the most effective remedial action.

According to the description given above, the software of an NMC is mainly comprised of the following modules:

- Communication management. This module manages the communication links connected to the NMC.
- Data processing. Includes protocol processing, message verification, format transformation for input and/or output signals or instructions.
- Database. Is the central repository of data received, analysed and messages or instructions issued, including reports generated and any actions taken by the network managers in NMC.

- Network analysis. Is the key module of the NMC. This module is in charge of detecting abnormalities in the network and determines which measures should be taken.

- Display module. Necessary information is displayed on the wall-sized display model.

- Report generation.

- Man-machine interface for receiving instructions from the network manager, checking the correctness and storing the manager's instructions in the database.

7. Cooperative Development of Software in Developing Countries

Software is knowledge-intensive and belongs to high technology. Development of software requires a group of highly qualified personnel and considerable computer resources, such as PCs, workstations, minicomputers or mainframes, depending on the size and capability of the software and networking facilities to interconnect various computers, as well as corresponding software tools such as language compilers, editors, debuggers, databases and many others. To meet all these prerequisites is not easy for a developing country. Therefore, two basic strategies must be followed. One is cooperative development of software applicable to many nations. The other is to develop software step by step. The software that is mostly needed in the telecommunication industry should be given first priority.

Proposals are given for a stepwise software development.

The initial stage

Software developed or deployed in the first stage should be easy in development or is crucial in telecommunication industry.

- Management

Financial management, inventory control, payroll system, statistics collection and other software packages for management purposes can be jointly developed by several countries. Though management systems may be different in various countries, they are easily modified to meet such peculiarities. Besides, all these software packages are relatively easy to develop.

- Hardware CAD

Simulation programs for digital and analog circuits run on personal computers, and PCB design programs, also on PCs, are already mature and can be obtained from the market at relatively low prices. From experience, these software packages are very useful in improving hardware design quality and efficiency, though their capability is very limited because of the PC platform.

- Data production

For some telecommunication equipment, such as telephone switching systems or mobile communication systems, data file generation including subscriber data file and office file generation is essential for an operational system. Manual production of these data files is labour-consuming and the quality cannot be guaranteed. Development of such an automatic data generation system is not difficult. Collaboration of several nations is possible if these nations use the same type of switching system.

For telecommunication operating companies the following software systems are recommended to be established first:

- Billing and accounting system. This system is most crucial for an operating company. It can be established on a PC platform using an off-the-shelf database. Application software will need to be developed according to the actual situation.

- Semi-automatic network management system. Under "semi-automatic", we mean the collection of traffic data from operating exchanges is automatic through data communication links. The traffic data in various exchanges have to be preprocessed and then collected, stored in a database, and finally displayed on a screen. All these functions can be performed on personal computers. The rest of the network management functions, such as traffic data analysis, decision-making, network management operations, are all performed manually.

- Standardization of software development methodology and documentation among cooperative countries.

Standardization is extremely important for software portability and cooperative development of software. It must be enforced at the very beginning.

The second stage

It is recommended that an R&D centre be established jointly by several companies or even by several developing countries, because the prices of software packages and the corresponding platforms are relatively high, and the rate of utilization is not high enough if they are owned by one telecommunication company.

The R&D centre should include the CAD system as shown in figure 2 for hardware design purposes. Here, ASIC design tools may not be included in the beginning for economical reasons and the IN-OUT-IN principle could be followed, i.e., develop INdigenously, fabricate OUTside and use INdigenously. For the CASE system, the design part of figure 3 may be purchased first.

In order to fully utilize the resources in the R&D centre, thorough training of technical personnel is of key importance, so that the engineers are able to use all the software packages. Only under such conditions can these software resources be effectively used, leading to increased quality and efficiency in developing new telecommunication products.

PCB testing plays an important role in manufacturing telecommunication equipment. There is no off-the-shelf product of figure 9 except the fault simulation program. Therefore, collaboration in the development of a system as shown in figure 9 is necessary.

For a telecommunications operating company, the planning and operational systems could be established at this stage, since they are important in optimizing the communications network and improving service quality.

The third stage

On the basis of the second stage, the third stage should include all the software tools given in figures 2, 3, 4, 5 and 9 as well as the maintenance subsystem mentioned in section 4. For the CASE system, the software testing tools must be developed by indigenous efforts. The hardware testing system should be improved to increase its performance. Either the development of these software tools or the integration of individual tools into a whole system requires good planning and a group of qualified experts. In this case, cooperative development by several developing nations, with the help of experts from developed countries is highly recommended. An example of such a joint development can be referred to in UNDP project RAS/86/165 - "Telecommunication Computer Software Development and Training".

This project offers a series of courses to trainees from developing countries in the Asia and Pacific regions. At the same time a model telecommunication software development methodology and a series of application software systems are under development. These are:

- Service order application system
- Outside planting application system
- Material and inventory application system
- Financial and accounting application system
- Report facility management system

Once these systems are developed, they will be shared by countries in the Asia and Pacific region.

8. Conclusions

The main conclusions of this article are as follows:

(1) Software plays a key role in the telecommunications industry and operating companies. As technology progresses the importance of software will be even morer crucial. Software systems are important in management, R&D and manufacturing processes of a telecommunications company. It is a key factor in improving efficiency and product quality.

(2) State-of-the-art software technologies in management, R&D and manufacturing processes are described and analysed.

(3) Development and implementation of software technology are recommended to be divided into three stages. In the first stage, those software packages that are easy to implement and can run on the PC platform, and which may at the same time produce significant economical benefit, should be developed. In the second stage a joint R&D centre should be established. The software tools are mainly purchased from abroad, but the PCB testing system must be developed indigenously. These software tools should perform the main functions in R&D and manufacturing activities. In the third stage, software systems should be perfected. Collaboration among nations, both in development and purchasing, is necessary at all these three stages.

(4) Unified development methodology and documentation standards are prerequisites for regional cooperation and need to be agreed upon from the beginning.

(5) A group of qualified software experts and training of technical personnel to make full use of the software is the key to success in implementing software technology in the telecommunications industry. From this point of view, the importance of education and training in computers, especially software development methodology, is significant. In this regard, the UNDP effort in software development and training in the telecommunications area is highly commended.

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