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# 20737

# MICRO- ELECTRONICS MONITOR

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This double issue carries an article written for the Microelectronics Monitor by Dr. B. Bowonder, BEL Professor on Technology Management, Administrative Staff College of India (Bella Vista, Hyderabad, India) on the subject of Virtual Reality: an emerging technology.

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## I. NEWS AND EVENTS

### JESSI seeks funding

The Joint European Submicron Silicon Initiative (JESSI) is seeking funding from the European Commission for a JESSI II programme.

The Commission has asked the European Parliament for £10 billion for its Fourth Framework Programme and JESSI is anxious to get a slice of this funding, despite criticism that the programme has achieved few successes to date.

JESSI ends its eight-year term in 1994. Two and a half billion pounds has been put in jointly by industry and the EC, with extra funding from the EC's ESPRIT programme. Now JESSI wants a similar amount to help fund its activities in long-term research, materials and equipment, technology and applications. (Source: *Electronics Weekly*, 17 November 1993)

### Groups ask GATT to cut chip equipment tariffs

Two major electronics trade associations, the European Electronic Component Manufacturers Association and the Semiconductor Equipment Manufacturers International, are asking the GATT negotiators to scrap tariffs on semiconductor manufacturing equipment in the final round of talks.

The move has the backing of US and European semiconductor makers, since it would let them buy their production equipment more cheaply and lower their own prices.

At present, the tariffs imposed on semiconductor equipment vary. In the United States, which consumed \$291 million worth of European equipment in 1992, an average duty of 3.9 per cent was imposed. In Europe, which spent \$606 million on US equipment in the same year, the average was 5.9 per cent.

The European Commission is in favour of scrapping the tariff. (Source: *Electronics Weekly*, 17 November 1993)

### Green TV laws store up mountain of trouble

Europe faces the prospect of a "dead television" mountain as its countries pass laws forcing manufacturers to take back worn-out TV sets and computer monitors. Prices of new sets will also rise as manufacturers are forced to redesign existing models to make them easier to recycle.

These are the conclusions of two years of research in the Netherlands by a group from the Centre for Environmental Science of Leiden University, Delft

University of Technology and Philips, Europe's largest manufacturer of consumer electronics.

Jan Timmer, president of Philips, recently committed the company to an environmental policy based on the belief that prevention is better than cure. Philips says it supports the European Commission's plan to make all manufacturers take back defunct TV sets and computer monitors, but warns that neither the trade nor the public has yet realized how costly this will be.

As part of a green marketing strategy, some TV retailers in Germany now offer to collect old TV sets from customers and dispose of them for DM 38 (£15). But Philips estimates that the real cost of doing this is DM 100 (£40), and predicts that this loss-making strategy will have to stop within months, and be replaced by higher charges.

In the short term, manufacturers will have to cover the cost of disposal by upping prices of sets that were not made for recycling. In the long term, only if the TVs are completely redesigned will they be recyclable.

The cathode-ray tube (CRT) makes TV sets and computer monitors particularly hard to recycle. The tube is made of two kinds of glass: one half for the rear cone containing the electron guns and high-voltage electrodes, and another for the flat front face which serves as the screen.

The cone glass contains 15 per cent lead to block X-rays generated by high-voltage components. If the screen also contained lead the picture would look brown, so it contains 15 per cent barium instead. The inside of the screen is coated with three different phosphor dyes, which create the colour image.

When an old tube is broken up for recycling, the two glass types mix. The mix can be washed to remove the dangerous phosphors, but cannot be melted down and reused for bottling because it contains poisonous metal. It cannot be used to make new screen plates because the residual lead will spoil the picture.

Mixed with new glass, some of the old material can be used to make new cones. But the mix of metals in recycled glass weakens it and makes its mechanical strength hard to predict or control.

With other European Community countries preparing to introduce similar laws, Philips expects in time to have to deal with 25 million returned CRTs every year.

The long-term answer is to find a reliable way to separate the cone and screen before smashing the glass. For this the CRT will have to be redesigned. Even then companies and consumers will not be saving money

until the next century, when sets containing the new tubes will reach the end of their lives.

The TV's cabinet presents further problems. It contains up to 10 different types of plastic. If the cabinet is ground up and melted down, the paper and trim will reduce the bulk strength of the resulting material. A cabinet made from recycled plastic could become a safety hazard if it cannot be relied on to bear the weight of the CRT.

Philips believes that cabinets can be made from a single material, which could easily be recycled. Polypropylene is a leading contender, as it could be embossed, and so avoid the use of paper labels and trim.

A TV contains some 2,000 components, from loudspeakers to screws and clips, and can take at least an hour to dismantle. Students at Delft University are trying to design a TV that is easier to pull apart, although they reckon the project will take another two years to complete.

Some components, such as the loudspeaker, are so difficult to recycle and of such low value there is no hope of reusing them. There is a better chance of recycling the smaller electrical components which are soldered to printed circuit boards. These must be diced into tiny pellets, which are then heated and immersed in chemical baths to separate the metal from the plastics. Then the metals - copper, tin, silver and gold - must be separated, too.

"It is just mining technology", says Wim Bruens, Philips's environmental manager and chairman of the environmental affairs committee of the European Association of Consumer Electronics Manufacturers, "but the difference is that the materials here are less valuable. We can sell them, or reuse them, but there will be no profit, only less loss. The problem is that raw materials are still too cheap. The big risk is that manufacturers will build products that can be easily recycled, but no one will buy them because they are too expensive." (Source: *New Scientist*, 4 September 1993)

#### Ray of hope for "old" televisions

Cathode-ray tubes may seem like prehistoric relics to Japanese electronics companies developing flat-screen televisions based on liquid crystal technology. Yet Matsushita has kept faith with the old ways and is to launch a flat-screen television based on cathode-ray tubes.

Matsushita first demonstrated a prototype of its so-called "beam matrix" version of the cathode-ray tube in 1985. Its current model, to be launched under the Panasonic brand name, is just 10 centimetres thick and has a 36-centimetre screen.

In a conventional cathode-ray tube, an electron gun fires an electron beam which is scanned across the back of the screen surface by magnetic coils. Behind the screen of a beam matrix tube is a sandwich of six or so plates. Strip cathodes in the plate furthest from the screen generate electrons that are focused into "pencil beams" through perforations in an adjacent, electrostatically-charged plate.

The pencil beams pass first through a modulating plate, which varies their strength, then through horizontal and vertical deflection electrodes. These move the pencil beams sideways, and up and down.

At the front of the sandwich is a phosphor-coated screen divided into 10,000 small rectangular sections. Each rectangle is scanned by its own beam, so each section thus forms a ten-thousandth of the picture. Matsushita's trick was to link the mosaic without any joins showing. The company has priced the sets at ¥288,000 (£1,500), and is making just 1,000 each month.

This may seem expensive, but it is a fraction of the estimated \$100,000 it will take to build a prototype flat-screen television based on liquid crystal displays. Moreover, people viewing cathode-ray tubes from oblique angles can still see the picture clearly, whereas the image of an LCD-based screen falls away unless the viewer faces the screen head-on. Also, cathode-ray tubes are brighter than LCDs. (This first appeared in *New Scientist*, London, 25 September 1993, the weekly review of science and technology.)

#### From scrap to Big Mac

DEC is at the forefront of US efforts to make computers more environmentally friendly. The computer giant is participating in a programme organized by the American Plastics Council (APC) to reclaim plastics from computer carcasses.

Reclaimed housings from DEC boxes are sent back to General Electric and recycled as roofing panels for McDonalds' restaurants.

Spurring the programme was the realization of the very short product life of the 10 million old computers that end up in scrap piles each year.

This was brought to light by a recent Carnegie Mellon University study, which estimated that up to 150 million used computers will be piled in the US's landfills by 2005. (Source: *Electronics Weekly*, 26 May 1993)

#### HCFCs ban set for 2014

Ozone depleting hydrochlorofluorocarbons (HCFCs), which came into use as replacements for



CFCs, are to be eliminated within the European Community by 2014.

The elimination of CFCs, set for 1995, has already been attained by many major electronics companies.

HCFCs, which are 20 times less harmful to the ozone layer than CFCs, are mainly used in the production of foam packaging. (Source: *Electronics Weekly*, 16 June 1993)

#### US firms beat CFC deadline

US computer manufacturers DEC and Convex Computer Corporation have eliminated ozone depleting substances, including chlorofluorocarbons (CFCs), from their manufacturing operations.

Under the US Government deadline set by the Clean Air Act Amendments of 1990, all equipment manufactured with or using CFCs after 15 May, while still being legal, must bear a warning label stating the harmful effects of CFCs on public health and the environment.

DEC has done away with CFCs throughout its world-wide manufacturing operations 18 months ahead of its own target date.

Preliminary investigations indicate that as well as saving several thousands of dollars in waste management, there has been a 30 per cent increase in manufacturing productivity by doing away with ozone depleting substances.

In addition to compliance with the Clean Air Act Amendments, Convex will also sell its old CFC-consuming equipment as scrap metal rather than as salvageable equipment that could be used with CFCs elsewhere in the world. (Source: *Electronics Weekly*, 26 May 1993)

#### European industry collaborates to protect the environment

The British semiconductor industry is publishing a code of practice to ensure that the activities of its members have the least possible impact on the environment. The aims of the code include minimizing waste, conserving resources, eliminating or reducing the use of environmentally hazardous substances or processes, and highlighting opportunities for increasing knowledge and developing new technologies. Members take part at their own cost, but the Government provides the infrastructure.

The code, which was announced by the UK Microelectronic Environmental Advisory Committee, has been compiled by a working group of the

Committee chaired by John Holmes of Motorola, with BOC, Building Design Partnership, Edwards, Fujitsu, Surface Technology Systems and the Edinburgh Microfabrication Facility. The code is being published on their behalf by the Semiconductor Safety Association (Europe).

The code is intended to give guidance on current best practices within the industry and to assist compliance with legal requirements. The working group hopes it will help to facilitate the ongoing drive for environmental excellence. (Reprinted with permission from *Semiconductor International Magazine*, May 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### Alternative cleaning methods

The most recent meeting of the Montreal Protocol signatories, held in Copenhagen in November 1992, agreed to substantially reduce the availability of CFCs. An EC meeting one month later imposed even tighter restrictions on EC member States. In the European Community CFC availability will be cut to 15 per cent of the 1986 level by the end of 1993. A 100 per cent cut - zero availability - will be enforced by the end of 1994.

On top of facing restricted availability, users are now confronted with substantially increased prices and the leading suppliers are servicing existing customers only and rationing quantities to prevent stockpiling.

Clearly electronic manufacturers that have not yet done so are going to have to get their skates on and decide which alternative to employ. It has to be emphasized that although several alternatives to the use of a CFC-based solvent do exist, there is no drop-in alternative. Special equipment or materials are needed and there is a learning curve to be surmounted.

But, according to Dr. Colin Lea of the National Physical Laboratory, all available cleaning options will clean adequately and now presently offered alternatives can be eliminated on lack of cleaning performance compared to a CFC113/alcohol benchmark. (Lea also points out that CFC113/alcohol is not, in fact, all that good, its popularity being based upon convenience rather than performance.)

So, what are the available options? The list includes HCFCs, alcohol, aqueous, semi-aqueous and avoiding the need to clean by employing low residue "no-clean" fluxes.

This last option is proving to be popular, but it is not a "drop-in" alternative to cleaning since the new no-clean fluxes, whether employed for wavesoldering or incorporated into solder pastes that will be reflowed, need to be evaluated by the user.

With these fluxes, the processing window becomes narrower, and parameters such as component solderability assumes increasing importance.

The soldering process window, however, can be widened by soldering the printed circuit assembly in an inert atmosphere. Providing an inert atmosphere, usually nitrogen, requires purpose-built equipment, although retrofit kits for specific soldering machines are now available.

The inert atmosphere ensures that oxygen levels in the area where soldering takes place are in the 5-100 ppm range and this low level of oxygen reduces the activity required of the flux.

The benefits offered by the no-clean option include cost saving: no solvent or equipment has to be bought and there are no energy and no labour costs to be considered. The residues left by the new no-clean, less active fluxes are virtually invisible and they do not clog up test probes.

On the down side, however, users need to be reassured that leaving the residues on the board will not lead to any long-term reliability problems and, because no cleaning takes place, any solder balls which may have been formed during a reflow process will not be removed.

If cleaning is to be carried out - and there can be good reasons for cleaning, for example to make sure that solder balls are removed and that test probes make good contact, or simply because the customer demands it - then options such as the use of HCFCs, alcohol or aqueous or semi-aqueous methods can be considered.

Each alternative has its pros and cons and a process that suits one manufacturer's product will not necessarily be right for another's.

Selecting the most appropriate method is not an easy task, but for those firms that have not yet switched from using CFCs, it is one that needs to be addressed now. (Source: *Electronics Weekly*, 2 June 1993)

### Computers and telephones converge

The computer on your desktop could soon have the power to forward your telephone calls, with the launch of a new hardware and software specification that could facilitate the convergence of computers and communications at the desktop level. Just unleashed on the marketplace, and the brainchild of two US-based corporations, Microsoft and Intel, Windows Telephony Applications Interface makes the PC a platform for computer-supported telephony.

The specification is for a graphical user interface to control functions like call forwarding or conferencing. Calls would be transferred by pointing a

cursor at a name or a department; PC software would handle the call accordingly.

The goal of computer-supported telephony is to bring computer-based intelligence to voice and video applications, while shielding users from its complexity. Previous attempts by communications and computer companies to break into this market have failed to muster wide appeal among users. The Microsoft-Intel specification, said to be supported by around 40 computer and communications companies, is predicted to appeal to a wider market because it integrates a voice terminal with a viable desktop computer. (Source: *Communications Week*, 10 May 1993)

### Keeping the world informed

The United Nations Department of Public Information (DPI), created in 1946 to keep the world informed of the new organization's aims and activities, was called on by the General Assembly to establish "branch offices ... in order to ensure that peoples in all parts of the world receive as full information as possible about the United Nations".

Today, a network of these branch offices, known as United Nations Information Centres (UNICs) and United Nations Information Services (UNISs), links the United Nations at its Headquarters in New York with 68 cities in Member States. There, they are the voice of the UN, and a very important means of stimulating local interest in global issues.

UNICs provide a wide range of services, representing the UN at official functions, providing professional, administrative and logistical assistance to UN offices and operations, and giving practical support to the UN's increasing peace-making activities throughout the world. Their other important functions are: assisting the press and broadcasting media in their respective countries in the production of news about the United Nations; providing speakers and lecturers to non-governmental organizations (NGOs) and educational institutions; and organizing special events to mark UN observances such as United Nations Day, Human Rights Day and Disarmament Week.

A reference library, open to researchers and the general public, providing access to UN official documents and other public information material, is another important part of the UNIC. In many countries, documents and publications can be borrowed from the Centre's library through inter-library loan procedures. All Centres maintain a United Nations film and video collection, and most have an auditorium where film screenings, workshops and seminars can be held.

UNICs are linked to UN Headquarters, and to each other, by electronic mail, facsimile or cable,

enabling them to obtain the latest information as fast as possible. This network is a unique source of information on such topics as peace-keeping, peace-making, human rights, economic and social development, disaster relief, environment, and election monitoring.

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#### Embedded version of Sparc out by 1995

An embedded version of the Sparc micro-processor to rival Fujitsu's Sparclite will be in production before the end of 1994, according to Nick Walker, chairman of Eurosparc, a group of European companies that develop Sparc-based products.

Two routes are being followed to develop embedded Sparcs, though it was not revealed which was more likely to yield silicon first.

One route is to produce a formal specification. This is called Version SE of the Sparc architecture. The second route is via the ESPRIT-sponsored Open Microprocessor Initiative (OMI). The goal of OMI is to develop customized extensions to existing RISC microprocessors, including Sparc, to make them more useful for their users.

Eurosparc defined the original requirements and passed them on to Sparc International for ratification. The extensions include three extra instructions, options for implementing a memory management unit or a cache, and I/O peripherals.

Companies working on the OMI Sparc project, called Smile, include Matra MHS and Philips. Philips, the prime contractor, has not yet produced a Sparc processor. (Source: *Electronics Weekly*, 28 July 1993)

#### Olivetti bids to take wireless LAN initiative

Olivetti has launched its wireless LAN based on the DECT - digital European cordless telephone standard. It only offers 1.5 Mbit/s data rates, far below today's 10 Mbit/s Ethernet LANs. But European plans for a higher speed wireless LAN called Hiperlan will face competition from US technology.

Hiperlan is a European Commission coordinated development. Local area network user radio access (LAURA) was begun last year under the ESPRIT programme to develop and evaluate new technologies

compatible with Hiperlan. It is not expected to conclude before 1995.

The aim is to support 10 Mbit/s wireless LANs of up to 100 m operating in the 17 GHz radio band. LAURA is controlled by the French company Dassault Automatismes et Telecommunications, and there are partners in the UK and Italy.

However, it seems unlikely that the market will wait for the participants in LAURA to complete their deliberations.

The partners in LAURA are evaluating the application of CSMA/CD algorithms which allow point-to-point data transfer at full channel speed.

The situation is saved for the Europeans by the fact that the US committee investigating its own Hiperlan standard (Committee 802.11) is still a long way from making a decision. US proposals are all over the frequency band.

The nearest to the European standard appears to be Motorola with an Ethernet wireless LAN, operating at a transmission rate of 10 Mbit/s in the 18 GHz frequency band.

Fortunately for the Europeans they have come to a common agreement on the use of specific frequency bands for wireless LANs. In the United States the Federal Communications Commission (FCC) has already allocated the frequency band 902-928 MHz for use of systems based on SST.

The Europeans do not have time on their side. Apple Computer is lobbying the FCC hard for the 18 GHz band and it wants to enter the market in a big way. This means that we can expect to see an FCC ruling before long.

The key could be Olivetti's chairmanship of the ETSI European standards committee developing the Hiperlan standard. With a DECT LAN already on the market, Olivetti will do everything it can to prevent Europe losing out to the United States. (Source: *Electronics Weekly*, 23 June 1993)

#### Network connections

We are including a list of countries and their status with regard to network connectivity. The listing is reproduced in its entirety on the following page. Credit for this listing goes to Mr. Larry Landweber and the INTERNET Society. All changes and corrections should be addressed to Mr. Landweber (LHL@CS.WISC.EDU). (Source: *Internet society news*, Winter 1993)

International Connectivity (Version 7) by Larry Landweber lhl@cs.wisc.edu

X Afghanistan	X Cocos (Keeling) Islands	X Haiti	O Moldova	X San Marino	X Vietnam
X Albania	▷ Colombia	X Heard & McDonald Is.	X Monaco	X Sao Tome & Principe	X Virgin Islands, Br.
X Algeria	X Comoros	X Honduras	O Mongolia	▷ Saudi Arabia	O Virgin Islands, U.S.
X American Samoa	X Congo	X Hong Kong	X Montserrat	O Senegal	X Wallis & Futuna Is.
X Andorra	X Cook Islands	● Hungary	X Morocco	O Seychelles	X Western Sahara
X Angola	▷ Costa Rica	● Iceland	X Mozambique	X Sierra Leone	X Yemen
X Anguilla	O Cote d'Ivoire	● India	X Myanmar	● Singapore	X Yugoslavia
● Antarctica	● Croatia	O Indonesia	O Namibia	● Slovakia	X Zaire
X Antigua & Barbuda	O Cuba	X Iran	X Nauru	● Slovenia	O Zambia
● Argentina	▷ Cyprus	X Iraq	X Nepal	X Solomon Islands	O Zimbabwe
O Armenia	● Czech-Republic	● Ireland	● Netherlands	X Somalia	
X Aruba	● Denmark	● Israel	X Netherlands Antilles	● South Africa	
● Australia	X Djibouti	● Italy	X Neutral Zone	● Spain	
● Austria	X Dominica	O Jamaica	X New Caledonia	O Sri Lanka	
O Azerbaijan	O Dominican Republic	● Japan	● New Zealand	X Sudan	
X Bahamas	X East Timor	● Jordan	O Nicaragua	O Suriname	
▷ Bahrain	● Ecuador	O Kazakhstan	O Niger	X Svalbard & Jan Mayen Is.	
X Bangladesh	▷ Egypt	O Kenya	X Nigeria	X Swaziland	
X Barbados	X El Salvador	X Kiribati	X Niue	● Sweden	
O Belarus	X Equatorial Guinea	X Korea (North)	X Norfolk Island	● Switzerland	
● Belgium	● Estonia	● Korea (South)	X Northern Mariana Is.	X Syria	
X Belize	● Ethiopia	X Kuwait	● Norway	● Taiwan	
X Benin	X Falkland Islands	O Kyrgyzstan	X Oman	O Tajikistan	
X Bermuda	X Faroe Islands	X Lao People's Republic	O Pakistan	O Tanzania	
X Bhutan	O Fiji	● Latvia	X Palau	● Thailand	
O Bolivia	● Finland	X Lebanon	▷ Panama	● Tokelau	
X Bosnia-Herzegovina	● France	X Lesotho	▷ Papua New Guinea	X Tonga	
O Botswana	O French Guiana	X Liberia	O Paraguay	O Trinidad and Tobago	
X Bouvet Island	O French Polynesia	X Libya	O Peru	● Tunisia	
● Brazil	X French So. Territories	X Liechtenstein	X Pitcairn	▷ Turkey	
X Br. Indian Ocean Territory	X Gabon	O Lithuania	● Poland	● Turkmenistan	
X Brunei Darussalam	X Gambia	● Luxembourg	● Portugal	X Turks & Caicos Islands	
▷ Bulgaria	O Georgia	O Macau	● Puerto Rico	X Tuvalu	
O Burkina Faso	● Germany	X Madagascar	● Qatar	O Uganda	
X Burundi	● Ghana	X Malawi	O Re'union	O Ukraine	
X Cambodia	● Greece	● Malaysia	▷ Romania	X United Arab Emirates	
O Cameroon	O Greenland	X Maldives	● Russia	● United Kingdom	
● Canada	▷ Grenada	O Mali	▷ Rwanda	● United States	
X Cape Verde	▷ Guadeloupe	X Malta	X Saint Helena	X U.S. Outlying Islands	
X Cayman Islands	▷ Guadeloupe	X Marshall Islands	X Saint Kitts & Nevis	O Uruguay	
X Central African Republic	X Guadeloupe	X Martinique	X Saint Lucia	O Uzbekistan	
X Chad	O Guatemala	X Mauritania	X Saint Pierre & Miquelon	O Vanuatu	
● Chile	X Guinea	O Mauritius	X St. Vincent & Grenadines	X Vatican City State	
O China	X Guinea-Bissa	● Mexico	X Samoa	● Venezuela	
X Christmas Island	X Guyana	X Micronesia			

Legend:

- Internet
- ▷ BitNet but not Internet
- O EMail Only (UUCP, FidoNet, or OSI)
- X No Connectivity

Please send corrections, information and comments to:  
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 Include details, e.g., on connections, sites, contacts, protocols, etc.

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The complete International Connectivity table and map are available by anonymous FTP from: <ftp://cs.wisc.edu>

### Current status of coordination of information systems and services

At its Spring 1992 session, the Administrative Committee on Co-ordination (ACC) initiated a comprehensive review of its functioning and methods of work, and of those of its subsidiary bodies. Within this framework, the ACC decided, at its April 1993 session, to establish a Senior Level Task Force to review and make recommendations on the general requirements for dissemination of information, the means of harmonizing the United Nations information systems as well as the roles and mandates of the Advisory Committee for the Co-ordination of Information Systems (ACCIS) and the International Computing Centre (ICC).

After considering the report and recommendations of the Task Force chaired by the International Telecommunication Union (ITU), ACC took the following decisions:

- To discontinue ACCIS and to establish an Information Systems Co-ordination Committee (ISCC) reporting to ACC through its organizational committee. ISCC will have as members United Nations system organizations participating in ACC, represented by individuals who have a comprehensive understanding of information management issues and related technologies. It will work extensively with electronic means and will be supported by a small Secretariat.
- ISCC is to meet as soon as possible, before the end of 1993 or early in 1994, to finalize, for approval by ACC, the terms of reference proposed by the Task Force, establish a work programme and make proposals for the budget for 1994/1995. The Secretariat of the former ACCIS, the functioning of which is to be continued pending the relevant decisions to be taken by ACC at its next session, is to extend all possible assistance to ISCC in the preparation for its first meeting.
- ISCC is also to undertake an evaluation of the publications/databases currently being prepared by ACCIS with a view to identifying those that should be pursued and those that could be discontinued. Pending the outcome of this evaluation, the Secretariat of the former ACCIS is to proceed to the finalization of the information products which are near completion.
- The report of the last session of ACCIS is referred by ACC to the ISCC, to be taken into account in the elaboration of its work programme.

- The Management Committee of ICC is to study the possibility and modalities of implementation of the recommendations of the Task Force concerning the transformation of ICC into an information management services centre with a broader role to provide information-based services on a full cost-recovery basis.

As soon as plans for the structure and work programme of the ISCC are finalized, readers will be informed in an appropriate manner. (Source: *ACCIS Newsletter*, Vol. 11, No. 4, November 1993)

## II. NEW DEVELOPMENTS

### World's fastest neural computer claim

Researchers at Siemens Laboratories in Munich claim to have built the world's fastest and most flexible neural computer to date. The computer greatly reduces computing time for simulating and developing neural networks: the Synapse I neural computer completes in only 1.5 minutes computer operations that previously took a week. In its final configuration, the machine will be twice as powerful. The core of the computer comprises eight special chips geared to matrix-based computation-intensive operations in neural networks. Manufactured in a 1-micron CMOS process, the 187 mm<sup>2</sup> ASIC has 610,000 transistors capable of performing around 800 million synaptic weightings or multiplications and additions a second. (Source: *Mikroelektronik*, May/June 1993)

### STM goes multi with smart IC technology

SGS-Thomson Microelectronics (STM) has moved further down the path of putting the data processing and memory functions on chip with the power functions. The key to the company's smart power IC developments is a technology SGS-Thomson has dubbed BCD3.

The BCD (Bipolar/CMOS/DMOS) technology combines the high density of CMOS with the high precision analog of bipolar and the superiority of DMOS in high voltage applications.

With its BCD3 generation STM will soon put an 8-bit microcontroller and non-volatile EEPROM technology on the one chip. It also allows for the integration of fully isolated DMOS transistors with all the contacts on top.

STM has produced what it calls a technology demonstrator chip, the H081, which it is producing in samples on a 1.2 micron process. This is a device which combines a single 60 V smart power chip, an 8-bit

microcontroller and full H-Bridge DMOS power stage with overcurrent and overvoltage features.

Included in the device are the microcontroller, 64 Bytes of RAM, parallel I/O, a watchdog timer and clock oscillator. Address and data lines are provided for external program memory.

The device also includes a pin connected to an on-chip temperature sensing circuit. This can be used to implement smart power management schemes where the power output is reduced gradually to keep die temperature within limits.

The H-Bridge power stage consists of four vertical DMOS power transistors each with a drain-source on-resistance of 0.3  $\Omega$ . A built-in capacitive charge pump ensures that the high side switches are driven correctly by providing a gate voltage higher than  $V_d$  when an ON state is required.

The device also contains an over current protection circuit which prevents damage due to output short circuits to ground. The over current level can be chosen by changing the value of the external sensing resistors in series with the drain of the upper switches.

Every time an over current condition occurs the transistors are switched off. The condition remains until the input signals are reconfirmed. (Source: *Electronics Weekly*, 27 October 1993)

#### Drawing a blank

The paperless office is not a dream, it is a joke. Today more gadgets are devoted to spattering more paper with more ink than ever before. At last a Japanese manufacturer of office equipment, Ricoh, is trying to reverse the trend. It has developed a machine that takes in printed paper and spits out clean white sheets. The age of the recycling non-violent shredder may be about to dawn.

Most photocopiers, laser printers and plain-paper fax machines make their marks with a black powder, known as toner, which is melted onto the surface of the paper. The new machine sprays on a chemical to loosen the toner's grip, applies a little heat and then uses a sticky roller to peel the toner off.

Using this technology, a single sheet of paper can be recycled 10 or 20 times, depending on its durability. And as well as eliminating bins full of waste paper, the machine could silence the shredder. Anyone concerned about secrecy could erase his message rather than reduce it to tangles of shredded paper. The result would not fool the experts in a forensic laboratory, but it might well suffice for low-level security.

More work is required. The prototype cleans only three pages a minute. Ricoh has yet to show it can

make erasing old paper cheaper than buying new. And only the toner is removed: the machine cannot wipe out marks made by dot matrix printers or thermal-paper fax machines. Pen strokes and impressions made with ordinary printing presses are also immune. This means that text or figures produced with a laser printer could be altered, but letterheads and signatures on the same piece of paper would be left intact. (Source: *The Economist*, 28 August 1993)

#### Will the electronic notepad write its way to the top?

Electrical shops are beginning to fill with the latest gadget for the technology obsessed: pocket-sized computers that you write on with a pen and that can send faxes of your notes as well. But consumers will be caught in a familiar trap: manufacturers cannot agree on standards so each of these personal digital assistants, or PDAs, will have a different specification and need different software.

The PDAs aim to mimic personal organizers but instead of paper or a keyboard they have a liquid-crystal screen and a special pen which makes electronic ink appear when it touches the screen.

PDAs can store scribbles and sketches as images and turn handwriting into type; they all become more accurate as they become accustomed to a person's writing.

Each manufacturer hopes its specification will eventually become the de facto standard.

One of the most attractive features of PDAs will be their ability to communicate, either through a telephone socket or a mobile phone link. Both Apple's and EO's PDAs will be sold with an electronic mailbox, which people can send text messages to and retrieve messages from anywhere in the world.

Apple says its Newton will incorporate a cellular phone in 1994. But standards for cellphones vary around the world so PDA manufacturers are holding off finalizing their designs.

Ultimately, PDAs should be able to tap into office computers and databases from anywhere. Apple and Amstrad plan to install a receiver for the American global positioning system satellites in their models, so the PDA will tell you where it is and display a map of the area. (Extracted from *New Scientist*, 3 April 1993)

#### Tiny tools build micromachines

Much has been written about the promise of micromachines. A less glamorous topic is the tools which must be developed to assemble such devices. But functional microtools are a prerequisite to any futuristic scenario that has micromachines coursing through blood

vessels in search of cholesterol and other harmful substances.

At the University of Tokyo, a team led by Masayuki Nakao has developed a set of four microtools - three for grasping and one for carving - which can be used on objects that are smaller than 1 mm in scale.

The micro carving tool uses a long, narrow needle made of tungsten and cuts by means of ultrasonic vibration.

The three grasping tools differ in the method they use to grab hold of objects: air suction, electrostatic force and the surface tension force of liquid.

The air-suction tool combines a narrow glass tube (inner diameter of 0.1 mm) with an air pump. The suction force draws the object to the tip of the glass tube. When the suction is stopped, the object is released.

The surface tension tool also makes use of a hollow glass tube, but this time it is filled with a liquid. The surface tension of the liquid at the tip of the glass tube is strong enough to fix the object. To release the object, a light is shone on the tip to evaporate the liquid.

The electrostatic tool creates an electrostatic potential between the stand on which the object sits and a needle-like protrusion at the tip of the tool. The object sticks to the tool until the electrostatic force is removed.

In practice, these microtools are more complicated to operate than the above explanations suggest, mainly because once picked up, sub-millimetre objects are more difficult to release than normal-scale materials.

The Nakao team has used microtools to grasp a 0.3 x 0.7 x 0.6 mm cubic object, and to carve holes similar to the eyes found on dice in a 0.3 mm cube.

The researchers plan to develop a number of other microtools. Work is already under way on the design of a microlathe and a microdrill. The ultimate goal is to develop a microscale version of the machining centre, where a large number of microtools of different types and different functions can be interchanged as required for continuous machining and fabrication.

Microprocessing is not completely new. In fact, semiconductor manufacturers are already processing materials at the submicron level. However, in these applications, the object being worked on is relatively large and easy to fix in one place. In the case of

semiconductors, the work takes place on a silicon wafer that is more than 10 cm wide.

Fabricating a micromachine is different. Here, the object being worked on is of sub-millimetre dimensions, making it difficult to fix in a stationary position, let alone process. And at this scale, the effects of static electricity and the viscosity of liquids suddenly take on major significance.

Semiconductor fabrication basically involves the deposition and the etching away of thin films in predetermined patterns, so little movement of the object is required. In contrast, parts need to be moved around and assembled to fabricate a micromachine. The tools and techniques needed to accomplish this task are just now being researched and developed. (Source: *Nikkei Weekly*, 28 July 1993)

#### Boundary element software speeds structure analysis

Century-old mathematical formulations not previously thought to have commercial utility have led to the development of an analysis method now being used in complex engineering problems that may involve stress analysis, heat transfer, fluid analysis, or the yielding and cracking of solids.

The boundary element method functions on the premise that any homogeneous region of a system can be analysed by being subdivided into sections consisting only of surfaces, not so-called whole-body or three-dimensional elements. By calculating the surfaces, Prasant K. Banerjee, professor of civil engineering at the State University of New York (SUNY) at Buffalo, explained, predictions can be made about a system's internal behaviour. So instead of making time-consuming volume calculations, the method solves 3D volume problems as 2D surface problems. Although the boundary element method involves extremely complicated mathematics, it is easily accommodated by desktop workstations.

In 1990, NASA, which partially funded Banerjee's efforts, publicly distributed his research software through Cosmic, the technology transfer arm of the Department of Commerce. While other boundary element software packages exist, the codes on which Banerjee's software is based are still the only ones available to the public.

Banerjee and his colleagues at the university are now applying the boundary element method to computational fluid dynamics and to composites.

To provide support services related to the research software, Banerjee created a boundary element software package that he distributes through the Boundary Element Software Technology Corp. (Source: *Computer*, October 1993)

### Plastic displays

Plastic packaged liquid crystal displays (LCDs) are about to make a comeback. A recent study of 15 Japanese display manufacturers by the K&T Institute has shown that low-cost plastic LCDs with greater than 1024 x 768 resolution will be commercially available by 1997.

Although the plastic LCD was first developed in the 1980s, plastic device technology is currently well behind that of glass substrate LCDs with only small 64 x 32 dot displays available.

Japanese manufacturers are planning to invest in the process technology which will make 640 x 480 plastic LCDs possible within two years and by 1997 plastic devices with 1024 x 768 resolution. (Source: *Electronics Weekly*, 27 October 1993)

### Zone laser

AT&T Bell Laboratories has made a self-focusing semiconductor laser, which does not require a lens when used in optical fibre communications systems. The device, known as a zone laser, differs from traditional edge-emitting laser diodes because it emits the light vertically instead of horizontally. The vertical cavity geometry lases in a transverse mode which produces a Fresnel lens effect. The structure of the laser consists of zones separated by ion-etched trenches. The focusing action derives from a 180 degree phase shift between the outputs of different zones. The output is similar to that of a Fresnel lens. (Source: *Electronics Weekly*, 27 October 1993)

### Thorn research is music to the ears

Researchers at the Central Research Laboratories (CRL) of Thorn EMI claim to have finally cracked a problem which has baffled audio engineers for over 20 years - how to make natural stereo sound recordings.

The result of the three-year project, Sensaura, is a rack of 24- and 32-bit real-time digital signal processing hardware and patented software which enhances stereo sound to produce what CRL's principal scientist Alastair Sibbald called "an accurate aural picture".

The aim was to overcome the artificiality of traditional stereo and to do it with a recorded signal, which can be played on a standard CD system with two speakers.

The system uses an artificial head microphone configuration first proposed in the 1960s by scientists at IBM. What CRL has succeeded in doing is to develop the real-time signal processing system, which can characterize and then compensate for the features of the

sound, which create distortion when heard by the stereophonic human hearing system.

If you know the frequency and phase characteristic of the sounds heard by the ear, you can model the digital recording to produce the correct sound pattern at the speakers. Two features need to be compensated for: what Sibbald called the twice through the ear effect; and crosstalk between the ears.

In order to replicate the actual source sound pattern received by the brain, the CRL system digitally compensates for resonances and delays within the ear. (Source: *Electronics Weekly*, 27 October 1993)

### Seeing chips: developments in optoelectronics

Telecommunications and computer technology see light as the fastest carrier of information. Research laboratories are competing for new methods for intelligent image recognition systems and for optical signal processing. Double-digit growth rates indicate that optoelectronics is a technology of the future.

Today's traditional image recognition systems trail behind the eye in the ability to concentrate in a wide visual field on what is important at the moment. Previous camera-computer combinations break up a picture into points. They test around each point for changes. This awkward and complicated process is tied to an immense flood of information. If movements are to be included as well, it rapidly pushes against the limits of possible computational speeds.

Thus, one demand on research is to reduce data through preliminary information selection. The electronic imitation should function just like the eye, which in constant communication receives from the brain the advantage of focusing and then only passing on partial information.

The direction is clear, as the beginnings indicate: a "retina-switching circuit" with a photodiode matrix might pass on information only from the image or matrix dots, which signal just requested information. That could be all movements or only movements in a part of the visual field. Self-changing contours, surface structures or colours could also be such signals. Initial chips which imitate the individual functions of the retina have been developed by the California Institute of Technology. But they only recognize either contours or movements or shadings.

There is already a wish-list for applications fields. Things like electronic eyes for production monitoring and traffic routing systems, for environmental protection and minimally invasive surgery can be imagined. (Extracted from *Ingenieur Digest*, June 1993)



### Polymer chips

Currently, there is competition in science for high-performance optoelectronics components at low prices. The Jena Fraunhofer researchers want to be out in front with the integration of polymers and silicon.

Professor Karthe, the head of the Fraunhofer Institute for Applied Optics and Light Engineering in Jena, is thinking in a cool, calculating way of things close at hand, such as telecommunications or CD equipment. With the hundreds of methods used today in the microstructuring of semiconductors, new materials could also be skillfully created and, thus, totally new physical effects. Professor Karthe goes far beyond the pure directing of light. He is considering division and combination, modulation and amplification of light with new materials and combinations of materials. Everything could thus become more productive and more reasonably priced.

The Jena Fraunhofer researchers are therefore counting on silicon and polymers: materials which are practically predestined for mass applications. "We know from chip production how to handle silicon, what characteristics it has and how it reacts to the various steps of production", Karthe explains. And polymers have similar merits: they are easy to produce, are suited for cheap mass production and are easy to handle.

Work on the silicon-polymers combination material is being carried out in several research institutes in Germany. The BMFT (Federal Ministry for Research and Technology) and the EC (RACE programme) are fostering the most promising work. The Jena Institute is the only Fraunhofer Institute involved in this.

The Institute can already show some results: polyacrylate, polycarbonate, polyamide and polyimide, for example, attenuate optical waves to a very small extent. Some of these materials have superior electro-optical characteristics and can already compete with such materials as lithium niobate in light modulators and optical switches.

The Fraunhofer team is convinced that they are on the right track: it will be possible to produce integrated optical polymer components with conventional moulding and injection moulding at extremely low prices. While lithium niobate switches can hardly be obtained on the world market for under \$3,000, Professor Karthe envisions the price of future polymer switches to be under DM 100.

The silicon-polymers combination material is destined not only for switches. The researchers in Jena have tested the most varied hybrid components. One of them: polymer waveguide components (branching elements, lattices, couplers) which were integrated into a silicon substrate. The next stage is the inclusion of

gallium arsenide LEDs and processor chips with integrated silicon photo receivers. (Source: *Ingenieur Digest*, June 1993)

### Glass fibre chip

Optical-fibre cables carry data over long and mid-range distances at a very reasonable cost. One weak point is still the conversion of the light pulse into electric signals. A Berlin scientist wants to put optics and electronics together on one chip.

Dr. Herwig Kogelnik is forecasting rosy times for the optical-fibre industry. The director of the photonics research laboratory at AT&T promises a new, enormous market for the field.

The success heralded for long stretches has long existed for optical-fibre cables for long distances. They are cheaper than copper connections and, over intercontinental stretches, even more economical than satellite communication. In the opinion of Kogelnik, "a level has been reached," in production technology "which makes the transmittal of information by means of light competitive and soon superior even for short distances". However, there is a catch here: the equipment technology for converting light into electric signals is still too costly. Thus far it has been necessary to have a separate light-directing disk of glass for incoming waves, photo diodes for their conversion into electric signals and other components which process and interpret the signals.

Professor Klaus Petermann, the acting director of the Institute for High-Frequency Technology of the Technical University of Berlin, has long been concerned with joining glass and silicon. If that can be done on one chip, it is an advantage not only in terms of space and cost but also a plus for quality.

Petermann is in any case convinced that herein lies the alternative to material systems made of gallium arsenide or indium phosphide, which are overly complicated and too expensive. However, these materials do have the advantage that they permit the reconversion of electric signals into light pulses. But silicon is available relatively economically from the large-scale production for microelectronics.

There is still something else to be said for silicon: its coupling to optical fibre could offer the added chance for it to remain the principal material used in microelectronics. This would be possible because silicon is transparent for the infrared light carried by optical fibre.

Signal attenuation does indeed cause problems at the transition from glass to silicon. While the loss of light in the fibre is less than 10 per cent per kilometre, it is significantly higher in silicon. This can cause difficulties, even if the optical information at the end of

the communication distance only has to overcome centimetres in the chips.

Petermann succeeded in lowering the attenuation in silicon to less than 10 per cent per centimetre. To do this, germanium is diffused into the silicon chip in strips.

If Petermann succeeds in uniting the processing of optical and electric signals on one chip, it would provide several advantages. First, the error liability of the system could be substantially reduced and the operating quality increased. Second, with the use of single components there would no longer be the very costly optical adjustment. Instead, mass production of the optoelectronic chips with the technology of microelectronics would be possible. In the end that would be beneficial to the economic networking of computer systems with optical fibres.

The construction of intelligent networks over optical-fibre cables in local areas would bring substantial gains in speed and even include households. The leap forward to new quality and quantity in telecommunication would be possible and affordable. However, Petermann calculates that a 0.125 mm thick optical-fibre cable can accept 30,000 to 40,000 telephone channels, a 10 mm copper coaxial cable on the other hand only about 10,000. And the limit is far from being reached. (Source: *Ingenieur Digest*, June 1993)

#### Low threshold buried-heterostructure AlGaAs lasers

A study of low threshold GaAs GaAlAs BH lasers is reported by scientists at the Institute of Semiconductors, CAS, and the National Integrated Optoelectronics Laboratory, Beijing. Using an LPE system, LPE growth of a DH (double heterostructure) wafer and LPE regrowth of a BH wafer were performed. By optimization of the structure design and improvement in process technique, the expected performance of low threshold current was achieved. The broad area threshold current density of the DH wafer is generally in the range of 800-1,000 A/cm<sup>2</sup>, and the lowest is 675 A/cm<sup>2</sup>. After the LPE regrowth, the threshold current is lower than 10 mA, and the lowest is 4 mA. This is one of the lowest thresholds for a DH laser diode yet reported. (Source: *Chinese Journal of Semiconductors*, July 1993)

#### Aluminium nitride packages

Toshiba has developed an aluminium nitride (AlN) surface-mount type pin grid array (SM-PGA) package suitable for emitter-coupled logic (ECL) devices that operate at very high speed and high frequency. The package satisfies the requirements for both a small parasitic effect and low thermal resistance. In addition, the compact configuration obtained by means of a cavity-up structure results in a shorter signal

delay time than conventional alumina packages when mounted on a mother printed wiring board (PWB). These advantages are realized due to the synergistic effect of the high thermal conductivity and high electrical resistivity of AlN ceramics. (Source: *Toshiba Bebyu*, May 1993)

#### Minute conveyor system is pneumatically driven

A pneumatically driven conveyor system designed to transport and position extremely small objects has been developed by a group at the University of Tokyo's Institute of Industrial Sciences.

The group made the prototype as part of a wider effort to develop practical tools for the fabrication and manipulation of micromachines.

The prototype conveyor system consists of a series of 63 pneumatically driven actuators spaced about 2-3 millimetres apart on a silicon base. Objects are moved around by controlling the flow of air blowing up from beneath the base.

To make the device, the group first drilled 63 rectangular holes in the silicon base, each hole measuring 180 x 80 microns. Each opening was covered by a thin film of polyimide with an electrode attached at each end.

Resting above the holes, these films act as valves. When voltage is applied, the valves stick to the silicon substrate and keep the holes shut, preventing the flow of air upward. But when the voltage is turned off, the air has enough force to deflect the valves upward and escape.

By controlling the voltage to each valve separately, it is possible to direct the flow of air in an orderly fashion and move a small object around the surface of the device on a cushion of air. In one test of the prototype, the group moved around a silicon wafer measuring 1 mm square and 0.3 mm thick. (Source: *Nikkei Weekly*, 12 July 1993)

#### PC video chip

A \$55 chip which brings full-colour, full-motion video to the PC has been developed by California startup Oak Technology. The chip, called OTI-107 Spitfire, makes it possible to design video capability into PC's as a standard feature without add-in boards. Oak Technology's device displays the video on a computer display screen in 16 million colours (24-bit colour). Building video on a mother-board requires two additional chips, both from Brooktree in California: the B1812 which digitizes video into the YUV format; and the B1884 video RAMDAC, which produces the analog RGB signals for the PC monitor. (Source: *Electronics Weekly*, 14 July 1993)

### Three-day wafer

Texas Instruments says that by using the "cluster" method of chip manufacturing, where groups of manufacturing tools containing their own vacuums are coupled together to reduce wafer transportation distances and to cut down on the need for large-area cleanrooms, it is possible to manufacture a single wafer in three days whereas the traditional manufacturing procedure of making batches of wafers at a time takes two to three weeks. (Source: *Electronics Weekly*, 14 July 1993)

### Germanium back in favour with chip firms

Germanium is on the way back, according to Jean-Pierre Noblanc of France's Centre National d'Etudes Telecommunications (CNET) in Grenoble, the microelectronics research arm of France Telecom.

At GEC Plessey Semiconductors in Swindon, there are moves to up the world-beating speeds of its bipolar products by using germanium in the material from which it makes its chips.

According to CNET's Noblanc, an alloy of germanium and silicon (SiGe) will be used as the material for its 0.25-micron BiCMOS processing. Noblanc said that CNET had developed a SiGe alloy in which germanium constituted 0.3 per cent and silicon made up 0.7 per cent of the total mass.

Noblanc said that the best advantages of SiGe came in MOSFETs, bipolar and BiCMOS chips. (Source: *Electronics Weekly*, 14 July 1993)

### University serves up cooler chips

Researchers at a US university have developed a novel circuit cooling technology that uses fluid embedded inside the chip itself to carry heat away from hot spots.

Staff at Texas A&M University at College Station, Texas, have patented a process of building miniature fluid-filled heat pipes on the bottom of a silicon chip. The tiny pipes carry heat away from hot spots on the chip, distributing it over a larger chip area for faster, more efficient cooling.

The micro heat pipes, which are 80  $\mu\text{m}$  in diameter, are filled with a measured amount of coolant - the university uses methanol. Fluid in a hot part of the chip will boil and migrate down the pipe to a cooler region, away from the hot spot, where it condenses back to a liquid again.

This alternate vaporizing and condensing of fluid in different regions produces a capillary pressure difference between the evaporation and condensation sites, which results in continuous movement of the

coolant, distributing heat uniformly around the chip. (Source: *Electronics Weekly*, 14 July 1993)

### The finest grey scale yet

One hundred thousand times the information density of a common laser printer and 2,000 times the density of the highest-resolution process available today - that is the boast of a new printing process. Developed by Oxford Computer Inc. in Oxford, Connecticut, it can print 100 million pixels per square centimetre.

Moreover, whereas standard printing processes simulate shades of grey by combining black and white dots of various sizes, every pixel in the Oxford Computer process can display one of at least 50 shades of grey. The company expects the technology will be useful for many forms of transmissive analog optical memories, though its first application is medical. (Extracted from *IEEE Spectrum*, October 1993)

### Organic electron traps found

Several organic compounds will not only produce electric charges in the presence of light but also trap the electrons in the minutest of spaces when the light is turned off. The substances were identified by chemists at the University of Texas at Austin.

No other materials with this property have been discovered, according to team leader Allen J. Bard, in the department of chemistry and biochemistry. He believes that their capacity for trapping electric charge may promise a new means of information storage.

Zinc octakis porphyrin was the first light-trapping organic substance to be found. Synthesized by Bard's former graduate student Brian Gregg, it is similar to the haemoglobin in human blood, but zinc- rather than iron-based. Encircling the zinc atom are four nitrogen atoms to each of which are bonded two fatty molecules, so that the molecule has eight arms extending outward from the zinc hub.

The substance worked well as a solar cell, but a post-doctoral fellow in Bard's group, Chong-yang Liu, discovered that the material retained its electric charge indefinitely when the light was turned off. The group has since found that the zinc compound is one of a family of organic substances with similar properties, which may have certain advantages over inorganic silicon.

For example, in the newly discovered photoconductive material, the elementary memory cell is as little as 40 nm in diameter, corresponding to a density of 79 gigabits per square centimetre -  $10^4$  times denser than a 64 M-bit RAM. In the new memory medium the write/read time is in the sub-nanosecond range - one or two orders of magnitude faster than for

a state-of-the-art silicon device. No refreshing is required by the new medium, which is also non-volatile. Finally, it has been erased and rewritten more than 1.5 billion times without any change in output current.

The new memory system might be used in a variety of ways, for example, for electro-optical disk-type backup storage. (Source: *IEEE Spectrum*, October 1993)

### The mercurial rise of a superconductor

A new superconductor, which contains mercury and is easy to make, has been demonstrated by an international team of scientists. The team believes that similar materials will become superconductors - that is, lose all electrical resistance - at a temperature as high as 125 kelvins (-148°C), the highest known transition temperature for a superconductor.

The superconductor, which loses its resistance when cooled below 94 K (-179°C), is made of layers of copper oxide, interspersed with layers of mercury oxide and barium oxide. It has a similar structure to the material with the highest known superconducting transition temperature, except that it has fewer layers of copper oxide and contains mercury instead of thallium.

Massimo Marezio of CNRS, Grenoble and AT&T Bell Laboratories, Murray Hill, New Jersey, and a team from Russia, France and the United States, mixed barium copper oxide with a mercury oxide and baked them at 800°C for five hours. A variant of the mercury compound with more copper oxide layers could reach the record superconducting transition temperature, says Marezio.

The basic building block, or unit cell, of the compound is  $\text{HgBa}_2\text{CuO}_4$ . It contains a layer of copper oxide, followed by layers of barium oxide, mercury oxide and barium oxide. The structure of the compound is also denoted as Hg-1201, where the figures represent the numbers of mercury, barium, calcium or yttrium, and copper atoms.

In contrast, the thallium version of the 1201 compound,  $\text{TlBa}_2\text{CuO}_6$ , becomes superconducting only below 10 K (-263°C). Several groups of researchers believe that replacing the thallium in other superconductors with mercury could produce compounds with much higher superconducting temperatures.

Marezio and his colleagues have already made a variant on Hg-1212 with yttrium instead of calcium, but it did not become a superconductor. However, the researchers believe the calcium material is more likely to become a superconductor because of the way its electronic charges are distributed in the molecule. (Extracted from *New Scientist*, 27 March 1993)

### Superconductors increase their pulling power

Japanese scientists have developed a superconductor that can keep a magnet suspended below it rather than floating above it. Researchers say the magnetism of the superconductor is much stronger than that of the conventional type, allowing a much greater weight to be gripped.

In a demonstration, a team lead by Masato Murakami at the International Superconductivity Technology Research Centre in Tokyo cooled a sample of the superconductor with a diameter of 8 centimetres to around 93 K (-180°C) inside a bowl of liquid nitrogen. They then suspended a 10-kilogram globe of the Earth two centimetres below the superconductor.

The superconductor is made of yttrium barium copper oxide (YBCO). By adding impurities such as silver, and controlling the alignment of crystals as they were growing, the Japanese researchers were able to induce magnetic attraction in the superconductor, a property known as "flux-pinning". The strength of the magnetism depends on the way the crystals are formed.

Murakami and his team are trying to improve the strength of the YBCO superconductors because they hope to apply them to frictionless, magnetic flywheels. These could be suspended in a vacuum above or below a superconductor, made to spin by means of electric currents passing through coils around them. (Extracted from *New Scientist*, 7 April 1993)

### Gas mask promises cheaper chips

The most advanced silicon chips could be made more cheaply and easily with a technique developed at AT&T Bell Laboratories in New Jersey. Researchers there have now made chips entirely of gases - instead of the liquid chemicals normally used. Gases are easier to handle than liquids and allow the circuits on the chips to be packed more densely, reducing the cost.

Until now, photoresist has been a liquid lacquer which is developed and eventually removed by liquids. The entire process requires large amounts of solvents and purified rinsing water, as well as extensive plumbing. But now Timothy Weidman and Ajey Joshi at Bell Laboratories have found a photoresist which can be deposited on the silicon, developed and removed using gases.

The silicon wafers are first put into a vacuum chamber, from which air is removed and various gases let in. Then a plasma is formed. Oxygen and chlorine can be used to etch while silane and metal organic gases are often used in deposition.

Weidman and Joshi's replacement for photoresist is a layer of a polymer called methyl silicon hydride,

which is deposited from a plasma of methylsilane gas. Exposing the layer to ultraviolet breaks the bonds between silicon atoms and they couple with oxygen from the air. This turns the polymer into a glass-like layer. A plasma of chlorine gas then removes the unexposed hydride. One of the disadvantages of using plasmas is that the ions in the gases can have very high energies and damage anything they collide with. Weidman says the energy of the methylsilane plasma is kept as low as possible to avoid damaging the light-sensitive hydride.

A dry lithography system could be linked up closely to cluster tools. A cluster is a mini production line, compact enough to be kept entirely under vacuum. It keeps contaminants such as dust and molecules from the air away from the delicate partly-made chips, and prevents chips being damaged as they move around. Dry lithography could form part of a cluster, but liquids cannot be used with clusters or vacuums. (This first appeared in *New Scientist*, London, 13 February 1993, the weekly review of science and technology.)

#### Matsushita develops quartz on-silicon technology

Matsushita Electronics has developed a Quartz Crystal on Silicon (QOS) technology by which a liquid crystal oscillator is directly bonded on a silicon baseboard. Water is absorbed in silicon and liquid crystal (SiO), and the material is dried in air, then bonded and finally heat processed by nitrogen gas. The method is quite simple. By applying this technology, mobile phones can be made compact and reduced to the size of a wrist-watch.

Current liquid crystal oscillation devices used for wireless communication are made by a liquid crystal board shaped with an oscillator which is bonded with a metal or ceramic baseboard, and it is connected to a separately made transmitter circuit and electrodes. The size of the transmitter is about 10-15 mm<sup>2</sup> with the thickness of 10 mm.

On the other hand, if the QOS method is employed, then the IC for the liquid crystal oscillator, and IC for signal processor can be packaged on the same silicon baseboard. Thus an oscillator can be made quite compact with the size of about 5 x 5 x 0.5 mm, which is 1/50-1/100 less than normal size.

Furthermore, it was previously not possible to make the liquid crystal oscillator thickness less than 30 µm because of manufacturing constraints, but the QOS method employs a filing process to adjust the thickness after the liquid crystal is deposited on the silicon baseboard so that a thickness of about 5 µm is possible. As a result, it is possible to make liquid crystal oscillation which can generate higher frequencies. Currently a clock cycle of 50 MHz is the maximum limit, but 120 MHz was experimentally produced. (Source: *Nikkei Materials and Technology*, June 1993)

#### Toshiba reduces 1 MB DRAM chip area

In order to realize the next generation of 1 giga DRAM, Toshiba has developed a new memory cell configuration which reduces the chip area by 20 per cent and is operable with less than 1 volt. The new wiring technique and chip area is reduced and the new circuit minimizes the influence of leakage currently preventing increased power consumption. By making the chip area small, yield from a wafer is increased and cost is lowered. One giga DRAM is expected to become indispensable as a large-capacity memory for the coming era of practical multi-media information devices.

Although DRAM generally employs the back-to-back method of memory cell layout, it is difficult to reduce the memory cell area. The new technique has solved the problem by cell layout, not by the micro-technique of chip design. Word lines which function as a switch gate and bit lines which send information to an amplifier are configured with the new technique, so that the area of one memory cell is reduced by 75 per cent, and the overall chip area reduced by 20 per cent.

Also since high integration and low voltage are desirable for portable communication devices, a conveniently portable device using a regular battery was assumed, and low voltage operation using less than one volt became possible. (Source: *Nikkan Kogyo Shimbun*, 24 May 1993)

#### Mitsubishi develops world's lowest power consumption analog to digital converter

Mitsubishi has developed the world's smallest A/D converter, consuming only 500 milliwatts of power. Power consumption is about two thirds of current converters. Since the device can convert analog signals such as TV signals to digital with high speed and high precision, Mitsubishi aims at application to high definition TV.

The key characteristics of the converter are high speed and high precision operation while maintaining low power consumption. The converter is operable with a single 5 volt power source, and can convert input signals into 50 million digital signals/second. The digital signal can display with 1,024 levels (gradient), and resolution is quite high.

So far the A/D converter developed by Philips that was announced at ISSCC last year was the world's smallest, using 750 milliwatts, but Mitsubishi has achieved a device smaller than this world record.

Generally, A/D converter input analog signal voltage is processed lower than it really is in order to operate with low voltage, which makes a base voltage difference that requires conversion. Mitsubishi has developed a new circuit called a "voltage differential

digital converter circuit", so that power consumption was reduced using this differential process and conversion process.

Mitsubishi plans to make the LSI for an image processor combining this A/D converter circuit and signal processor. The development is expected to be applied to a high definition TV that has five times higher screen resolution and will be sold widely in the near future. The converter equipped with high speed and high resolution signal processing capability will be a good candidate for major applications. (Source: *Nikkei Sangyo Shimbun*, 25 May 1993)

#### Hitachi develops next generation of Bi-CMOS

Hitachi has developed the next generation of high speed BiCMOS operating with low voltage. The size of transistors that make up the circuit is reduced to 0.2 micron, half of the current size, and the device is 1.6 times faster than existing low voltage CMOS. In the past if the low operational voltage was applied to a microscopic circuit, the high speed characteristic of BiCMOS was lost. However, the problem was overcome by placing a diode in the circuit.

Hitachi plans to apply the developed circuit technology to a microprocessor that is four to five times faster than current products.

BiCMOS combines a bipolar transistor and low power CMOS transistor and has the advantage of both characteristics.

Using the technology, an arithmetic circuit was made with 0.25 micron level. The device was tested using 2.5 volts, which is half the operational voltage currently used for BiCMOS, and it was found that signal communication time is 100 picosecond, 1.6 times faster than a CMOS circuit operated at the same voltage level. If the existing circuit technology is applied, the speed will stay the same as the CMOS circuit.

It is said that the new technology can be applied to the next generation LSI, which employs 0.1 micron level. The circuit will operate at a high speed even using a low voltage source, such as a 1.5 volt battery. (Source: *Nikkei Sangyo Shimbun*, 21 May 1993)

#### Darmstadt College of Technology develops microphone chips

Very small microphones, manufactured using micromechanics techniques, are starting to replace conventional transmitters. These silicon microphones bring together the acoustic sensor and amplification electronics on a single chip. The first applications are likely to be hearing aids.

This new type of transmitter is not an individual component, but a small package on a microchip. By

means of etching and targeted "contamination" with suitable substances, a pressure-sensitive zone is created, only a square millimetre in area and a thousandth of a millimetre thick.

Part of the microchip thus becomes a piezoelectric crystal whose principal property is that pressure variations, such as those caused by sound, produce changes in the voltage between the ends of the crystal.

The transmitter is insensitive to vibration, such as that caused by walking. This fact, together with its unprecedented compactness, makes the silicon microphone ideal for very small hearing aids that fit invisibly inside the auditory passage. Electret capacitor microphones, which have to date been the smallest sound transmitters, are at least twice as large.

Another decisive advantage of silicon microphones is that they can be cheaply mass produced, as the sensor and amplifier circuit can be manufactured as one piece and, consequently, in a single production process. Over a dozen microphone sensors can thus be produced on a silicon wafer and separated right at the end of the manufacturing cycle.

However, the direct conversion of a sound into an electrical signal is impractical for some applications, as data exchange along electrical cables is increasingly giving way to optical communications. Optical microphones that generate a direct light signal for optical fibre lines, bypassing the electronic stage, are therefore being developed. Their sound sensor is a membrane lit by a light diode: when an acoustic signal strikes the membrane, it modulates the light beam. (Source: *Sueddeutsche Zeitung*, 22 April 1993)

#### High-resolution X-ray reducing lithography technology

Hitachi's Central Research Laboratory has succeeded in transferring a 0.07  $\mu\text{m}$  pattern, equivalent to the patterns needed for 16 Gb DRAM, using an X-ray reducing lithography technique on the synchrotron orbital radiation (SOR) facility at the National Laboratory for High Energy Physics of the Ministry of Education.

The resolution of existing optical lithography technology has improved to about 0.05  $\mu\text{m}$  patterns using transparent masks, at the research level, but the transparent masks are only about 0.1  $\mu\text{m}$  thick, and therefore susceptible to distortion. The reflective mask used to etch the pattern in the new approach, however, can be made with a thick substrate about 5  $\text{mm}^2$ , and transfer pattern positioning precision is high.

The test was designed to demonstrate the principles for X-ray reducing lithography resolution. The company plans to continue research and development, with an eye towards practical application.

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#### DRAM vias will be filled with aluminium

A new processing technique developed in Japan will enable aluminium instead of tungsten to be used to fill the via holes between the layers of 256 Mb DRAM products. The technique has been developed by NEC, Nichiden and Sumitomo Chemical Industry, and offers the advantage that the lower resistance of the aluminium enables the devices to operate at a greater speed.

It had been intended to use tungsten to fill the holes, because it has proved very difficult to deposit aluminium into the via holes used in 256 DRAM devices which are only 0.3  $\mu\text{m}$  in diameter and 0.8  $\mu\text{m}$  in depth. The aluminium has tended to stick at the top of the holes and it proved very difficult to cover the surface of the bottom of the holes.

The new technique employs dimethyl aluminium hydride as the source gas in a chemical vapour deposition process. This enables the process temperature to be reduced to the 100°C to 130°C range where the particles of aluminium no longer adhere to the entrances to the holes. (Reprinted with permission from *Semiconductor International* magazine, October 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

#### MCMs operate at up to 300 MHz

The Japanese NEC company has evolved a multichip module (MCM) that is capable of operating at up to 300 MHz. The company employs silicon wafers as substrates with standard IC processing technology. Solder bumps are used for the chip to module connections rather than wire bonding, since this reduces the inductance and therefore the noise by a factor of about ten. NEC spaces the solder bumps at 1,200  $\mu\text{m}$  intervals so that standard chips can be employed for the flip-chip connections.

A polyimide layer film of low dielectric constant is employed to minimize the wiring capacitance. A plating technique enables the wiring layer to be thickened and hence the resistance of the wiring to be reduced. The company says that the high wiring density possible with a silicon substrate, combined with the flip-chip connections, enables the total wiring length to be reduced to one seventh of that of previous products. The signal transmission delays are thereby reduced. (Reprinted with permission from *Semiconductor International* magazine, October 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

#### Fujitsu moves in on superfast junctions

Fujitsu has made a breakthrough in the development of integrated circuits based on superconducting Josephson junctions, which could be used to build superfast "Josephson computers".

The Japanese firm has developed a modified design for the Josephson junction which it claims is five times smaller than the standard version. Using the new design Fujitsu says Josephson chips containing up to 10,000 gates can be produced on a mainstream 0.8-micron fabrication process.

A Josephson junction is made up of two superconducting elements separated by a very thin insulator.

Fujitsu has cut the area taken by a single junction by using high-resistivity zirconium instead of molybdenum in the junction resistor, so reducing the amount of material required, and by putting the control circuitry in a separate layer underneath the junction elements. (Source: *Electronics Weekly*, 1 September 1993)

#### Digital signal processor

Motorola has introduced a 16-bit digital signal processor aimed at digital cellular phone applications which handles voice compression, modem and control functions. It combines a 16-bit 56100 processor core with an on-chip 14-bit sigma-delta codec, a phase-locked loop and Motorola's on-chip emulation (OnCE). There is also an internal memory of 4k x 16 data RAM, 256 x 16 program RAM, 4k x 16 data ROM and 8k x 16 program ROM. The programmable phase-locked loop allows the chip to use a low-frequency external system clock for full-speed operation while also supplying an output clock synchronized to a synthesized internal clock. The clock speed of 60 MHz enables the chip to process up to 30 million instructions per second. (Source: *Electronics Weekly*, 1 September 1993)

#### French flat CRT display technology for Texas

Flat cathode ray tube (CRT) display technology invented by the French Atomic Energy Commission has been licensed by Texas Instruments.

The technology, which uses cold cathode field emission and supports a CRT less than 5 mm thick, will be developed into commercial products for laptop computers by Texas Instruments and Pixel, the French company given the exclusive rights to manufacture the technology.

According to Francis Courreges, Pixel's vice-president of sales and marketing, the company has

already demonstrated a 6-inch display which is less than 2.5 mm thick.

Although Courreges described the field emission display (FED) as a flat CRT, it does not rely on the creation of electrons using thermal ionic emission.

Miniature cold cathode microtips emit electrons as a result of electromagnetic field excitation using an electronic gate structure on each tip. Because the cathodes are less than 200 microns from the phosphor plate which registers the display, there is no need for electrical focusing. This reduces the complexity and the power consumption of the FED.

According to Courreges, FEDs have the wide viewing angle of CRTs, but with the advantages of thinness, low power consumption and a robust design which he claims will easily translate into full production.

Resolution is determined by the number of microtip cathodes behind each pixel. The tips are around 1 micron in diameter and there can be anything from tens to hundreds of them behind each pixel.

Texas Instruments is the first company to license the Pixel technology, but the French display maker expects to follow this with further agreements with the United States and Far Eastern manufacturers.

Pixel itself will start its own pilot production in the second half of next year. (Source: *Electronics Weekly*, 1 September 1993)

#### IBM gains high density fillip

IBM researchers claim a breakthrough that will allow them to build high density disk drives storing more than 30 times their present capacity and will allow magnetic media to compete with high density optical data storage systems.

Scientists at IBM Adstar, its hard disk manufacturing subsidiary, say that the technological breakthrough makes it possible to manufacture disk drives with storage densities of as much as 10 billion bits of information per square inch compared with 350 million bits per square inch for IBM's high end disk drives.

Adstar researchers have discovered a new method to produce the phenomenon of "giant magneto-resistance". This allows disk drive heads to detect weak magnetic fields and increase data densities in drives using magneto-resistive head technology. IBM claims that magneto-resistive head technology allows for increases in data densities in hard disks of as much as 60 per cent per year at a compound growth rate.

The "giant magneto-resistance" phenomenon results in the generation of a five times stronger

electrical signal, enabling disk drive heads to detect more data at higher densities. IBM researchers built a special multilayer material made out of thin-film alternating layers of magnetic and non-magnetic materials consisting of nickel-iron alloy and silver layers. The structure was then heated and the magnetic poles in each magnetic layer were aligned in the same direction. This alignment of magnetic poles is believed to be responsible for generating the giant magneto-resistance phenomenon that makes it easier to detect small magnetic fields. IBM is now working on a prototype head able to read data at high densities. It is also planning commercial production of the head and drives. (Source: *Technology Weekly*, 1 September 1993)

#### Japan boosts storage:

Researchers at Japan's Tohoku University have developed a method of creating hard disks capable of storing as much as 100 times more data than current drives.

The researchers working at eight private technology firms say they used clean rooms to develop a new type of hard disk material made up of layers of cobalt-nickel-chrome which increases the magnetic properties of the hard disk, allowing for higher data densities. Magnetic retention is increased by as much as 60 per cent compared with current hard disks.

The eight firms involved in the project plan to produce commercial hard drives based on the new technology. (Source: *Technology Weekly*, 1 September 1993)

#### Toshiba solder system

Toshiba has developed a tape-automated component bonding system which completely automates the entire soldering process, starting with the deposition of flux on the PCB.

Unlike conventional techniques where flux is manually deposited on PCBs, the new technique uses a specially developed head and brush which ensures a uniform coating of flux on each PCB. It integrates into Toshiba's tape-automated bonding (TAB) system achieving full automation from cutting individual semiconductors from the tape on which they are carried to soldering them to PCBs. Toshiba will initially use the new technique for its own production. (Source: *Technology Weekly*, 1 September 1993)

#### Mercurial superconductor shows an acceptable face

In March 1993 a new high-temperature superconductor based on mercury was made by a Russian scientist. Now a team of American scientists has discovered that it possesses a property unique among such materials: it is easy to fabricate, making it very attractive commercially.



Most high-temperature superconductors, which are based on yttrium or bismuth, have properties which depend on how the particles are aligned. So in order to produce the best results, all the particles must be made to point in the same direction, a process which is time-consuming and expensive.

For example, bismuth-based superconductors are usually made in a complex rolling, drawing and heating process, which limits the shapes that can be made.

Jennifer Lewis and her colleagues at the University of Illinois and the Argonne National Laboratory found that the magnetic properties of the mercury superconductor do not depend on the way in which its particles are aligned. This was true at magnetic fields of about 1 tesla - similar to normal operating conditions - but not at very low fields. The researchers embedded particles of the material, which also contains atoms of barium, copper and oxygen, in an epoxy matrix.

Easier fabrication would be a substantial money-saver for industry. However, the synthesis of the new superconductor is a little dangerous because it involves mercury, a hazardous substance. (This first appeared in *New Scientist*, London, 21 August 1993, the weekly review of science and technology.)

#### A turn-off for superconductors

A novel type of molecular switch that controls superconductivity may lead to a new generation of superconducting circuits and devices, according to scientists from the University of Texas at Austin. They believe they are the first to use conducting polymers to control electricity flow in superconducting films.

A very thin layer of superconductor is deposited on a base of magnesium oxide, explains John McDevitt. Then, once a superconducting circuit has been microfabricated, the polymer, such as polypyrrole, polyacetylene or poly-3-hexylthiophene, is electrochemically coated on top of it.

In its neutral state, the polymer coating has no effect on the circuit. This is the "on" position, says McDevitt. On oxidation, the polymer becomes conducting and substantially weakens the circuit's superconducting properties - the device is turned "off".

It is similar to when semiconductors are switched into good conductors by doping. "The important difference is that doping is irreversible, whereas here the polymer can be cycled between conducting and insulating states by adding or subtracting electrons."

The switch has one big advantage: polymers and high temperature superconductors are chemically compatible. "Compare this", McDevitt says, "to conventional conductors such as silicon, copper or tin,

which when used as contacts react with the superconductor, damaging both materials".

However, there is one drawback. The polymer is oxidized at room temperature but the superconducting properties are only observed at liquid nitrogen temperatures.

"Practical devices need the oxidation process to be completed at low temperatures - that is below the transition temperature of the superconductor", McDevitt explains.

In addition to making new devices, McDevitt believes that information gained from studying conductive polymer/superconductor devices may help to elucidate the nature of superconductivity in ceramic superconductors and also shed light on the conduction mechanism in conducting polymers. (Source: *Chemistry and Industry*, 3 May 1993)

#### Mercury-containing superconductor has high $T_c$

A mercury-barium-copper oxide that is superconducting at temperatures as high as 94 K has been discovered jointly by researchers in Russia, France and the United States. Although many cuprate superconductors have been discovered in the past six years and some of them work at even higher temperatures, the new compound,  $\text{HgBa}_2\text{CuO}_{4+\delta}$ , is especially promising for several reasons. It is structurally simple and apparently easy to synthesize, unlike many recently discovered copper oxide superconductors. And the smaller separation between its  $\text{CuO}_2$  layers may lead to advantageous superconducting properties, according to its discoverers, S.N. Putilin of Moscow State University and colleagues. Moreover, the compound's transition temperature ( $T_c$ ) of 94 K is "very high, especially for a superconductor based, as it is, on a single copper layer", says Robert J. Cava, a prominent superconductivity researcher at AT&T Bell Laboratories in Murray Hill, New Jersey. If other members of this family can be synthesized with double or triple  $\text{CuO}_2$  layers, Cava says, they should work at even higher temperatures, holding out the hope of breaking the 127 K record currently held by a superconductor with two thallium and three copper oxide layers. Development of the thallium compounds has slowed because of several problems. Perhaps  $\text{HgBa}_2\text{CuO}_{4+\delta}$  or another member of this new cuprate family, will have a lofty  $T_c$  without those problems, Cava suggests. "Only further research will tell", he adds. (Source: *Chemical and Engineering News*, 22 March 1993)

#### New device targeted for 800 GHz fabricated with metal and insulator only

A group at Tokyo Institute of Technology has tested a switching element that can be expected to operate at the high speed of 800 GHz, and they

confirmed its operation under liquid nitrogen temperatures. The element is a structure of alternating layers of  $\text{CoSi}_2$  (metal) and  $\text{CaF}_2$  (insulator) films formed by MBE. Electrons shooting from an emitter via the tunnelling effect are controlled by the base. Operation is possible by an improvement in the compatibility of the interface between the metal and insulator films. In the element that was tested, a saturation region did not appear in the collector current. The group says this can be resolved by working on the structure of the emitter.

A group led by assistant professor Masahiro Asada of Tokyo Institute of Technology has tested a transistor with an MIM (metal-insulator-metal) structure consisting of alternating layers of metal and insulator, and they have confirmed switching operation under liquid nitrogen temperatures. The element uses the tunnelling effect to shoot electrons from an emitter to a base, and the collector current is controlled by the base potential. In comparison with a semiconductor element, because the electrons flow through a metal and an insulating film with a low dielectric constant, high-speed operation can be expected. If the surface area of the element can be reduced to  $0.1 \times 0.1 \mu\text{m}^2$ , Dr. Asada says, "according to calculations, it should be able to operate at 800 GHz".

For an element with this structure to operate, it is necessary to improve the compatibility between the metal and insulating films to prevent electron scattering. The reason a combination of  $\text{CoSi}_2$  and  $\text{CaF}_2$  was used is that compatibility with the silicon substrate was taken into consideration. Dr. Asada believes that other metals and insulators can be used with a different substrate material. Continuous films of  $\text{CoSi}_2$  and  $\text{CaF}_2$  with a thickness of 1.9 nm were grown by MBE.

If aqueous  $\text{H}_2\text{SO}_4$  and HF are used for etching, sufficient selectivity can be obtained. However, dry etching remains a problem for future consideration. There is also a problem because a saturation region was not observed in the collector current, but the group believes that this can be solved by increasing the emitter metal and insulator films one layer at a time. Further, if another layer is added, multi-value properties can be obtained in which the collector current has a minimal value by using multiple collector voltages. (Source: *Nikkei Microdevices*, April 1993)

First 64 M DRAM engineering samples: 50 ns high-speed access achieved at  $3.3 \pm 0.3$  V operating range

Scientists at NEC ULSI Device Development Laboratory have created a 64 M DRAM with an effective access time of 42 ns at an ambient temperature of 90°C for a 3.0 V power source.

By adopting a main-auxiliary word line structure and relaxing Al wiring pitch, the samples were created

without complex exposure techniques. High speed was achieved by applying a three-layer well and a new booster circuit.

This process will be applied to a 16 M cut down board. NEC will assess market reaction and feed results back into product design.

NEC claims it will be the first to ship 64 M DRAM samples. There are three types of word structures - x4, x8 and x16 bits - and they will be realized on the same chip using LOC (lead on chip) technology. An access time of 42 ns under conditions of a 3.0 V power source and ambient temperature of 90°C has been achieved. The product specifications are an access time of 50 ns, a cycle time of 90 ns, and power source current during operation of 100 mA. To keep down production costs, intricate exposure techniques such as multi-layer resist or phase shift were not used. (Source: *Nikkei Microdevices*, April 1993)

#### Swiss cheese is key to silicon wafers

Silicon wafers deliberately created with voids during processing may hold the key to better semiconductors particularly as gate dimensions shrink below 1  $\mu\text{m}$ .

The voids, produced by helium ions which have been implanted into the silicon substrate and subsequently driven off, may provide a more effective means of trapping metal impurities, according to research scientists at Sandia National Laboratories in the United States.

The traditional "gettering" technique widely used in the semiconductor industry is to introduce dislocation defects or nucleation sites in an unimportant area of the wafer - usually the backside. Copper ions, a particularly troublesome metal impurity, are attracted to the defects creating metal silicides.

The drawbacks of this technique are that the nucleation sites cannot reduce the metal ion concentration below their solid solubility limit and that the silicides can be created near a transistor's gate.

In the void technique helium ions are implanted into the silicon substrate which is then heated to drive off the helium. This leaves broken silicon bonds which attract metal ions until the walls of the void are lined.

The binding energy for copper ions in the cavities is 2.2 eV compared to 1.5 eV per atom in the copper silicides precipitates. The scientists report that because the new technique is much stronger than the conventional process, silicides can actually be dissolved with the copper ions migrating through the lattice to a nearby void.

The voids are stable up to 1100°C and hence compatible with most semiconductor processes. To date experiments have centred on copper but preliminary work shows that the technique will be equally effective for reducing concentrations of other metal ions such as iron.

The helium ions create cavities just a few microns below the surface of the silicon wafer and the process can be well controlled. (Source: *Technology Weekly*, 28 July 1993)

#### Swiss develop chip to simulate biologic behaviour

The EPFL (Lausanne Federal Polytechnical School) and the Swiss Electronics and Microtechnics Centre have just patented a new concept of artificial life: a microprocessor that develops like a biological creature.

The idea germinated two years ago, when new chips, dubbed FPGAs (Field Programmable Gate Arrays), came on the scene. Manufacturers of electronic devices have since been able to dispense with designing specific chips for each application. All they have to do is code an FPGA microprocessor for a specific function that may range from a calculator to a washing-machine regulator.

An FPGA chip consists of a large number of strictly identical, interconnected electronic circuits. A specific code, made up of 0s and 1s, must be programmed into each circuit to give it a precise function.

The idea of Daniel Mange, a professor at the EPFL's Information Science Department, and Pierre Marchal of the Swiss Electronics and Microtechnics Centre (CSEM) is to program all of the codes for the whole chip into one of the circuits. This giant code describes all of the microprocessor's desired properties. Most important, it automatically duplicates itself from one circuit to the next, thereby invading the chip. Finally, only the part of the code that is specific to each circuit is activated, depending on the circuit's location. The analogy with the biological world is obvious: each cell contains the complete genetic code (genome) of an individual, but only certain genes can express themselves, depending on the location of the cell in which they are found.

The first, extremely simplified, prototype was ready in November 1992. But the researchers are still progressing, primarily by simulating their devices using specific software programs. Today, the feasibility of the new technology seems established, although concrete applications are still a long way off. One important requirement is the creation of much more powerful FPGAs. But Daniel Mange has already dreamed up a next step. "I proposed to Jean-Daniel Nicoud, director of the Microcomputing Laboratory, that we computer

simulate the embryological development of a neural system."

Each circuit would correspond to an artificial neuron, giving the system two basic life processes. Its deterministic side would consist of code duplication, which is similar to cell division. In contrast, the chip's neural functioning would lead to the emergence of complex behaviour from the simple rules the researchers would ascribe to each circuit. (Source: *Journal de Genève*, 5-6 June 1993)

#### "Monocircuit" phone uses five times less components

The first "monocircuit" telephone in the world will use only 40 components, instead of more than 200 used in an average telephone.

The AS2531, which has just been introduced by the Austrian company AMS (Austria Micro Systems), integrates an improved speech transmission circuit, a numbers memory, a melody generator, and a ringing function - in short, all the functions necessary for a high-performance, medium-range, electronic telephone on a single chip. What is more, the telephone is programmable and can be easily adapted to the requirements of different postal and telecommunications administrations.

Utilization of the circuit, which also includes a squelch circuit and volume control for the listener, is expected to cut the number of components in the average telephone from 200 to 40.

The AS2531, manufactured in CMOS (complementary metal-oxide semiconductor) technology, is also characterized by very low power consumption, both during use and when idle. When the phone is not being used, the 14-number-capacity memory uses less than 0.1 microampere. The circuit operates in a range extending from 13 mA to 100 mA. A reinitialization routine integrated into the power supply ensures correct startup. In addition, a double Wheatstone bridge regulates the return loss (alternating impedance) and adjacent tone, since both these parameters are completely independent of each other. The AS2531 is available in 28-pin packages (SOIC (small-outline integrated circuit), PLCC (plastic-lead chip carrier), or DIL (dual-in-line)). (Source: *Electronique International Hebdo*, 10 June 1993)

#### Ascom develops high-speed data encryption technique

The Swiss telecommunications group Ascom, in conjunction with the Swiss Federal Institute of Technology, claim to have made a breakthrough in the field of security in high-speed data transmission by developing a special encryption technique suitable for speeds of up to 170 Mbit/s and therefore also compatible with future international transmission technologies such as Asynchronous Transfer Mode (ATM).

The new block encryption technique, called IDEA (International Data Encryption Algorithm) is designed to protect communications networks effectively from unauthorized access.

The new method has been patented and brand-protected by Ascom and the company's aim is to establish IDEA as a de facto standard by making it widely available in the form of software (Freeware or Shareware). Ascom sells software licences for commercial applications.

Ascom said IDEA has already been tested for application in the international communications network of a major financial institution. The beginning of 1993 saw the production and successful testing of the first samples for the serial integration of IDEA in VLSI (very large-scale integration) chips.

Unlike the widely established American DES (Data Encryption Standard), there are no marketing restrictions for IDEA. (Source: *International Telecommunications Intelligence*, 14 June 1993)

#### Silicon transistor for high-speed circuits developed

Researchers at Bochum's Ruhr University have recently achieved a maximum working frequency of 40 GHz with a prototype heterobipolar transistor (HBT). The silicon transistor will now be further developed to make it even faster, and improved to make it suitable for applications in ultra high-speed integrated circuits, for which only the more expensive semiconductor material, gallium arsenide, has been used in the past.

Professors Berthold Bosch and Hans-Ulrich Schreiber (of the chair of electronic components at Bochum's Ruhr University) have been awarded funding from the BMFT's (Federal Ministry of Research and Technology) Nanoelectronics Programme for this purpose. The "silicon/silicon-germanium ultra high-speed heterobipolar transistors and integrated circuits" research project runs until mid-1995 and is being conducted by the Bochum scientists jointly with Ilmenau Technical University, Daimler-Benz AG's Ulm research institute, and the SEL (Standard Elektrik Lorenz) Research Centre, Stuttgart, which are receiving additional funding.

Now that Bochum has achieved the 40-GHz cut-off frequency with a prototype, it will also demonstrate the Si/SiGe HBT's advantages on practice-oriented ICs. These are required for future, even more powerful glass-fibre data transmission systems or even faster computers. HBTs are characterized by a heterojunction in the single-crystal semiconductor material. This is an abrupt junction from silicon to the silicon-germanium compound. This heterojunction lies between emitter and base and forms an additional energy barrier for some of the mobile carriers in the component. This means that fewer carriers can pass from the base region

to the emitter region when the operating voltage is applied, increasing the transistor's current gain. The base region can therefore be made narrower than before and the region's resistance reduced at the same time. The result is an improved integrated circuit high-frequency response with higher execution speeds. (Source: *Mikroelektronik*, May/June 1993)

#### Fraunhofer Institute develops record speed A/D converter

Gallium arsenide electronics, characterized by very high operating frequencies and switching speeds, can offer new international peak values for microelectronic components and integrated circuits. Researchers at the Fraunhofer Institute of Applied Solid-State Physics (IAF) in Freiburg and Integrated Circuits (IIS) in Erlangen have succeeded in developing an analog-digital conversion circuit that operates at a scanning rate of 3.6 GHz, thus achieving the highest value that has ever been made public world-wide. The circuit is constructed with AlGaAs/AlGaAs/AlGaAs quantum wave heterotransistors developed at the IAF. Using the same technology, the IAF researchers achieved another world record with the demonstration of a frequency divider that operates in the frequency range between 18 GHz and 34 GHz. The circuit is required in electronic metrology for characterizing high-speed ICs.

The IAF has also achieved an international peak value in digital heterotransistor circuit integration density. A gate array that carries out 400 Mops (million operations per second) with the appropriate wiring has been developed and produced. The circuit integrates more than 20,000 heterotransistors on a surface measuring 4 mm square. This means a record that has previously been beaten only by a Japanese industrial laboratory.

The operating frequencies of a GaInP/GaAs heterobipolar transistor that the IAF has developed together with Daimler-Benz AG's research institute in Ulm also signify a world record. A cut-off frequency of 103 GHz for current amplification and 90 GHz for power amplification was measured. Such transistors are important components in future high-frequency, high-range satellites, radio relay and mobile radio systems, and in vehicle distance warning systems. The developments are the outcome of the III/V electronics integrated research funded by the BMFT (Federal Ministry of Research and Technology). (Source: *Mikroelektronik*, May/June 1993)

#### German researchers set speed records in photonics

German researchers have succeeded in setting new world records in optoelectronic component parameters. High transmission rates are among the factors of interest for optical linking in data systems. Researchers at the Fraunhofer Institute of Applied

Solid-State Physics (IAF) in Freiburg are working on the development of specialized laser diodes for such applications. The research team, which is led by Professor H.S. Rupprecht, has been able to demonstrate, using metrological methods, a 30-GHz modulation bandwidth for InGaAs/GaAlAs/GaAs multi-quantum wave laser diodes. This high bandwidth holds out prospects for data transmission rates of 35 Gbit/s over a single glass fibre, equivalent to the amount of information contained in more than 50 HDTV-quality television programmes at a transmission rate of 560 Mbit/s each. The 20 Gbit/s that a monolithically integrated optoelectronic receiver circuit, likewise developed at the IAF, can process represent another world record. The circuit, composed of a GaAs photo-diode and a two-stage amplifier with AlGaAs/GaAs-quantum wave ultrafast transistors, has a bandwidth of 14.3 GHz. A research team under Professor K. Ebeling at the University of Ulm is working on surface-emitting laser diodes with a vertical resonator structure, which can readily be arranged in arrays or in matrices which can therefore be used for a large number of optical multipoint or multichannel connections. The Ulm researchers have succeeded in reducing the threshold current to 0.6 mA (pulsed) or 0.65 mA (continuous output) by targeted modifications to the structure. These developments are the results of the joint photonics research scheme funded by the BMFT (Federal Ministry of Research and Technology). (Source: *Mikroelektronik*, May/June 1993)

#### Safer compounds shown to be effective for microelectronics manufacturing

Scientists at the University of California at Santa Barbara have demonstrated that the lasers and transistors used for optical communications can be made from ingredients that are substantially safer and less toxic than those currently used by the semiconductor industry.

An interdisciplinary research team headed by Steven P. Den Baars reported that they have successfully made state-of-the-art indium phosphide lasers and transistors by a method that replaces two highly toxic gases with less hazardous chemicals.

Using a process called metal organic chemical vapour deposition, the scientists were able to replace arsine and phosphine with two different compounds, tertiarybutylarsine (TBA) and tertiarybutylphosphine (TBP).

"This demonstrates that both TBA and TBP are high-purity sources that can be used to grow high-quality devices. It means that we have overcome the major technical obstacles to replacing these highly toxic gases in the manufacture of fibre-optic components of the type that may be used in a 'national information super-highway'", Den Baars said.

TBA is reputedly two to 10 times less toxic than arsine and TBP 20 to 100 times less toxic than phosphine. Moreover, TBA and TBP are liquids rather than gases and thus do not spread rapidly through the air when released. (Source: *Computer*, July 1993)

#### Single-electron memory

According to theory, a memory cell has only two requirements: (1) that its state can be changed to represent a "1" or "0"; and (2) that its state can be sensed. Today that is done by charging and discharging a capacitor. In the future, it could be done with a single electron.

Using quantum tunnelling effects in GaAs material at extremely low temperatures (0.1 K = -273.05°C), a team of Japanese researchers from Hitachi and English researchers from Cambridge University's Cavendish Laboratory have demonstrated, for the first time in the world, that one bit of information can in principle be stored by only one electron in a semiconductor memory. The development clears the way for the future realization of 16 Gb DRAMs.

The development is based on a new device structure that used side-gated structures in delta-doped GaAs material to form a multiple-tunnel junction (MTJ). Through a phenomenon called the Coulomb blockade effect, this design allows control over single electrons: memory "write" is accomplished by feeding single electrons from the MTJ into a capacitor. When the device is within the Coulomb blockade regime electrons cannot enter or exit the memory node. When the memory voltage reaches the boundary of the Coulomb blockade regime, one electron enters or leaves and the electron state reverts to the Coulomb blockade regime; after a further discrete increase in the node voltage, the boundary of the Coulomb blockade regime is again reached and a further electron can be transferred. To discharge the node, the added electrons must be removed one at a time, requiring a definite voltage change. This makes it possible to have two electron states for the same applied voltage, enabling the 1 and 0 memory states to be defined.

The same fabrication process was used to implement a Coulomb blockade electrometer that can detect or "read" the voltage on the memory node, with minimum interference to the electrons on the node.

While the initial demonstration used units of 100 electrons, it is possible, say the researchers, to reduce the number of electrons and represent a binary code with a single electron by redesigning the gate capacitor. Also, if structures could be made at a scale of less than 5 nm, the memory could operate at room temperature. Hitachi is reportedly confident that the MTJ and related components can be reduced to 10 nm in size and used in a practical 16 Gb DRAM chip by the year 2010. (Reprinted with permission from

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IL, USA)

#### Ti oxide for adhesion layers may enable Al replacement with Au, Ag or Cu

Researchers at the Georgia Institute of Technology (GIT) (Atlanta) have found that a titanium oxide thin film may allow replacing aluminium in ICs and multichip modules with gold, silver or copper.

Because only a thin adhesion layer is used, the Ti film does not affect the dielectric properties of the insulator surrounding the metal. Furthermore, since Ti does not diffuse much into noble metals, such as gold, conductivity is not degraded.

Because of their higher conductivity, engineers would prefer the noble metals or copper, Dr. Paul Kohl, professor of chemical engineering at Georgia Tech., notes.

However, those high conductivity metals have often caused problems in ICs because they do not bond well with silicon dioxide and polymers.

Higher-conductivity metals used for wiring patterns permit faster ICs and also allow groups of circuits to be combined into compact multichip modules. While the latter area is the topic of GIT's research, Kohl says the TiO<sub>2</sub> coating is also applicable for IC interconnects. "This insulator metal composite would also be useful for interconnects wherever the name of the game is high conductivity, low capacitance, fine line structures and easy, robust processing", Kohl declares.

Kohl believes his work has solved the bonding problem with the selection of Ti oxide. The lightweight metal is well known for its use in advanced aircraft structures.

More work is needed before the Ti oxide process is ready for commercial use, Kohl says. Basically, though, anyone using Georgia Tech's recipe should be able to produce similar results.

Georgia Tech's findings were reported at the recent Spring meeting of the Materials Research Society in San Francisco. (Reprinted with permission from *Semiconductor International* magazine, June 1993, Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

#### Hard copy

A technology now under development at the University of Southern California (USC) in Los Angeles promises computer "printouts" in the form of fully moulded and finished three-dimensional objects. A

team led by Melissa Orme, research assistant professor in USC's aerospace engineering department, is working to realize a longstanding dream of engineers: to invent a "net form" metalworking process that can take raw stock and create objects that require no further polishing, cleaning or working. Current metalworking processes, even when under computer control, generally require that a part be cleaned and finished before it is ready for use.

In the process a computer-controlled nozzle dispenses a precise stream of uniform molten metal droplets. About 100 micrometres in diameter, the micro-droplets are generated in a vacuum by the breakup of a capillary stream, and are directed onto a temperature-controlled substrate. There they rapidly solidify and build up the shape needed.

The trick, according to Orme, is careful control of the target substrate's temperature and the drops' timing and size. The rate at which the layers of micrometre-thick metal succeed one another is such that the arriving drops of molten material fuse completely with their still-soft predecessors. If done properly, the result is a homogeneous metal structure with a finer grain - and hence greater strength - than conventional methods can produce.

So far, Orme's group has demonstrated the process with Rose's metal - an alloy of bismuth, lead and tin with a low melting point around 190°C - to fashion small, detailed pipe sections. The team is now trying out more useful metals, such as aluminium, which has a melting point of 660°C. (Source: *IEEE Spectrum*, June 1993)

#### Laser tunable over broad spectrum

The first commercial broad spectrum tunable laser has been released by a small Silicon Valley company.

Spectra-Physics Laser Inc., based in Mountain View, California, recently licensed the technology to build the laser from Cornell University in New York.

Unlike most lasers, which can emit only a single wavelength of light, the optical parametric oscillator can be tuned, by turning a dial to give off light over a broad range of wavelengths ranging from ultraviolet to infrared.

Based on an optical crystal that was first developed in China in 1985, Chung Tang, a Cornell electrical engineering professor, took advantage of an unusual property found within the beta barium borate (BBO) crystal.

The non-linear crystal has the ability to split a photon in two. The wavelength that results depends on the angle at which the light entered the crystal.

Thus, by tuning the crystal's slanted surface, the wavelength of the laser beam can be changed.

For example, surgeons could use one frequency to fuse muscle tissue and another to cauterize blood vessels.

Spectra-Physics is marketing the devices for material processing, medical equipment, pollution monitoring and other applications. (Source: *Electronics Weekly*, 26 May 1993)

#### Canon increases storage capacity

Canon in Japan claims to have created a new high capacity data storage medium using microscopic conductive islands on an organic thin film.

The company has used a scanning tunnelling microscope to create tiny conductive spots less than 10 nm in diameter in a thin film of non-conductive polyimide resin. The film is less than eight molecules thick.

Theoretically the microscopic spots could be used to store individual binary data bits. As each spot is around 100 times smaller than the pits which represent data bits on a compact disc, Canon claims it may be possible to hold 10,000 times more information than on a CD.

The conductive spots were created by bringing the electrode of the scanning tunnelling microscope close to the resin film.

With an applied voltage, electrons tunnel from the probe through the resin to a gold layer below it.

When 3 V is applied the 10 nm diameter spot is created on the film. (Source: *Electronics Weekly*, 26 May 1993)

#### Fuzzy logic chip makes patterns

While semiconductor makers like National Semiconductor, Hitachi and SGS-Thomson Microelectronics are offering fuzzy logic compilers for their microcontrollers, one US company introduced a dedicated fuzzy pattern recognition chip.

Fuzzy logic, which offers shades of grey in the traditional black and white world of digital electronics, is being used by America Neuralogix to recognize data streams which are noisy, jittery, skewed, or which even contain errors.

The technique enables a best fit to be identified even where there is no direct match between digital patterns. The NLX-110 fuzzy pattern comparator formats the serial data from eight inputs into packets or

fields which can be compared against patterns stored in memory.

The logical differences for all the groups are accumulated and the difference sums represent the closeness value which is compared to a pre-programmed threshold to determine the best, or worst, fit. It operates at rates up to 20 MHz.

Noise tolerant microcontrollers running fuzzy logic software are being used in low cost control applications in washing machines and vacuum cleaners. A few dedicated fuzzy parts have been developed for higher cost specialist applications. Significantly, the Neuralogix chip will sell for \$15, in quantities of 10,000.

The device uses a neural networking design and has a self-learning capability which adjusts the threshold registers automatically. (Source: *Electronics Weekly*, 16 June 1993)

#### Crystal colour

Researchers at the University of St. Andrews are using the non-linear effects in a crystal to produce a continuous range of frequencies from the ultraviolet to the infrared from a single laser source. An infrared light source is up-converted to higher frequency ultraviolet light, of high energy photons, using non-linear optics. These high energy photons are "split" in the crystal oscillator and the resultant photon energies or frequencies are determined by the orientation of the crystal. Rotating the crystal produces light in wavelengths from 420 nm up to 2,300 nm. The team has built a benchtop demonstrator and they are seeking applications, particularly in medical diagnostics. (Source: *Electronics Weekly*, 23 June 1993)

#### Fragments of memory

Long seen as a technologically predictable jelly-bean business, DRAM is departing from past form with some innovative new architectures such as Rambus, synchronous and "cacheDRAM" (mixed SRAM/DRAM cells) and with unprecedentedly wide organizations. Furthermore, just emerging, is a new low-power standard.

The trend towards high speed is driven by the new synchronous Rambus and cacheDRAM architectures. High speed devices could be taking 20 to 30 per cent of the total DRAM market by 1995.

Synchronous DRAMs are memories which work with microprocessors operating up to 100 MHz which is the speed of 1994 Pentiums. Their high speed results from segmented arrays which give an access time of 10 ns.

The beauty of synchronous DRAM is its effect on system cost. RAMbus DRAMs offer greater data-processing advantages but are further away. By providing a new interface between the DRAM and the microprocessor, they allow data transfer at a rate of 500 Mbytes per second.

A third approach to fast DRAM is the cacheDRAM approach. This involves integrating SRAM and DRAM on the same chip. As with synchronous, it provides a 10 ns access memory.

A second trend, after speed, is a trend to wider organizations. As microprocessors get wider, to 32-bit and now to 64-bit, it makes sense to have DRAMs in wider organizations. That is because, in power-conscious applications like PCs, the fewer DRAMs you need to switch on the better. It saves power for a 32-bit address to access only two DRAMs, each of which are organized X16, instead of having to access four DRAMs, each organized X4. The trend towards the wider chips is strong.

The third main trend after faster and wider DRAMs is towards lower power DRAMs. Faster, wider and lower power - the trend for DRAM is no longer simply to denser. But the density treadmill goes on - NEC is already sampling the 64 Mbit. (Extracted from *Electronics Weekly*, 28 July 1993)

#### Neural networks take on optics

Irish scientists claim to have made a breakthrough in the development of neural network computing systems which come closest to the operation of the human brain in acquiring and processing knowledge.

Researchers at Dublin University have demonstrated an optical neural network, which can learn to recognize patterns that have changed position or are actually in the process of moving, as the brain can. This is the result of a three-year collaboration between Trinity College, Dublin and the Japanese electronics group, Hitachi.

According to Dr. Paul Horan, a researcher at Hitachi's Dublin Laboratory, the important difference between this and previous neural network research is the use of optical techniques to carry information on parallel and cross-connected data paths within the network. But the optical system provides more than high speed parallel interconnections; it is also used to process the data by implementing the multiplication, weighting and summation functions defined by the image recognition algorithm.

The aim is to build computers, which can learn by experience by making a large number of simple yes/no decisions simultaneously. In a sense it is a process of "trial and error" learning.

The physical limitations of connecting processors together electrically has restricted the development of working neural networks. It has also prompted researchers to consider optics.

In the United Kingdom, Professor Midwinter at University College London has pioneered the development of minute and highly integrated electro-optical switches known as quantum-well devices. But Dr. Horan believes the Trinity/Hitachi collaboration is the first demonstration of a working optical neural network using quantum-well devices.

The Dublin demonstrator is capable of distinguishing between reasonably complex images, for example the letters 'T' and 'I', and this can be done even when the images have moved position or are in motion. The image is first sensed and then converted into an electronic data stream; this is used to modulate a semiconductor laser which provides all the individual data streams for the optical processing. The optical system consists of two GaAs quantum arrays containing banks of electro-optic modulators which reflect or transmit the optical signals according to the application of a voltage (0-9 V).

The arrays, made at Trinity with the help of researchers at Sheffield University, are relatively large (2.5 mm square) for the number of modulators they contain (21). Each modulator, which is etched on the GaAs layer, is 80 microns wide.

Dr. Horan said the aim was to demonstrate the principle and there is plenty of scope for shrinking the geometries.

The first array multiplies all the possible configurations of bits, known as autocorrelation. To do this the 21 optical outputs from the array are polarized by 90 degrees and applied back into the array. The second array is used to match or weight each of the 21 x 21 outputs from the first array with a set of 21 data points defined by the pattern to be recognized. This requires 21 x 21 x 21 or 8,000 separate multiplications to complete the recognition which is decided digitally after conversion back into an electronic data stream. The speed of operation is determined by the optical switching time of the arrays which is less than 30 ns even for the relatively large area device. Dr. Horan points out that the processing speed will not increase as the complexity of the array increases as with electronic systems.

As well as speed, the use of optical processing makes it possible for the first time to build second order neural networks which include the N x N or autocorrelation function.

According to Dr. Horan this was not possible with electronic networks due to the number of interconnections required. The optical network makes



this practical and offers recognition even when the image has moved. This could have important implications for the recognition of moving images in medical applications. But like most neural network research, the Dublin work is still around 10 years away from commercial systems, according to Professor Hagarty, but he believes it is an important step forward, adding "We are now another horse in the race". (Source: *Electronics Weekly*, 10 May 1993)

#### PC in a cube

Engineers at Cambridge University have built a PC using a revolutionary PCB interconnection system.

The engineers, from Chiprack Electronics, built the 486 PC based on the Chips and Technologies chip set mounted on five multilayer PCBs. The PCBs were stacked one above the other using a patented connector system made under licence by Harwin.

The complete PC, including RAM and ROM, occupied a 50 mm cube. Heating was not a problem, because the multilayer PCBs and the edge connectors acted as a heat sink. Chiprack expects to launch its first PC product in 1994 and Harwin, which is in production with the connector, expects to sell it into a number of embedded applications. (Source: *Electronics Weekly*, 17 November 1993)

#### Hitachi enters the atomic age

Hitachi scientists are planning to build atomic scale electromechanical wires and switches which they forecast could replace conventional electronics within the next decade.

The integration potential is so great that the scientists at Hitachi's Advanced Research Centre in Japan have calculated that 10 million gates could be fitted on a 20  $\mu\text{m}$  square slice of crystal; an entire supercomputer could be built in a 201  $\mu\text{m}$  square.

The scientists are just beginning experiments to investigate the practicalities of the scheme. However, calculations show that the circuits, constructed from lines of atoms sitting on the surface of a wafer, are feasible.

A wire in the circuit would comprise strings of atoms arranged on the surface of a wafer - rather like beads on a necklace.

The string will pass a current because electrons can flow from one atom to another. However, if a single atom is removed, the wire and the circuit is broken.

More complicated arrangements would emulate the action of a number of basic logic functions, such as Nand and Nor gates. Hitachi engineers have also

devised a simple storage element allowing memory functions to be built.

The scheme is electromechanical in that single atoms are physically arranged on a wafer to create the circuits and moved in and out of the line to switch the circuits.

This is unlike the single electron transistors and memories which Hitachi is also developing that rely on quantum mechanical tunnelling effects to operate.

Hitachi hopes to demonstrate a working atomic wire within 12 months. (Source: *Electronics Weekly*, 10 November 1993)

#### Supercomputer does the double

Kendall Square Research (KSR) claims that by doubling the performance of its second generation multiprocessing supercomputer it has solved the paradox associated with computer systems with large numbers of processing elements.

Shared-memory architectures may be easier to program than distributed-memory ones, but they tend not to be scalable because performance degrades as more processors are added and have to access the same pool of memory.

KSR's latest 80 Mips/Mflops systems place memory close to each processor, like in a shared memory system. Every processing card has two processors, each of which has 32 Mbyte of DRAM and 512 kbyte of fast static RAM.

The systems are arranged so that 1 Tbyte (1,000 Gbyte) of a single memory space can be addressed by any of the processors. To do this KSR has arranged its processors in a ring structure. It also treats its memory like a cache structure.

The first ring contains 32 processors, with their associated 1 Gbyte of cache DRAM. Communications between processors in this ring occur at 100 Mbyte/s. If a memory address is not found in this physical block of memory, the search is then diverted into the next ring of 32 processors.

According to Tim Allen of KSR, this does cause a fourfold increase in latency, but he counters that this penalty is only paid once as the cache-like nature of the organization means that the memory address and other addresses likely to be required are then loaded into the first processor ring. (Source: *Electronics Weekly*, 10 November 1993)

#### Motorola updates Mosaic

Motorola has described the latest version of its Mosaic high performance bipolar technology and it

claims to have demonstrated a transistor with a noise figure as low as 0.9 dB with 18 dB gain at 1.2 GHz.

It is the fifth generation of Motorola's oxide isolated self-aligned implanted circuits (Mosaic) and has been transferred to 0.6  $\mu\text{m}$  silicon technology. In addition to the lower junction capacitance and parasitics due to the geometry shrink, gate delay has been reduced by minimizing the extrinsic base resistance.

In an ECL ring oscillator test circuit described in *Electronics Letters* in October 1993, a minimum gate delay of 25 ps at a switch current of 1.2 mA was measured. (Source: *Electronics Weekly*, 10 November 1993)

#### Light-emitting silicon device developed

A light-emitting silicon device has been developed by a nine-member team of scientists at the Solid-State Physics Laboratory (SPL).

Called a "junction diode", it puts out a beam of orange-red light on application of a small current (500 milliamperes) at 10 V. The light could be switched on and off at 1,000 million times per second.

SPL scientists said that light-emitting diodes replace conventional wiring between components in optoelectronics.

Light beams carry more information and they do not interfere with one another as electrical currents do, and supercomputers can work even faster if their chips could communicate by light instead of electricity.

The SPL device was made from a silicon wafer whose surface was made "porous" by the well-established electrochemical etching - a process that riddles the wafer surface with an array of holes, 20,000 times thinner than a human hair. (Source: *The Hindu*, 1 December 1993)

#### Mitsubishi snaps in milliseconds with intelligent technology

Mitsubishi Electric is the latest Japanese company to develop a camera based on high speed imaging-processing technology, which can detect the contours of moving objects in under half a millisecond.

The consumer electronics company has developed a photodetector array, which can detect changes in light shading on an object and produces just that information necessary to recreate the contours of the object.

Mitsubishi calls it "an intelligent camera", which could be used in car guidance systems that need to process image information in real time.

The device uses an array of photodetectors on a gallium arsenide substrate. The sensitivity of the

detectors varies with those in the rows' higher resolution than those in the columns. Arrays detecting equal levels of brightness cancel each other out and an electrical signal is only produced when the brightness level varies between adjacent rows and columns.

In a sense it is the optical equivalent of the bit-mapping techniques used in data compression where only changes in the picture are registered. The 128 x 128 element array can detect the contours of an image in 0.4 ms.

In September 1993 NTT described a larger but slower array using a high speed ferroelectric liquid crystal light modulator, which can distinguish the light and dark boundaries of objects in 1 ms with 500 x 500 pixel resolution.

Both systems process the optical information in similar ways, by detecting the changes in brightness between adjacent pixels. This enables the system to define the outline of an object, even when moving, much faster than in conventional charge-coupled device (CCD) photodetectors.

The ferroelectric liquid crystal device uses a three-layer spatial light modulator, with a partial mirror sandwiched between the photoreceptive film and the liquid crystal panel. The liquid crystal molecules in the panel orientate themselves according to the light level falling on them.

NTT has developed a means of detecting only those areas of the liquid crystal which are in the transition state of polarization between the two extremes. As a result the outline of an object, the boundaries between light and dark areas, are traced, by reflecting a polarized light through the crystal.

It derives most of its speed because it produces an analogue output signal direct from the photodetector without any intermediate digital processing. NTT also claims the analog output produces "smoother" edges.

NTT is confident that it can improve its prototype system to support 1,000 x 1,000 pixel resolution imaging with a 10  $\mu\text{s}$  response time. (Source: *Electronics Weekly*, 17 November 1993)

### III. MARKET TRENDS AND COMPANY NEWS

#### Market trends

##### World trade volumes rise for 1992

A tentative report from the committee for the General Agreement on Tariffs and Trade (GATT) shows that the global trade for 1992 grew 4.5 per cent on an export volume basis. In comparison, the growth for 1991 was 3 per cent. Thus, for the first time since

1988, the volume of export trade surpassed the level of the previous year. The report attributes this growth to the start of economic recovery in North America, plus solid demand for imports in Central and South America, the Middle East and Asia. Nevertheless, the global economy continues to slow down, making the prospects for 1993 uncertain.

For 1992, the total exports for the world reached \$3.7 trillion, a 5.5 per cent gain from the \$3.53 trillion in 1991. Service-related trade including trade in transportation, communications, insurance and finance climbed 8 per cent to \$960 billion.

Japan's 1992 exports advanced 1 per cent in volume, compared with a 3 per cent gain in 1991. Imports slipped 0.5 per cent. In contrast, the United States and Canada combined saw exports rise 7 per cent, while imports grew 9.5 per cent.

Asia, except for Japan, experienced stable growth in exports and imports; this is especially true for Hong Kong, Taiwan and Korea. In Europe, German imports climbed 13 per cent in volume for 1991, but fell to 2 per cent for 1992. Trading with Western Europe from among the Commonwealth of Independent States (CIS) and Eastern European nations advanced, but exports dropped 10 per cent for the third straight year of declines.

The report offers an uncertain forecast for 1993, because of the gradual slowdown of the global economy (a trend in progress since 1992), plus weak economic growth in Japan, and in Western European countries such as Germany and France.

Despite generally tight budgets, chemical makers' spending on management information systems continues to grow, largely because of the system upgrades needed to compete globally while meeting a wide range of environmental regulations.

A recent study by Consulting Resources (Lexington, MA) estimated the world market in 1992 for computer hardware, packaged software, and services in the chemical industry at \$11.4 billion year. While the largest spending component is systems hardware - more than 40 per cent in the United States, Europe and Japan - the study forecasts 13 per cent annual growth to 1997 in the area of services, which in the United States and Europe now constitutes a larger part of the budget than does software. Hardware growth is projected as flat, and software, representing 20 per cent of spending in the United States and Europe, is projected to grow at 8 per cent.

Software has also become the centrepiece in system upgrades. Given the proliferation of software packages that link business systems internationally and the evolution of open system standards, hardware selection is almost incidental to software selection.

Large computer hardware suppliers must now cater to a broader range of customer's needs, including software and service. A good example of the tight focus on end-use markets combined with software and service offerings is a program launched by IBM for chemical and pharmaceutical manufacturers in the United Kingdom.

Chemical companies have played a major role in the development of application software. Several large suppliers crafted off-the-shelf software modules working with chemical customers. Some of the broad-range projects were undertaken in virtual partnership with suppliers; however, many others involve the purchase of commercially available systems - a trend expected to continue given the high costs of developing and maintaining in-house software. (Source: *AEC*, No. 4/1993 and *Chemical Week*, 19 May 1993)

#### East Asia looks forward to decade of growth

Accelerated growth will be the norm for developing countries in the next 10 years, according to a forecast from the World Bank. Whereas these nations advanced an average of 2.7 per cent annually for the last 10 years, this rate will nearly double between now and the first years of the coming century, reaching 4.7 per cent. Economic reforms in developing nations have paved the way for this growth, including a shift to private ownership among previously state-run or public corporations, relaxed regulations for imports, and controls for inflation. This has resulted in expanded imports and has helped promote foreign investments.

The forecast predicts that growth in eastern Asia, particularly in China, Hong Kong and Taiwan, will be especially noteworthy, and may form the so-called fourth growth peak of the world's economy. As prices for primary goods reach a point of stability, developing countries will experience additional growth. In the future, developing countries will shift from relying on capital loans from commercial banks in foreign countries, to encouraging direct investments by private industries and investments in securities and shares. This trend already is under way. Direct investment offers advantages to developing countries, because it permits easy acquisition of the accompanying management skills and technology. However, direct investments also take larger proportions of the business profits away from the host country than do indirect investments. Thus the report warns that developing nations should guard against excessive dependence on medium-term foreign investments. (Source: *AEC*, No. 4, 1993)

#### Interconnect plans in the SIA, SEMATECH roadmap

At Tegal's Nineteenth Annual Plasma Seminar, held in July 1993 during Semicon West, SEMATECH's John Martin presented an overview of the SIA, SEMATECH roadmap for interconnect technology.

including gates, contacts and vias. The overall goal of the roadmap is to achieve the technological advances needed to arrive at 0.12  $\mu\text{m}$  manufacturing by 2004, and 0.10  $\mu\text{m}$  in 2007. The formation technique for CMOS gates is expected to continue to be etching for both the poly and amorphous silicon and the gate spacer. Etch tools are expected to change significantly during the SIA roadmap time frame, he reported.

Major changes are anticipated in the area of interconnect formation during the 15 years covered by the roadmap. The interconnect group's vision of the metallization revolution on the horizon includes copper integrating with, and, in some cases replacing, aluminium alloys. The metal definition tools are expected to change as dramatically as the metallization itself. Polishing technologies are likely to be employed for Cu and Al alloys in the final years of this decade. A requirement for high dielectric constant materials will create additional challenges. (Reprinted with permission from *Semiconductor International* magazine, September 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

#### Failures in the spotlight

Only one in 13 new product ideas evaluated ever make any money, according to a study carried out by Semiconductor Equipment and Materials International (SEMI) - the semiconductor equipment trade association.

The research confirms a similar study by management consultant McKinsey which estimates that almost half of all R&D costs go into products that fail.

A spokesman for SEMI said: "The cost of failure in a technical product introduction is very high and in some cases fatal. When a new product fails, shrinking margins make cash replenishment difficult for many companies". (Source: *Electronics Weekly*, 27 October 1993)

#### Chip demand to flatten out as PC boom ends

The silicon cycle is reaching its peak, according to Jean Philippe Dauvin, chairman of World Semiconductor Trade Statistics (WSTS).

Dauvin expects chip shipments to plateau out after 12 months of exceptional growth, which have seen the world chip market increase by 23 per cent.

The biggest regional growth recorded in 1993, said Dauvin, was in the United Kingdom where the value of the total available market (TAM) grew by 87 per cent in the first quarter on the back of the PC boom. But WSTS expects the boom in demand for PC chips to "plummet" in the second half of 1994 but that growth will resume in 1995. It expects the telecoms production recovery to continue through 1994 providing

a "long-term stable trend" which will mainly benefit Europe.

Demand for chips from the automotive electronics sector will fade in 1993 but resume in 1994-1995, WSTS predicts, but the current recession in the consumer business will not pick up before 1995-1996.

Dauvin said capacity issues, which have caused severe shortages of some types of chips, will be solved in the first quarter of 1994 as the Japanese ramp up capacity.

Hot products for this year, predicts Dauvin, will be flash EPROM (up 100 per cent by revenue), 32-bit micros (up 62 per cent) and DRAM (up 35 per cent). Next year they will be flash (up 60 per cent) and DRAM (up 19 per cent).

With the success of flash, non-volatile memory is expected to take an increasing share of the memory market away from DRAM. (Source: *Electronics Weekly*, 13 July 1993)

#### Summer high for chip orders

The semiconductor book-to-bill ratio is continuing its upward trend, according to the latest Electronic Components Industry Federation (ECIF) figures, despite an anticipated slackening during the summer holiday period. July bookings were the second highest in the ECIF record book (1.66 compared with 1.23 in 1992). While billings in July and August followed the traditional pattern and eased slightly, they were almost double those in 1992. Both bookings and billings for every month in 1993 were record highs for that month. The improvement has been largely dependent on MOS micro components (microprocessors in particular). But there are signs that growth is spreading to other products and markets such as discrete semiconductors and the mobile communications sector. Semiconductor Equipment and Materials (SEMI) figures show that world-wide shipments of semiconductor manufacturing equipment peaked in June, showing a book-to-bill ratio of 1.22 (0.9 in June 1992). The preliminary figure for August is 1.15. (Source: *Electronics Weekly*, 29 September 1993)

#### Will virtual travel get off the ground?

Many a business traveller would like to be in two places at once and so avoid costly and time-consuming journeys. In the last few years videoconferencing has begun to make this possible and the first major study to consider its impact on a major international airport contains depressing news for the aviation industry.

A US Federal Aviation Administration and the Massachusetts Port Authority commissioned report to see if there is enough demand for another airport in the area in addition to Boston's Logan airport predicts that

by 2010 between 13 and 23 per cent of business travel from Logan airport may be replaced by videoconferencing.

Thirty per cent of trips by business people to other branches of their own company within the United States are likely to be replaced, while 15 per cent of journeys to other companies within the United States may be replaced.

The estimates were arrived at by looking at several large American companies that had invested heavily in videoconferencing equipment and seeing how much travel was substituted. They also studied how the videoconferencing industry developed during the Gulf War when the fear of terrorist attacks put many people off flying.

The American telephone company AT&T currently sells videoconferencing equipment for \$30,000 but expects this equipment to drop to about \$5,000 by the year 2000. The study assumed that by 2010 there will be videoconferencing equipment in all departments of large companies in the United States and that by 2030 all executives will have a flat screen above their desks big enough to see six other people and a digital fax to send them documents.

In Britain the situation is different, as most business flights are international. A spokesperson from the British Airports Authority, which runs seven major airports, says the consensus at BAA is that like all previous advances in communications, videoconferencing will stimulate international business and so generate a greater need for travel.

But British Telecom, which makes videoconferencing equipment, experienced a surge of interest in the technology during the Gulf War. (This first appeared in *New Scientist*, London, 13 March 1993, the weekly review of science and technology.)

Measures for true open systems - focus will be on emerging parallel machines

True open systems for mainframe computers have arrived. Support for TCP/IP which is the standard protocol used in Unix is progressing. Also, distributed database functions between mainframe computers and computers running Unix can now be used. With the advent of parallel computers, we can glimpse at the shape of next generation mainframe computers.

Looking at the product trends of mainframe computers from 1992-1993, the keywords become "open systems". Previously, the call had been open systems for mainframe computers. However, until now only the words have moved forward, content did not follow. But that changed dramatically in the past year.

During the downsizing which strongly hit mainframe computers from 1991-1992, each maker examined the course of the computer industry and basic policies on system configurations. To ensure the survival of mainframe computers, which form the foundation of earnings, their role was clearly set forth.

Across the spectrum of a company, large volumes of data are maintained. Database servers process these data at high speeds. Management servers control the whole system, which is connected through a network. These two roles are greatly desired in mainframe computers.

In order to provide a company-wide server function, a distributed cooperation function between personal computers and Unix machines that will become departmental servers is indispensable. In the open systems for mainframe computers advanced by each company, the focus is becoming "how can Unix machines and personal computers co-exist".

Today, open systems are synonymous with TCP/IP support. TCP/IP (Transmission Control Protocol Internet Protocol) is the communication protocol in the Unix standard. Personal computers can be connected if they comply with TCP/IP.

Fast makers began to support TCP/IP software for mainframe computers around 1990, but this did not extend to uses in engineering fields like CAD/CAM (computer-aided design and computer-aided manufacturing). The services that could be run on TCP/IP were limited to file transfer and virtual terminals.

Communication between programs and the Network File System (NFS) began to be supported this past year. Terminal emulators that could be used on TCP/IP were also completed. The move was from only connecting to using.

Until now the manufacturers of mainframe computers built a network system by using an original protocol and OSI (Open Systems Interconnection). The addition of TCP/IP has changed the direction to addressing three bases.

In October 1992, IBM Japan announced an idea called the Networking Blueprint. Here, the application is made independent of the communication protocol. Basic software, which used databases and data communications that previously could only be run on IBM's SNA (Systems Network Architecture) protocol can now be run on TCP/IP even without passing through a gateway. In the future, this kind of activity will probably spread to every company.

Support for distributed database functions between the relational database management system (RDBMS) of a proprietary computer and a typical Unix RDBMS like Oracle or Informix is advancing.

Specifically, a client computer, like a personal computer, can access an RDBMS running on a Unix machine or an RDBMS running on a mainframe computer using the same interface.

In the Unix arena, transaction processing (TP) monitors like TUXEDO, a product of Unix Systems Laboratories in the United States, and Encina, a product of Transarc Inc. in the United States are being released one after another. The manufacturers of mainframe computers are beginning to offer mechanisms that can process cooperatively based on program inter-communication between a proprietary database data communication system for mainframe computers and a Unix TP monitor.

The functions for connecting to personal computers are rapidly improving. Many mainframe computers are beginning to provide functions to access databases on the mainframe from spreadsheet software running on personal computers. Moreover, it is noted that not only the personal computer made by any one company, but those of other companies are included.

When personal computers began to be used as terminals for mainframe computers, the Micro-Mainframe Link (MML) attracted attention. Major advances have been made considering that at that time the MML was connection technology between the mainframe and the personal computer from the same manufacturer; in addition, the only tools that could be used were the company's proprietary office automation tools.

NEC has adopted a different strategy from other companies for connecting personal computers. A network operating system for using a personal computer local-area network (LAN) was installed on a mainframe. In October 1992, NEC announced the entry level ACOS 3500 of the ACOS-4 system. This machine was equipped with a LAN manager and a NetWare server function. Even on the small-scale ACOS-2 computer, a product called PCNET/Server is installed as the LAN manager.

A personal computer on a LAN can use the mainframe just as one can through a normal LAN server for personal computers. A network operating system installed on a mainframe and connected to personal computers may become a new use for small mainframes. Unisys in the United States installs NetWare in its A series.

Furthermore, Unisys announced in May 1993 the A7, which runs its proprietary operating system and Unix on the same machine. The A series architecture contains the one-chip SCAMP and an i486 micro-processor. As for the operating systems, MCP/AS, which is compatible with high-end machines, is loaded in SCAMP and Unix is loaded in the i486.

Although there are ways to run a proprietary operating system and Unix in parallel using virtual computers on a large machine, the method used in the A7 is the first of its kind. (See table on page 33)

The architecture of the database processing section is based on the DBC 1012, a dedicated database machine, from Teledata in the United States which NCR acquired in March 1992. The trend is towards building large-scale Unix servers running on dedicated database machines rather than parallel computers.

According to Nobuhisa Nasegawa, head of business promotion and systems sales promotion at Fujitsu states, "Parallel machines are being considered as the choice with improved price-performance ratio over mainframes" by domestic manufacturers. Fujitsu and NEC have already produced parallel computers in the supercomputer field.

Mainframes are continuing to lose the price competition with high performance reduced instruction set computers (RISC). Parallel computers not only have improved processing capacity, but there are high expectations for a breakthrough in lowering prices. (Source: *Nikkai Computers*, 21 June 1993)

#### NanoDynamics: redefining the future of semiconductor fabs

Several distinguished scientists are preparing for the technological and economic limits of semiconductor manufacturing as we know it today. Their company, NanoDynamics (New York, N.Y.), is based on nanotransistor technology where single electrons can induce a three-volt jump at room temperature. Reportedly, the result is supra-tera Hertz switching without heat loading.

The technology being developed at NanoDynamics (founded by Dr. Chia-Gee Wang) starts where the current dominance of silicon FET technology eventually reaches its technological and economic limits: without new directions, Wang sees one-gigabit 0.1  $\mu\text{m}$  DRAM fabrication lines costing \$2 billion in a decade, a possible world-wide investment of \$2 trillion, which is larger than the GNP of most nations.

To Wang, the economic solution for the future of semiconductor manufacturing will come from breakthroughs in the applied physics of microelectronics that drastically reduce the physical dimensions of the transistor and through the development of X-ray based lithography that will eventually be less expensive than currently conceived optical methods.

For the scientists at NanoDynamics, the solution is in the patented work of Dr. Raphael Tsu, who conceived nanotransistor technology. He has conceived a thin layer of silicon dioxide on silicon where the

**Major Open Systems Mainframe Computers Announced from 1992 to mid-1993**

Maker	Description
Fujitsu	Extended to products compatible with the Message 90s system configuration system. Added products to extract data from DB2 running on IBM mainframes and store in RDBII on the M series or Informix on DS/90.
	The TISP TCP/IP software application operating system was expanded to XSP and FSP in addition to MSP. New support for NFS server on TISP.
	Supports distributed transaction processing between TP-TUXEDO, the TP monitor for Unix, and AIM/DC transaction processing software for the M series.
NEC	Announced UXNET II, TCP/IP software for products compatible with the Solution 21 system configuration system. Supports the tnETOS terminal emulator and inCOM-XE for program intercommunication on TCP/IP.
	NetWare and LAN manager installed in ACOS System 3500.
	UXNET II support in ACOS System 3300 EX and LAN manager installed.
IBM Japan	Announced Open Data Link software which allows databases on the ES/9000 to be accessed from personal computers, including those of other makers, in the Open Vision system configuration system.
	POSIX interface offered for MVS/ESA V 4.3.
	Announced basic communication software ACF/VTAM for Networking Blueprint (a multi-protocol network communication base). Supports the APPC program intercommunication function on TCP/IP.
	Supports distributed transaction processing between the AIX CICS/6000 Unix TP monitor and CICS software for transaction processing.
Hitachi Seiyakusho	Offers TCP/IP software like XNF/TCP (for VOS 3) and XNF/K/TCP (for VOSK)
	Supports the Unix HI-OSF/1-MJ in accordance with OSF/1 on the M-880 and M-860 in the native mode.
	Supports distributed database functions between XDM/RD relational database for the M series and Oracle running on a Unix machine (including those of other vendors).
Unisys Japan	Strengthened TCP/IP support in the 2200 series and offers NFS.
	Supports Open/OLTP (based on TUXEDO) for Unix TP monitors in the ACCF system configuration system in the 2200 series and A series.
	Supports distributed database functions between UDS RDMS 1100, the relational database for the 2200 series, and DMS-II, the database for the A series, with Oracle on Unix machines (including those of other vendors).
	Introduced the small-scale A7 computer that runs a proprietary operating system and Unix. NetWare can also be installed.

TCP/IP: Transmission Control Protocol/Internet Protocol; TP: Transactions Processing; POSIX: Portable Operating System Interface; OSF: Open Software Foundation; NFS: Network File System; RDB: Relational Data base

oxygen atoms are stretched. This stretch imposes a strain energy on the silicon dioxide so that, for one or very few atomic layers, the silicon dioxide will spread perfectly over the silicon lattice producing a perfect crystal. For such a perfect superlattice crystal structure, typically nanometer sized, a single electron resonantly tunnelled through will cause a large voltage jump of three volts. The mean-free-path of a three-volt electron is more than a few atomic layers. The electrons in such a situation will behave quantum mechanically, in that they will become quantum waves that can tunnel through the silicon dioxide barriers without scattering. Overall, in one step, by eliminating both electron trapping and scattering, a signal oscillation can be achieved without generating any significant heat load.

In a seminal experiment, Dr. Tsu showed that for a very small silicon ball, about 60 Å across, on amorphous silicon dioxide, electronics can be resonantly tunnelled into the ball.

Dr. Tsu believes that a strain-layered transistor of nanometer dimensions will function in the same manner, such that one or a few electrons will cause a large potential change in a perfect superlattice structure. The net result would be a transistor switch to replace FET technology.

The goal of NanoDynamics is to develop the lithographic technologies necessary for sub-0.1 µm line-widths. These include patented or patent pending methods for Auger nanolithography, X-ray microscopy, X-ray step and repeat and a concentrated X-ray source with selective line energies. (Reprinted with permission from *Semiconductor International* magazine, October 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL., USA)

Thriving GaAs digital LSIs becoming nucleus of systems such as communications and EWS

The applications of GaAs digital LSIs continue to grow. They are already used in the processors of supercomputers. They have become essential to communications devices such as engineering ATM switching systems and optical communications and have begun to appear in computers and peripheral devices such as engineering workstations (EWS) and large hard disk devices. The GaAs LSIs are characterized both by high speed and reduced power consumption. Another advantage is that if the high speed is utilized, simple circuit constructions can be created without parallel processing, which is necessary with silicon. What has spurred their growth is the fact that GaAs LSIs have achieved a maximum integration of 120,000 gates in practical applications and their cost has come down to the same level as bi-CMOSs.

The problem with the GaAs LSI is idle time power consumption. If this can be reduced, however,

large capacity memories can be realized, and GaAs digital LSIs can also be used in portable devices. This technology was selected as recipient of the 1993 Nikkei BP Technology Prize in Electronics.

GaAs digital LSIs are finding their way into the cores of high-speed systems, and at the same time, the range of their applications is expanding.

In the past, they were only used in applications such as flip-flops for high-speed LSI testers and as multiplexers and demultiplexers for 2.4 Gbit/s optical communications. The level of integration was several hundred gates at most.

However, recently GaAs LSIs with several hundred thousand gates have been created for use in supercomputer processors. It is also certain that they will be used as the LSIs that comprise the core of digital communications systems whose market is expected to expand in the future. In addition, they are now appearing in workstations, etc.

If GaAs is used, it is possible to increase integration and achieve both high speed and low power consumption at the same time. Because parallel processing is not needed if the speed is fast enough, in some cases GaAs LSIs can realize much higher performance than silicon LSIs with smaller circuits.

Examples of GaAs LSI applications include:

- Supercomputer processors;
- LSIs for wide band ISDN (integrated services digital networks). Matrix switching LSIs for ATM (Asynchronous Transmission Mode) switches and multiplexers/demultiplexers with an add/drop function<sup>1</sup> that have a transmission speed of 155-622 Mbit/s for use in optical communications;
- Data transmitting/receiving LSIs such as HIPPI and FDDI communication links for high-speed transfer of data between computers;
- Image processing LSIs for engineering workstations;
- Prescalers for mobile communication devices;
- Controllers, etc., for memories and large hard disk devices.

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<sup>1</sup> A function that inserts or branches data within the transmission path.



Among the applications currently in use are those for optical communications and supercomputers, but it is predicted that the others on the list will be practical applications of GaAs, and some are expected to enter mass production within the year. Further, because GaAs operates at high speeds with a power source voltage of about 0.9-1.5V, it is believed they will be most suitable as LSIs for portable devices running on a single battery.

**Production line makes high integration and low cost possible**

There is a large movement of electrons at low voltage in GaAs, and it is believed that if GaAs LSIs are created they can run faster and with less power than silicon LSIs. However, because the mass production system was not set up, GaAs has lost out to silicon in terms of integration, cost, delivery, etc.

There are at least five reasons why GaAs has recently attracted attention:

- They have achieved a maximum integration of 120,000 gates on a practical level;
- The yield has improved and the cost has come down to the level of bi-CMOSs;
- The gate array standard turnaround time (TAT) has become a short six weeks;
- The design environment is now complete. Tools are available on the same level as the silicon ASIC, and it will now be possible to design high-speed LSIs without paying special concern to the properties of GaAs;
- There are more and more devices that operate at high speeds greater than 100 MHz, and the demand for GaAs LSIs is on the rise.

First, the level of GaAs integration has surpassed that of silicon bipolars (ECL). This is one reason why they have replaced silicon bipolar LSIs in supercomputers. With 120,000 gates available, the GaAs chip can be used to make RISC and DSP devices.

The reason why integration has rapidly increased these past few years is that we have become experts in manufacturing technology. The elemental technology for increasing integration was developed in 1980. It is the self-compatible technology that uses very heat-resistant tungsten silicide for the gate electrode. If this is used, excellent Schottky properties can be obtained, and difficulties such as the fluctuation in transistor threshold voltage can be reduced. However, there was no mass production line for GaAs LSIs. Therefore, we began construction in the world's largest GaAs LSI dedicated production line at Yamanashi in 1990, and the

line began full operation in 1992. Because the elemental technology already existed, the level of integration rose rapidly.

With the operation of the production line, the yield also increased. The number of masks used during GaAs LSI manufacturing is seven in bulk processing, which is less than half the masks used for silicon bipolars. The wafers (4-inch) are still expensive, but because the number of process steps is fewer, the overall cost is not all that high. With the increase in yield, the cost has already come down to the same level as the bi-CMOS, and it should drop even lower in the future.

The production line is set up to run 24 hours a day, and the TAT has also been shortened. It has become shorter than for silicon bipolars and is about the same as for CMOS LSIs. The design environment, including CAD tools, can be handled the same way as with CMOSs. The cell library is also mutually compatible. Not only can we use the same tools that we use with Fujitsu's CMOS gate array, but we can also use commercially available CAD tools.

There is no limit to the pursuit of performance in computers and communication devices. GaAs can respond to needs that silicon cannot.

When silicon bipolar (ECL) LSIs are replaced by GaAs in supercomputers, they become 1.2 times faster with the same power consumption. System designers can increase system performance without changing mounting techniques such as cooling methods.

When the processing speed is lowered to the same level as silicon bipolars, the power consumption drops to one third-one quarter that of silicon. Further, integration can be increased with no increase in power consumption. If we say that the limitation of air cooling is 1.5 W, it is difficult to integrate 1,000 gates on silicon bipolars, but 0.8  $\mu\text{m}$  GaAs LSIs can be integrated to about 3,000 gates and 0.5  $\mu\text{m}$  LSIs can reach about 10,000 gates or more.

CMOS LSIs are approaching an operating frequency of 100 MHz, but there are cases in which the power consumption of GaAs is lower than CMOS at above 100 MHz. Although the power consumption of CMOSs increases proportionately with the operating frequency, the power consumption of GaAs is relatively constant regardless of the frequency. The faster the operating frequency and the higher the ratio of active circuits, the more advantageous GaAs becomes.

Portable devices are operating on lower and lower voltages, and GaAs offers advantages here as well. The optimal power source voltage for GaAs LSIs is about 1.2V, and they can run at high speeds on a single battery. They are expected to be used in mobile communication devices, etc. There is almost no change

in the gate delay time in the range of power source voltages between 1V and 2V.

Until now GaAs has been handled as a post-ECL device, and its role as an ultra-fast LSI has been emphasized. Actually, the power of GaAs digital LSIs has already eclipsed silicon bipolars.

In the future, GaAs will infiltrate the fields in which bi-CMOSs and high-speed CMOS LSIs are used. The 0.5  $\mu\text{m}$  rule GaAs LSI in particular has a low power-delay product, and it will become a powerful weapon. GaAs is expected to dominate the high-speed territory that cannot be covered by CMOS.

If the above features of GaAs are used, the performance of computers and communications devices can be improved.

The Convex Computer Corporation (US) began selling a mini-supercomputer C-3800 in 1991 that uses GaAs across the board in the CPU. At present, they are still shipping this model. In addition, Fujitsu began selling ultra-parallel supercomputers (VPP-500 Series) in 1992 that use GaAs LSIs in the CPU.

The reason GaAs are used in the VPP-500 series is because a higher level of integration can be attained than with silicon ECL bipolars, and the power consumption is about 40 per cent lower than with ECLs. Although the integration from the 15,000 gates of silicon to 24,320 gates (three-input NOR conversion) with GaAs is being increased, power consumption is reduced by about 17 per cent, and the mounting method that was already set up was not changed.

The gate delay times are 60 ps (without a load), and 170 ps (fan in = fan out = 3, wiring length = 1.3 mm). The average wiring delay per unit length is a small 40 ps/mm. The wiring capacity is a low 150 fF/mm; the semi-insulating substrate used with GaAs works to our advantage. We can expect more and more supercomputers to be mounted with GaAs in the future.

A wide band ISDN requires an ATM switching system. GaAs can make the highly competitive ATM a reality. If matrix switching LSIs are made of GaAs, they will be LSIs that enable high-speed data transmission but with lower integration than the bi-CMOS LSIs. There will also be fewer parts needed.

With the bi-CMOS LSI, a 156 Mbit/s data transmission rate can eventually be reached with an integration of 30,000 gates and a 50 Kbit memory. With GaAs, however, a rate of 1.2 Gbit/s can be reached with only 12,000 gates and a 40 Kbit memory. That is because parallel processing will not be needed. Trial calculations indicate that when you build a device with 1,000 lines, the number of parts needed will be roughly one-tenth that number.

Full-fledged introduction of GaAs will begin in the latter half of the 1990s, and there is a strong possibility that the GaAs LSIs for the ATM will become their largest market.

If the low power-consuming GaAs is used for multiplexers and demultiplexers in optical communications, cooling the LSI will be a breeze. The power consumption of a GaAs LSI operating at 600 MHz is between one third-one quarter less than that of an equivalent silicon ECL. This will allow air cooling where water cooling is now used. The power consumption of a 1.2 Gbit/s GaAs LSI with 5,000 gates is 0.8 W. This will permit natural air cooling.

Due to the increased integration within the range of permissible power consumption, the number of parts will be decreased. This means the device will be more compact and cost less. Optical communications modules mounted with photoreceptive elements, preamps, etc., are already on the market, and we can expect to see compact multichip modules (MCM) containing logic circuits, etc., in the future.

There is a demand for using GaAs LSIs for image processing in engineering workstations. The reason is because GaAs LSIs can already operate above 300 MHz. With the GaAs it is possible to hold the power consumption to about 2.5 W for roughly 20,000 gates.

It is also possible to use highly integrated CMOS LSIs and adopt a parallel pipeline format, but high-speed GaAs LSIs will be more suitable for moving images, where real-time processing is required. The architecture will also be simpler.

One of the greatest problems with GaAs is reducing the power consumption during idling.

The optimal operating voltage for GaAs LSIs is a low 1.2V; they are easy to connect to batteries, and in that sense, they are well suited for portable devices. If a GaAs microprocessor were built, it would be possible to raise the operating frequency from the 300 MHz range to the 500 MHz range all at once on 1V operation. However, the obstacle to practical application here is the fact that the idle time power consumption of GaAs is high. Right now, there is almost no difference in power consumption of GaAs circuits whether they are idle or in operation. When a gate is OFF, a current flows in the Schottky junction of the next gate, and power is consumed even when no switching is under way.

That being the case, delicate power control that is possible with the CMOS becomes quite difficult. It also makes large-capacity memory difficult to build. Except for a very few, almost all circuits are idle when a memory is operating, so GaAs memory consumes more power than CMOS memory. If the memory

power consumption is large, it is difficult to build a microprocessor because a massive cache memory is needed.

It is important to realize a CMOS-type circuit construction with the GaAs. One candidate is an MIS structured complementary type circuit that uses hetero-junction technology. One report states that this will not only reduce idling power consumption, but can also lower the operating power consumption below that of silicon CMOS circuits by a power of 10.

The introduction of hetero-junction technology such as the HEMT will probably be necessary for miniaturization. That is because it is easy to suppress the short channel effect. With HEMT, the short channel effect is small with a 0.35  $\mu\text{m}$  rule, and it will be possible to realize a high-speed gate delay of 15 ps/gate.

Further, the defect density is falling and crystal quality is becoming higher in GaAs ion silicon technology, in which a semiconducting chemical compound is formed on a large diameter silicon substrate crystal. The application of this technology will make the utilization of silicon manufacturing equipment even easier, and it is important in terms of realizing a major reduction in the cost of the GaAs LSI. (Source: *Nikkei Microdevices*, April 1993)

#### Computer maps mushroom

As cheap, powerful systems appear on the market, geographic information systems (GISs) are moving out of their traditional uses of helping governments keep track of power lines and natural resources.

Combining digital maps with databases, the GIS can quickly generate displays of everything from traffic patterns to the spread of disease. However, it is the potential unleashed by this technology in dealing with one of the most drastic urban scenarios - a major earthquake - that has led the city of Los Angeles to earmark some US\$ 30 million for spending on geographic information systems over the next five years.

The next time a seismic catastrophe hits Los Angeles, engineers will be able to enter data on the earthquake's precise location and magnitude into a computerized mapping system of the city. Almost instantly, the program will update the map, colour-coding the fault lines and variations in soil types, and distinguishing thousands of buildings, bridges and roads by the methods and materials used to build them. The engineers will then be able to zoom in on the hardest-hit spots, as the computer directs emergency crews along unobstructed routes.

The market in GISs is predicted for rapid growth, thanks to the development of systems that

combine greater power with lower cost. This is leading to the spread of the technology into unexpected areas. American fast-food giants are using GISs to combine data on demographic and traffic patterns, as a tool to help pinpoint the best areas for new pizza outlets.

Meanwhile, the scientific community is also putting GISs to work. By feeding reams of data into such systems, scientists can visually analyse everything from encroaching deserts in Africa to the effects of acid rain in Europe.

Some geographic information systems are being linked with off-the-shelf maps and software, such as the US Census Bureau's first national digital map, which contains every street in the country. Other applications link GISs with communications technologies. At one emergency centre in Florida, USA, dispatchers can see a caller's location on a wall-sized digital map, along with the location of the county's ambulances. An electronic map in the vehicles responding to an emergency guides the driver and provides the caller's name and the type of emergency.

The GIS may soon become as familiar as the paper map, even to the ordinary traveller. Software already exists that allows drivers to plot the fastest route between two cities, plot it on an electronic map, and estimate how long it will take to get from A to B. (Source: *Business Week*, 26 July 1993)

#### Superconductor device markets to flourish

Three international trade groups have predicted that the market for superconducting devices will grow 100-fold in the next three decades.

Prospects for commercialization were the focus of the 2nd International Superconductivity Industry Summit (ISIS) in Japan in May 1993. An ISIS survey of about 70 international companies in the superconductor industry forecasts that the global market for high- and low-temperature superconducting devices will grow dramatically from its present size of about \$1.5 billion per year to \$150 billion or more per year by 2020. (See table on page 38)

Commercialization of new superconducting devices is expected to begin soon, spurred by an increase in R&D efforts since the discovery of high-temperature superconductors in 1986. The market currently is dominated by low-temperature devices, but high-temperature devices already are moving into niche markets, especially in the electronics area.

ISIS views demonstrations of superconducting technologies as the key to accelerating their commercialization. Additional R&D and manufacturing scaleup are needed to achieve full commercialization, concluded the group, especially for high-temperature superconductor technologies.

Use of superconductors will grow 100-fold				
Market/example of devices	1993	2000	2010	2020
<b>Electronics</b> Computers/circuits, microwave	neg	23%	32%	46%
<b>Energy</b> Energy storage/generation, motors	neg	15	16	18
<b>Transport</b> Levitated trains, electromagnetic propulsion	neg	9	6	9
<b>Medical/scientific</b> Magnetic resonance imaging and spectroscopy, SQUIDS <sup>a</sup>	100%	30	24	11
<b>Other</b> Magnets, magnetic shields	neg	23	22	16
<b>TOTAL</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>
<b>TOTAL SALES (\$ billion)</b>	<b>\$1.5</b>	<b>\$8-\$12</b>	<b>\$60-\$90</b>	<b>\$150-\$200</b>
<sup>a</sup> Superconducting quantum interference device. neg = negligible				

Source: International Superconductivity Industry Summit survey

The US and Japan lead in the funding of superconductivity-related R&D. However, Japanese industry reportedly outspends US industry by a factor of at least two. (Extracted from *Chemical and Engineering News*, 14 June 1993)

Internet - A gateway to a fascinating and bewitching world

Internet is a global computer information network, containing a slice of all human knowledge, allowing users of the individual networks linked to it to go through "gateways" to access other networks and information databases. Internet resembles a computer network cooperative and is so huge that the pundits describe it as a "network of computer networks". There is no central authority that oversees it and the rules are largely informal.

Internet is doubling annually in users, networks, computers and traffic - faster than any other telecommunication network! The basics of using Internet are simple. All that one needs is a computer modem, a communication software package and a subscription to an on-line information service linked to Internet.

Public access to Internet is provided by popular services such as CompuServe, MCI and Apple link.

You can get into Internet by using the services of an Information Provider who will allow you access into Terminal Mode. This means that you use your existing computer, and dial into a host system that has an Internet feed attached. Your equipment then functions as a remote terminal connected to the host computer of the Information Provider. The Internet access mode on the CIX (Compulink Information Exchange) dial-up conferencing system is such an example. You can get your own E-mail address and it is possible to have your computer terminal provide multiple simultaneous connections to different Internet modes on the system.

There are many different levels of using Internet. At the most basic, it is possible to simply send and receive E-mail at a low-cost, efficient link between E-mail services world-wide. That is how members of "CompuServe" - one of the networks that make up the Internet - can send messages directly to the screens of users. The Internet links an estimated 1.5 million computers over 10,000 networks in 50 countries serving about 6 million users.

Network connections are expensive as they generally involve connections to the Packet Switch network and large payments to Information Providers. So companies like Demon Internet Services provide a valuable service by leasing out network time on their own host computer. Once the subscription to one of

these services is obtained, the charge for sending an E-mail is generally only a few pennies.

CIX has access to Usenet, which is a kind of Global Bulletin Board discussing everything imaginable and quite a lot of mind-boggling stuff. The Demon system by contrast offers a full Internet connection over which you can chat with people, send mail, collect files, read Usenet news, search for a quotation or search a library catalogue.

A random sample of information available includes Buddhist texts, digital images of the planets, biotechnology, aboriginal studies, the Koran, cooking recipes from Stuttgart, correspondence courses, a newsletter on feeding infants, the complete works of Shakespeare, Chinese classics etc.! This is undoubtedly a fascinating system for people who know what they are doing just as certainly as it can be a purgatory for the inexperienced.

Internet is fundamentally a research tool and was not set up as a playground for recreational users. Computers connected know nothing of GUIs (Graphical User Interfaces) or any other friendly front-ends. There are few written standards or recommended procedures or "netiquette". The system is so large that tracking down a file is a Herculean task. You will have to find your way around in a manner called by the Americans an "experiential" grope around without despairing. It is not easy to find Internet addresses as there is no central directory. It does not have security and ease-of-use features that commercial users want. At peak business hours promptness of service can be a problem. If you do send mail to a Usenet news group you should be prepared for that information to be posted anywhere without your sanction including the front page of a newspaper.

Finally once you are connected you will find that time has no real meaning - you are within cyberspace. You can settle down happily for a couple of hours not noticing the size of the phone bill you are running up. (Extracted from *PC Plus*, April 1993, *Financial Times*, 13 May 1993 and *The Independent*, 28 May 1993)

#### The fat controller

What is a microcontroller, as opposed to a microprocessor? Some regard the former as "any processor that is not in a computer", some suggest that it depends on the number of integrated functions glued onto a processor core regardless of the application, and others, somewhat cynically, say that embedded control is the last refuge of those processors unable to gain "design wins" in computer systems".

Perhaps the fairest definition is that a microcontroller is a processor that is programmed once. It may perform a number of tasks, and run more than

one program, but whereas a computer's microprocessor performs whatever tasks are set it by a human user loading and running applications, the microcontroller, once programmed, takes its instructions from the memory where the program resides. This memory is usually non-volatile PROM or EPROM.

The microcontroller switches between tasks determined by interrupts, saving the data from one task as it does so and restoring it later, once the higher priority interrupting task has been dealt with.

The world-wide microcontroller market is vast, worth \$5.85 billion in 1992 and is expected to rise to \$7.75 billion by 1994. This is for microcontrollers of all sizes. But 8-bit microcontrollers still dominate the scene, accounting for nearly 60 per cent of the world-wide market in 1992, with 16- and 32-bit devices together accounting for only 7 per cent.

Although suppliers of 32-bit architectures stress that the market for higher-bandwidth parts will grow as the natural demand for processing power increases, there is still no sign that demand for 8-bit controllers is slacking. Market researcher Instat expects the world-wide market for 8-bit microcontrollers will increase from 0.8 billion units in 1992 to over a billion units in 1993 and will grow steadily to more than 1.6 billion units by 1996.

Other moves in the 8-bit market include the increasing importance of fuzzy logic in microcontrollers. (Source: *Electronics Weekly*, 26 May 1993)

#### **Company news**

##### IBM plans a parallel processing future

In a bid to win new customers for its troubled mainframe computers, IBM says it will adopt a cheaper and more powerful computer architecture based on hundreds of microprocessors operating in parallel.

IBM says it will incorporate parallel processing technology into its key System 390 mainframe models by 1996. IBM hopes this will enable it to make its mainframes more cost-effective, since it is cheaper to manufacture parallel processing mainframes.

IBM has been losing mainframe customers as they have switched to lower-cost client/server architectures that rely on cheaper but powerful minicomputers and networks of PCs or workstations.

IBM announced the POWERparallel SP S/390 parallel query server and the S/390 parallel transaction server. These systems will use hundreds of microprocessors based on its PowerPC RISC architecture, which is being used as the foundation for a wide range of IBM workstations and desktop PC products.

The key to IBM's parallel processing strategy is producing software that will run on the new systems. IBM says that it will offer parallel processing versions of its Information Management System, Customer Information Control System and DB2 database management system. (Source: *Electronics Weekly*, 17 November 1993)

#### Fujitsu predicts price fall for GaAs chips

Fujitsu Mikroelektronik is putting its money on gallium arsenide (GaAs) gate arrays significantly closing the price gap on CMOS gate arrays by 1996.

Fujitsu has boldly committed to a dedicated GaAs semiconductor facility in Yamaguchi where it is currently producing devices on 4-inch wafers at 0.8-micron.

The company will move to 5-inch in two years and 6-inch by the end of the decade, moving down through the process technologies from 0.5 to 0.35-micron and then 0.15-micron by the end of the decade.

It is producing GaAs gate arrays ranging from 2,000 to 50,000 gates at operating frequencies up to 1GHz. The experience of producing these devices is a factor in reducing cost.

The push on GaAs devices will run alongside Fujitsu's long-established CMOS gate array business.

The company is now producing devices ranging from 3,000 gates to 820,000 gates with 400 I/Os. It was the first to move to a 0.5-micron process, which it announced at Electronica in Munich in 1992. (Source: *Electronics Weekly*, 14 July 1993)

#### Korean firms target world DRAM market

Korea is set to be the dominant player in the memory chip market of the 1990s, just as Japan dominated it in the 1980s and America in the 1970s.

Samsung, the world's number one DRAM supplier, has built enough manufacturing capacity to take 20 per cent of the world market for the upcoming generation of 16-Mbit DRAM and has targeted the end of 1994 for achieving that share.

Hyundai, Korea's number two chip maker, is also targeting a 20 per cent share of the world 16-Mbit market, but does not expect to catch up with Samsung in terms of unit output until the third quarter of 1994.

Hyundai has stabilized its 16-Mbit process and intends to start commercial production and to hit the one million a month mark by the second quarter of 1994. Full capacity is 2.5-3 million units a month.

Both companies are making 16-Mbits on 8-inch wafers. It is not known if any of the Japanese chip companies are running 16-Mbit DRAMs on 8-inch wafers in production quantities. However, according to the Koreans, it will not be economical to make 16Mbit DRAMs on 6-inch wafers.

Samsung expects to be producing between 2-3 million 16-Mbits a month by the beginning of the fourth quarter.

The price is beginning to erode fast (around \$65 with reports of DM 90 (\$55) pricing in Germany) and the Koreans are projecting the crossover on price per bit with the 4-Mbit will occur in the first half of 1994. That would imply a 16-Mbit price of \$40-45. (Source: *Electronics Weekly*, 23 June 1993)

#### Varian/Chinese agreement

Varian Associates (Palo Alto, Calif.) has signed an agreement making it the first non-Chinese semiconductor equipment company to participate in the manufacture of chip fabrication tools inside the People's Republic of China. The 10-year cooperative agreement calls for Varian to provide manufacturing expertise and training in such areas as mechanical assembly under cleanroom conditions; quality assurance; assembly; installation; and the service of ion implanters and sputtering systems. In addition, kits of sputtering and ion implant systems will be locally assembled in China. Varian will work with the Changsha Research Institute of Equipment for Semiconductor Technologies, and the Nanguang Machinery Factory, a manufacturer of vacuum equipment, to implement the agreement. (Reprinted with permission from *Semiconductor International* magazine, September 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

#### Nokia heads back to profit

The world-wide telecommunications boom looks set to take the Finnish company Nokia to its first profitable year since 1990. In the four-month period from May to August, profits swelled to \$54.4 million from \$5 million last year. Both its cellular phone and network equipment units report strong growth. Nokia has also undertaken tough cost-cutting actions and closed four consumer electronics facilities. Analysts are now looking for Nokia's best results for five years with a profit forecast of \$144 million for 1993. (Source: *Electronics Weekly*, 27 October 1993)

#### Siemens and IBM sample DRAM

Siemens and IBM have started sampling the 64-Mbit DRAM they have co-developed but have postponed making a decision about whether they will combine forces to manufacture it.

IBM and Siemens reckon the decision is not urgent because first production of the 64-Mbit will not be required until late 1995, ramping up to volume production in 1996.

As well as the 64-Mbit deal, Siemens and IBM jointly manufacture 16-Mbit DRAMs and share, with Toshiba, a joint R&D effort on the 256-Mbit DRAM. (Source: *Electronics Weekly*, 27 October 1993)

#### Fujitsu aims for Euro chip top ten

Fujitsu plans to be a top ten semiconductor player in Europe by 1996, leaping from its current number 17 spot, based on the strategy of a well-balanced product portfolio. At present memories represent 45 per cent of the company's semiconductor business in Europe, ASIC devices are 20 per cent, telecoms chips are about 15 per cent and components - which includes connectors, relays and keyboards - represent about 20 per cent.

Fujitsu expects the memory percentage to drop to under 40 per cent as the ASIC and telecoms chip businesses continue to grow. (Source: *Electronics Weekly*, 14 July 1993)

#### IBM Microelectronics serves DRAM menu

IBM Microelectronics will have 16-Mbit DRAMs available in standard 300mm SOJ packaging in the third quarter of 1994.

The company is now taking orders for 400 mm SOJ parts configured by 4 with 4k refresh and access times of 50 ns and 60 ns.

It will launch devices in 400 mm TSOP and RTSOP packaging in the second quarter of 1994.

A 3.3V 16-Mbit device with self refresh will also be launched next year. This will be configured x16 and x18. The parts will be made at IBM's Burlington wafer fab in the United States and at Essonnes in France using a 0.5-micron CMOS process on 8-inch wafers.

A 16-Mbit synchronous DRAM is also on the market configured x16 and x18. IBM is hedging its bets with parts based around both the JEDEC standard and another pin-out being pioneered by Samsung and Mitsubishi which is said to offer better performance. (Source: *Electronics Weekly*, 29 September 1993)

#### NEC develops CIM system for mid-sized manufacturing companies

NEC has developed a production management system for mid-sized companies. The system responds to these companies' demand for computer-integrated manufacturing (CIM) by adapting to the manufacturing

structure of mid-sized companies with a system that will work with point-of-production (POP) terminals and existing personal computers.

The new PROSIA MC 10 is one of NEC's CIM series responses to the trends towards downsizing (the shift towards using smaller computers) and open systems. Since it runs on workstations and personal computers, the system comes with Infomix, a standard database system for the UNIX system.

The system is also meant to be used with the Product Number Management Method widely used by mid-sized companies, which uses order numbers to manage the process from order to production. It can also be used with the MRP Method (a method of planning quantities of raw materials and parts needed for each part of the manufacturing process) used by large companies for estimating production. (Source: *Nikkei Sangyo Shimbun*, 15 June 1993)

#### NEC enhances logic-synthesizing tools

NEC has strengthened business strategy by marketing ASIC and enhanced logic-synthesizing tools used for its own chips. First of all, NEC paid attention to the calculation of rising/falling delay time of input wave when the tool made by the US Synopsys, Inc. is used. As a result the accuracy of timing was increased. Furthermore, the tool's algorithm used for NEC's IC was revised, and the capacity was enhanced to the level of commercially available tools. The tool used for NEC's chip is reasonably priced at ¥500,000.

Logic synthesizing has been slowly but steadily growing as a tool of EDA used for ASIC design. At the same time, problems with the tool have been surfacing. As an example, inadequate timing in design can be cited. With increased integration of IC's, operational errors caused by circuit timing, synthesized by the tool, have been increasing. Also users are dissatisfied with high cost of commercially available tools, about ¥10 million. It is difficult to justify the allocation of a commercially available tool to one designer since the price is so high.

In order to solve this problem, NEC improved the method of calculating the delay time of a commercially available tool (Design Compiler by the US Synopsys, Inc.). Furthermore NEC's logic synthesizing tool is redesigned from the algorithm. (Source: *Nikkei Electronics*, June/July 1993)

#### Apple sows seeds of a future without keyboards

After years of build-up and months of delay, Apple Computer has finally launched Newton, its hand-held personal communicator with a touch-sensitive screen which converts handwriting into computer-readable text. It is also launching a range of Macintosh computers which break new ground in

speech recognition and synthesis. They all should be in shops as of early 1994.

Newton is the first major product for which Apple has offered licences to rivals, after the painful realization that not licensing the Macintosh technology hurt sales. Apple hopes to create a de facto world standard for personal digital assistants and communicators, and has already licensed Sharp (which is making the first of the planned Newton range), Motorola, Cirrus Logic, Siemens and Matsushita.

The core of the licensed technology is optical character recognition software which converts lines written onto the LCD screen into the ASCII text used by all computers. The launch of Newton has been delayed for nearly a year by the practical difficulty of recognizing cursive (joined-up) writing, rather than disconnected characters or capital letters.

Apple is also offering two new PCs, codenamed Cyclone and Tempest and costing under \$3,000, which synthesize speech in response to typed text, and recognize spoken commands. (Extracted from *New Scientist*, 31 July 1993)

#### Chip suppliers flying higher while PC makers have mixed results

Intel is not the only US semiconductor company to have had a sparkling second quarter. Motorola has announced a 28 per cent rise in sales to \$1.39 billion while Texas Instruments had 13 per cent growth to \$2.1 billion revenues.

Brooktree saw sales up 23 per cent to \$30 million, IDT announced a 35 per cent increase in sales to \$72.7 million and LSI Logic saw revenues up 16 per cent to \$177 million. VLSI Technology's \$128 million revenues were up 23 per cent on the second quarter of 1992. Profit was \$3 million compared to a loss of \$1.5 million in the second quarter of 1992.

Among the programmable logic companies Altera recorded revenues up 44 per cent to \$33 million; Xilinx's revenues rose 39 per cent to \$54.4 million and profits up 49 per cent to \$8.9 million; Atmel saw revenues grow 53 per cent to \$50.6 million and profits double to \$6.2 million; Microchip Technology had sales up 36 per cent at \$27 million and profits up 46 per cent at \$2.7 million.

Personal computer makers' recent results reveal a mixture of fortunes.

Compaq Computer, the second largest PC company in the world, has made almost as much money in the first half of 1993 as they did in the whole of 1992. Compaq doubled its sales in the second quarter to \$1.63 billion. Profits increased from \$29 million to \$102 million.

Its half-yearly revenues of \$3.24 billion and profits of \$204.6 million compare with annual revenues of \$4.1 billion and profits of \$213 million in 1992.

Elonex has increased revenues but profits have dropped. Annual revenue increased from £57.8 million in 1992 to £78 million in 1993. However, profits dropped from £9 million to £6.8 million.

Apple Computer, the third largest PC maker in the world, made a pre-tax loss of \$188 million, on revenues of \$1.86 billion for the third quarter, compared with revenues and profits of \$1.74 billion and \$131.7 million in the third quarter of 1992. (Source: *Electronics Weekly*, 28 July 1993)

#### Silicon giant raises stakes in the chips war

The American chip maker Intel, which makes the microprocessors at the heart of four out of every five personal computers, has launched a new chip that is five times as powerful as its predecessor. Called the Pentium, the chip arrives at a time when Intel's rivals are trying to break its dominance of the microprocessor market.

The stakes are high: the microprocessor market for personal computers is worth \$5 billion a year. Intel spent \$779 million researching new chips in 1992 and sold 30 million microprocessors that year. Its old ally, IBM, has recently formed an alliance with Apple to try to break Intel's stranglehold on the market. Apple has always used Motorola to supply microprocessors for its Macintosh computers. Apple, IBM and Motorola are now developing their own microprocessor, called the PowerPC.

Challenges are also coming from another direction. The distinction between personal computers and computer workstations, their more powerful cousins that are widely used in research, engineering and design, is beginning to blur. The American company Digital, which makes workstations and the larger minicomputers, launched its own multipurpose chip called the Alpha which can be used in top-of-the-range personal computers as well as workstations. The Pentium is also powerful enough to run a workstation.

The Pentium is the fifth generation of Intel's X86 series of microprocessors. The chip has 3.1 million transistors on a square of silicon 15 millimetres across. This is nearly three times as many as its predecessor the 486, and connections on the Pentium are as fine as 0.8 micrometers, and it has a number of features to increase its speed over earlier models.

Intel has promised to produce a second generation of Pentium processors by the end of 1993. This will have connections just 0.6 micrometres across



with clock speeds faster than 100 megahertz. These chips will operate at 3.3 volts instead of the 5 volts used in most chips, which will reduce the amount of heat the chip generates. The heat of a chip limits its clock speed. These chips should then substantially outperform the current Alpha and PowerPC chips.

In a recent report on Intel's Pentium micro-process, market research firm InfoCorp predicted that the P6, the successor to the Pentium, will be in production by 1996.

By 1997, Intel will be producing the P7, which will finally break with the Intel X86 architecture while the P6 will still be compatible with X86 software.

Intel's 486DX3 will be available in the fourth quarter of 1993 and will cost about \$500. (Extracted from *New Scientist*, 3 April 1993 and *Electronics Weekly*, 28 July 1993)

#### Synergistic joint venture with former East German manufacturer

Synergy Semiconductor Corp. (Santa Clara, Calif.) has formed a joint venture with Halbleiterwerk Frankfurt an-der-Oder (HFO), a bipolar semiconductor manufacturer. HFO was formerly the East German division of the Mikroelektronik und Technologie GmbH. The new joint venture is between Synergy Semiconductor, the state of Brandenburg and the Treuhandanstalt, the agency established by the German Government to oversee the privatization of former East German businesses.

As part of the agreement, Synergy will license its sophisticated, ultra-high-performance ASSET (All Spacer Separated Element Transistor) Technology. This joint venture will produce products for the European market. The two companies will work together on the development of high-performance telecommunications and computation applications. Current plans also call for developing bipolar foundry relationships to produce both digital and analog products. (Extracted with permission from *Semiconductor International* magazine, May 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

#### Sandia forms centre for microelectronics technologies

A national Centre for Microelectronics Technologies (CMT) has been established at Sandia National Laboratories to support cooperative research and development by universities, industry and government in advanced semiconductor technologies. The Centre will combine what is described as a "major" donation of equipment by IBM with Sandia's Class 1 cleanroom facilities.

The new centre complements Sandia's existing programme with SEMATECH and the Contamination-Free Manufacturing Research Centre recently formed at Sandia by SEMATECH. Access to the facility will be through an industrial review board that will review proposals. Equipment installation and checkout is expected to be completed late this year. (Extracted with permission from *Semiconductor International* magazine, May 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

#### Hitachi looks to Europe for product research

Hitachi, the Japanese electronics group, is planning to start product-related research in Europe following the success of "blue sky" research collaborations with universities in the United Kingdom and Ireland.

A three-year collaboration with Trinity College, Dublin has led to a breakthrough in neural networking computers which mimic the thought processes of the brain, using optical data processing.

Hitachi's European research is mostly fundamental research, which is speculative and over five years from a product. The next step is applied research and then product development, both traditionally done in Japan.

But success is university collaborations like Dublin and at Cambridge, which has isolated electrons as part of making very high capacity memories, has prompted Hitachi to move more product-related research into Europe.

In the past Japanese electronic companies have been criticized for only carrying out "token" research in the United Kingdom. Apart from Asic design, Fujitsu and Sony are the only two Japanese companies to set up product development centres in the UK. (Source: *Electronics Weekly*, 26 May 1993)

#### SGS-Thomson pursues power semiconductor improvements

After concentrating in the last few years on enhancing bipolar products for high current applications between 450 and 1,200 V, SGS-Thomson Microelectronics' developers are now turning their attention to possible improvements in the MOS [metal-oxide semiconductor] sector for voltages ranging from 60 to 800 V.

SGS-Thomson Microelectronics' strong market position in power transistors for electronic ignition systems - the firm claims a market share of about 25 per cent - is based mainly on the structural potential of the company's own VIpower-M1 process, which enabled it to put the world's first intelligent component

for motor vehicle applications, the VB020, on the market in 1988.

SGS-Thomson Microelectronics presented the successor to this classic ignition transistor, the VB027 not so long ago. This second-generation product of the VIPower M1 process has a 50 per cent higher current density than its predecessor in the power section, but the transistor area is only just over half the size (7,100 square microns instead of the previous 13,800). The number of mask steps required for manufacture has also been cut from 11 to 10. Similar advances to those achieved in the bipolar sector can be expected in the next few years particularly in MOSFETs [MOS field effect transistors] in the 60-V cut-off voltage range. The limits of technical feasibility are far from having been reached, especially as regards reducing conducting resistance. With the M01 process introduced in 1991, conducting resistance was still 0.5 ohm sq mm, but the M02 process presented in 1992 reduced it to 0.33 ohm sq mm.

SGS-Thomson Microelectronics also plans to cut conducting resistance to 0.20 ohm sq mm by 1994 and to as little as 0.15 ohm sq mm by 1995. This will be achieved principally by drastically increasing the switch transistor cell density. The point of departure for this is the 1 million cells sq in. of the M01 process. They managed to increase this to 1.3 million cells sq in. in 1992 and are aiming for a cell density of 2.3 million cells sq in. in 1994 (M03 process). In 1995 the developers want to cap it all by fitting 5 million cells sq in. on the switch transistor.

Current sales figures confirm that SGS-Thomson Microelectronics has backed a winner with its intelligent power elements in the low and medium power ranges. While business in bipolar transistors, rectifiers and analog logical and standard components is generally declining, the company has almost doubled its sales of power MOSFETs (+79 per cent) and VIPower elements (+86 per cent) in Germany.

Further new products will shortly be presented in the MOS sector. For example, the VN190 single low-side driver will come on the market before the end of 1993. This is an intelligent power MOSFET with integrated overvoltage and excess-temperature protection, built-in current-limit control, and diagnostic functions. Internal resistance will be 100 milliohms. Production of a newly-developed dual high-side driver in a TO 220 housing is also scheduled to start in 1993. There will be two versions of this component with probable forward resistances of 2 x 100 and 2 x 200 milliohms. (Source: *Markt & Technik*, 21 May 1993)

## IV. APPLICATIONS

### Hot chips

The first validated thermal models of Intel's new Pentium processors are being developed by Intel and US thermal analysis software firm Flowmerics. The models are being developed using Flowmerics' Flowtherm software, which uses computational fluid dynamics (CFD) techniques to characterize the thermal behaviour of the chip. They are based on three-dimensional solutions of the equations which govern the flow of air around the chips, as well as the conduction within them. Thermal models are important for firms building the Pentium into systems, because the processors dissipate up to 16 W of heat, almost twice as much as any of their predecessors. (Source: *Electronics Weekly*, 14 July 1993)

### Laser surgery

A portable surgical laser, based on laser diode technology from Sony, has been developed by Dr. Tony Raven, working for the UK company Diomed of Cambridge. Because the Diomed 25 is a fraction of the size and weight of conventional surgical lasers, its development could extend the availability of laser surgery in hospitals and smaller treatment centres throughout the world. It weighs only 25 lbs and can be carried by hand to the operating theatre. It needs only a standard wall socket for operation, so removing the need for dedicated laser rooms. The semiconductor technology used is both highly reliable and maintenance free. (Source: *Electronics Weekly*, 14 July 1993)

### French firm takes logic tools one step further

A logic synthesis tool from French firm IST is claimed to have taken the next step in boosting the performance and applicability of these design aids.

Asyl-Plus employs Binary Decision Diagrams (BDDs) in its core instead of the more usual Boolean equation factorization technology. The outcome is a tool which achieves denser and higher speed circuits.

In a benchmark on a 5,000 gate sequencer for a microprocessor's controller, Asyl-Plus achieved a circuit 15 per cent smaller than that obtained by the Synopsys tool and 23 per cent smaller than from Compass Design Automation software. All circuits were compared with wiring taken into account. The Asyl-Plus circuit also had a critical path which was 18 per cent faster than Compass and 24 per cent faster than Synopsys.

A critical part of the Asyl-Plus synthesis tool is a lexicographical technique for ordering the input

variable) on the BDD. This prevents the BDD tree becoming too big and too difficult to synthesize into logic primitives. A corollary of lexicographical input ordering is that routing between logic functions is inherently a factor minimized by the algorithm and may be constrained by the user just like implementation area and critical path speed.

These features make Asyl-Plus particularly suited to synthesis of FPGA circuits and may be used to retarget circuit designs from one FPGA to another. To do this the tool reconstitutes the Boolean equation of the combinatorial logic between registers before using the BDD technique to target the new FPGA. (Source: *Electronics Weekly*, 8 September 1993)

#### How a MiniDisc could supplant 1,000 floppies

Sony is trying to encourage sales of its CD-like MiniDisc system by publishing specifications for its use in data storage and retrieval. This may give the MD a better chance of success than Philips's tape-based Digital Compact Cassette format, which cannot offer the high-speed search and access facilities needed for computer applications.

Physically, data MDs will be the same size as audio MDs, but the file storage format and extra error correction codes needed to avoid data corruption reduce their storage capacity to 140 megabytes, from around 260 megabytes for an audio MD. But this is still equivalent to either 1,000 floppy disks, 2,000 high quality still pictures, well over 10 million words of text, or 15 minutes of full motion video. Data will be stored and transferred according to existing CD-ROM standards, to encourage the computer industry to adapt CD-ROM applications for the data MD format. Demonstration versions will be available from the middle of next year.

The data recording track will be digitally coded to prevent an audio MD player playing data MDs, which could produce high-frequency sounds that would damage hi-fi loudspeakers.

Data MDs will come in three forms: unerasable, like a music CD or MD, and used like a CD-ROM for electronic publishing; blank, for erasable recordings; and partly written, for interactive applications such as those where the user uses prerecorded text or graphics as a template for new work. (This first appeared in *New Scientist*, London, 31 July 1993, the weekly review of science and technology.)

#### Computer games paint sound pictures for the blind

Virtual reality and computer games are having an unexpected spin-off in helping blind people to use mice, icons and menus. These are increasingly popular among sighted people but are more difficult for blind

people to use than the text-based displays they are replacing.

For blind people, hitting the right part of an icon by moving the cursor with a mouse can be much more difficult than simply typing a command. But with virtual reality, the "screen" can be replaced by headphones giving a three-dimensional impression of a room.

Previously, computer technology was a boon for the blind and partially sighted, allowing many to work more easily with sighted colleagues. But programs that use a mouse, menus and icons, such as Microsoft's Windows or Apple Macintosh systems, make computers almost impossible for the blind and partially sighted people to use.

On text-based screens, words and symbols could be displayed in large type, read out by a voice synthesizer or converted to Braille. But magnified menus and icons can take up most of the screen, and without virtual reality, communicating the position of the cursor on the screen is practically impossible. A voice synthesizer could read out the items on a menu, but people would still have the problem of picking an item. Braille displays show only one line at a time.

Changing an icon or menu into a sound requires changes to some basic instructions in the program. Research into what changes are needed is still at an early stage. The Royal National Institute for the Blind (RNIB) is looking at several approaches as part of a European Community project called the Graphical User Interface for the Blind (GUIB).

As part of the project, the RNIB is trying to develop a "sonic mouse". Icons can be roughly located by scanning a finger over a touch pad, and listening for their sound.

A speech synthesizer can read a menu at up to 450 words per minute. This is too fast for a sighted person to understand, but not for an experienced blind person, who can hit the return key when the desired word is spoken. (Extracted from *New Scientist*, London, 7 August 1993, the weekly review of science and technology.)

#### A new calling for computerized phones

The day when phone numbers can be allocated to people rather than telephones, so that subscribers can be reached wherever they are, has been brought closer by a computer system. The system will enable telephone companies to custom-build an unprecedented range of novel services for clients in a fraction of the time it takes today, including the provision of personal numbers.

Other new services might include sequence calls whereby customers who want to speak regularly to a specific group of people are saved the bother of phoning them all individually. Instead, the customer would dial a special code and the telephone company would automatically ring the members of the group in sequence, connecting them to the customer as and when the line becomes free.

GPT of Coventry, one of Britain's biggest telephone equipment manufacturers, says that its new system, called Gain Inventor, would enable telephone companies to create this type of service within minutes. At present, it takes as long as two years for telephone companies to set up these services because they must painstakingly test the circuits and lines of a network to ensure, for example, that the new services do not disrupt emergency calls.

The Gain Inventor computer system sidesteps lengthy testing because it has a database of pretested instructions that are ready to use without any further checking. These are elementary call-handling instructions, such as "answer the call", "play a recorded message" or "redirect the call". Phone companies could link the instructions together to create new services or to suit specified customer requirements. Bellcore, an American telephone research company, developed and tested the instructions.

The Gain system represents each available instruction with an icon or symbol on the computer screen. Using this system, staff could take as little as 10 minutes to set up a new service. Gain can also simulate a phone network, enabling telephone firms to try out new services by allowing customers to visit the company and sample them on the computer.

One recent study by the London-based consultancy, KPMG Peat Marwick, predicted that intelligent networks could generate sales of £7.7 billion in Europe by the year 2000. (This first appeared in *New Scientist*, London, 25 September 1993, the weekly review of science and technology.)

#### Coded videos for the blind or deaf

Future generations of blind and deaf people will be able to enjoy television programmes on video if the electronics industry thinks ahead, says Britain's Royal National Institute for the Blind (RNIB). There is a golden opportunity to do this because the world's ten leading manufacturers of video cassette recorders - Hitachi, Matsushita, Mitsubishi, Philips, Sanyo, Sharp, Sony, Thomson, Toshiba and JVC - start work on the standard for a new generation of digital VCRs.

All they need do, says the RNIB, is make them capable of recording the small amount of extra digital code needed to provide a spoken commentary on the

pictures for the blind or subtitles for the deaf. Existing analog VCRs cannot do this.

The RNIB has been working for two years with the Independent Television Commission on a TV commentary system called Audetel (audio description of television). This converts a spoken commentary about scenes without dialogue into digital code, which can be slotted into spaces in the broadcast waveform, and decoded if required. Teletext already carries subtitles so deaf people can follow the dialogue. But the frequencies of Teletext and Audetel signals are too high for current VCRs to record reliably. (This first appeared in *New Scientist*, London, 28 August 1993, the weekly review of science and technology.)

#### Tastebud tuning

That silicon chip buried in your computer is more versatile than you may think. Scientists in the United States are using silicon to make an artificial tongue with a most discerning palate - it can spot the difference between alcohol and water. And soon they hope it will be able to sense dangerous substances in the air and drugs in the bloodstream.

Michael Sailor's team at the University of California at San Diego has based its "tongue" on the luminescent properties of electrochemically etched silicon wafers called porous silicon. They realized they had all the makings of a chemical sensor after observing that the intensity of emitted light was dimmed when ethanol was present, while water had no effect.

Now Sailor claims he can tune his "tastebud" by chemically altering the silicon's surface. Partial oxidation with iodine followed by hydrolysis makes the surface more sensitive to water and less sensitive to ethanol, says Sailor.

The team is now trying to refine the surface further, so that the chip is sensitive to other substances such as carbon dioxide or methane. Sailor sees such devices being used as air analysers in mines or on board submarines.

Apart from the material's commercial potential, Sailor is excited by the light shed on how and why porous silicon luminesces. "It tells us that the porous silicon is very surface sensitive, or in other words the business end of the material is at the surface", he says. And he warns that scientists must understand the photophysical reactions in the material before practical devices can be designed. (Source: *Chemistry & Industry*, 3 May 1993)

#### Inmos T9000 transputer presented

The T9000, the latest of the transputer family, officially saw the light three years after the start of its design when Inmos, the British company of the

SGS-Thomson group, presented it to Europe's press in May 1993.

The T9000 is a unique "newborn", the most rapid monolithic computer in the world, a chip smaller than a fingernail with 3.3 million transistors. As opposed to ordinary microprocessors, a single T9000 transputer contains both communication channels and storage, making it a real self-sufficient computer. To appreciate the T9000's velocity and power one need only point out that each of the four communication channels can transmit, in one second, all the information contained in at least 20 Bibles, i.e. about 155 million words per second.

Another characteristic of the Inmos T9000 in addition to its velocity is its ability to connect several components operating as a "team". Specific integrated communication channels allow several transputers to communicate with each other without interrupting their work; a network of hundreds of T9000s can work "as a group", thereby allowing problems to be solved much more quickly than when using traditional solutions.

The potential field of application of this latest transputer is extremely wide, ranging from telecommunications to military electronics, image processing, optical character recognition, to network communications systems and supercomputers.

In technical terms, the T9000's velocity can reach 200 Mips (millions of instructions per second) and 25 Mflops (millions of floating point operations per second); the device measures less than 10 x 20 mm and incorporates a 32-bit super-scalar integer processor, a 64-bit unit for floating point operations, a virtual channel processor, 100-mBit/s communication channels and a 16-Kbyte memory.

The T9000 is the basic product of a new family. Variations for specific applications will be developed at a later stage but its compatibility in terms of operating instructions and communication procedures will remain the same.

Inmos's future activities, which have already started, include the Chamelon program whose goal is the production of innovative microprocessors from the mid-1990s to the beginning of the next century. (Source: *Media Duemila*, May 1993)

#### Putting the super into conducting

High temperature superconductors promise to revolutionize the electronics industry, but since their discovery a few years ago, progress in building integrated circuits out of them has been patchy.

While the debut of commercial superconducting microprocessors is still far from reality, there have been several advances made by different companies and

research laboratories around the world that could lead to the development of effective ways of producing superconducting chips.

One of the most promising developments has been the creation of the first commercial device based on a tiny superconducting element known as a Superconducting Quantum Interference Device or SQUID from US firm Conductus.

A SQUID is capable of detecting minute changes in magnetic fields, making it possible to detect the faint magnetic fields produced by the human body and help diagnose disorders. Conductus also claims to have developed a data storage chip that is ten times faster than the fastest memory chips currently in use. The prototype device runs at 120 billion cycles per second.

Other developments include US firm Superconductor Technologies, which has demonstrated the world's first superconducting multichip module.

The device combines conventional CMOS chips connected by 10 micron-wide superconducting lines made out of a special thallium-based superconducting material.

The multichip module has been shown to have high performance at liquid nitrogen temperatures.

Since CMOS devices generally show a 2.5 times performance increase at such temperatures, the use of superconducting connections demonstrates an effective hybrid approach in utilizing the properties of high temperature superconductor materials without having to tackle the problem of building chips out of them.

TRW's Applied Technology Division has laid claim to the world's first digital logic gates built out of high temperature superconductors. TRW's experimental device consists of a logic gate resembling a CMOS design and it can switch at 250 billion times per second.

The power consumption is ridiculously low. Each logic gate dissipates just two nanowatts.

Chips based on high temperature superconductors offer a way out of the inherent limitations to ever faster chips that are intrinsic to our present semiconductor materials, but they will also bring new problems such as how they can be connected to other components and there is also the problem of coolers. (Source: *Electronics Weekly*, 2 June 1993)

#### The virtual library: virtually a reality?

A virtual library is an information service or a resource which users access via a telecommunication network. It may not be based on actual library but an amalgam of services and resources. Two things have accelerated this change. Networks have got bigger,

e.g. Internet or global network, and secondly, a wide range of resources accessible by networks is increasing. The advantages are that research workers can keep in touch through E-mail, papers can be written jointly with people you have never met halfway round the globe, subscribe to electronic journals by E-mail, bulletin boards give interesting information, a program called "gopher" lists resources at its site and the File Transfer Protocol, which copies files from a remote computer to your computer. Traditional publishers are worried about copyright. Internet has no standards of cataloguing, indexing, classifying. Virtual libraries can affect actual libraries in two ways. Firstly, it is an exploitable information service which their own users may find useful, and secondly, libraries can add their resources to the network. (Source: *Aslib Information*, April 1993)

### Virtual reality operation

Virtual reality imaging is beginning to make inroads into operating rooms. It can show images that are far easier to understand than the actual human anatomy. A three-dimensional picture projected onto a patient's skin not only allows the doctor to see the image through special virtual reality glasses, which enhances three-dimensional vision, but would also be able to manipulate the patient's internal organs. Over the last few years, work has been carried on with three-dimensional pictures of patients' skulls and brains. The images are produced by taking two-dimensional magnetic resonance and CAT-scan pictures, converting them to three-dimensional ones with advanced computer graphics, then using a video mixer to produce a television image. Using an electronic scalpel on the television screen, the physician can simulate surgical cuts, showing exactly which area a particular skin incision will reveal. In brain surgery, it can help physicians plan a safe path to a tumour, avoiding contact with motor strips, for instance, that could leave a patient paralysed. It can also help in facial reconstruction techniques, showing surgeons how a bone should be cut and repositioned. The process has already been used in planning several operations. However, a few technological improvements are essential to make the process successful. For instance, the lighting and clarity of the images is not sufficiently developed. Similarly, the current virtual reality glasses are too bulky and need to undergo some improvements before they become a viable option in the operating room. (Source: *Financial Times*, 30 March 1993)

### Information handling on PC networks

Development of Intel 386 and 486 processors has greatly improved speed, memory management and access capabilities and this meant that "real" computing power was available cheaply on the desktop and in the library. As the demand for networking microcomputers grew, LANs (Local Area Networks), WANs (Wide Area Networks), MANs (Metropolitan Area Networks) came

into existence. Ethernet standards specified physical connections. Networks also needed an agreed language or protocol for data access and transfer and Transmission Control Protocol Internet Protocol came into existence. A microcomputer on the network also needs in addition its own operating system, a networking programme and a network manager. CD-ROMs are also now being networked using OPTINET, which can act as a service to eight CDs and up to 100 users at a time. (Source: *Aslib Information*, April 1993)

### Trap set for the office time-waster

Modern office workers are succumbing to the time-wasting temptation with the help of the personal computer. Playing with on-screen graphics, tinkering with layouts and experimenting with fonts is an international obsession, and a costly one according to recent studies. An average PC user wastes 5.1 hours every week. A survey by KPMG Management Consulting revealed that the total price for owning a PC, including hidden costs, could be as high as £5,900 a year. In comparison, the mainframe works out at a mere £6,000 to £6,750 per user over five years and it is still the most secure and cost-effective option. KPMG has also discovered that over 90 per cent of total workstation ownership costs are not being actively managed. Since all offices have local workstation gurus who are well versed in PCs - they are called upon to help every time a less-experienced user has a problem, thus distracting them from their own work. In this manner, a significant degree of the organizations' resources continue to run out of control. A solution to the time-wasting temptation can be, however unfashionable, the mainframes, which can act as a centralized point of control. For instance, the time taken to make back-up copies is eliminated as this is done automatically and mainframes can also control access to data. (Source: *Financial Times*, 13 May 1993)

### Chips hold key to door security

An electronic key with a chip in its tip is to be marketed by the locksmiths Chubb Security of Sunbury-on-Thames. The key, called Electro, has a tiny silicon chip which stores a unique number ranging from 10 to 70,000 billion.

The key fits a special battery-powered lock which stores all the authorized numbers in a memory chip. When a key is inserted, the lock generates an electromagnetic field, which is picked up by an antenna on the chip. The antenna switches on the chip, allowing the lock to read the key's unique number. If the number matches one in the lock's memory, the key can turn.

The numbers in the lock's memory can be stored individually, by inserting a controller's key followed by the numbered key; or a computer can load a list of authorized numbers.

Although individually numbered swipe cards have been available for years, storing the number on a chip is more secure because it is almost impossible to read or reprogramme the number without breaking the key. (This first appeared in *New Scientist*, London, 6 February 1993, the weekly review of science and technology.)

#### The way forward for smart power

Although new intelligent high-side switches, such as the IR6000, are a major step forward in quasi-intelligent devices, there is still a long way to go to the power-handling microprocessor. Nor is it desirable, at present, for the ubiquitous micro to be able to handle power.

"Intelligent" or "smart" in the context of power-handling devices denotes that certain degrees of control and protection have, in most instances, simply been fabricated into the control terminal of the MOS-gated power switch.

The self-isolated vertical DCMOS power IC process lends itself admirably to the diffusion of control and protection circuitry for today's generation of smart power devices.

It could also be used to fabricate whole systems onto a small part of a silicon wafer. This degree of integration and sophistication will make possible MOS gate drivers capable of driving a three-phase inverter.

The trend towards greater integration and sophistication will gather pace inexorably as designers become familiar with the performance and capabilities of these ICs.

The single-chip off-line switched mode supply is not the figment of a marketing executive's wildly optimistic imagination. Advances in silicon technology mean that such a part can be successfully fabricated today. The introduction of such a part rests solely on the will of design engineers to adopt it.

It is the fully-protected power switches, which have recently been promoted by certain vendors, that will almost certainly be the standard bearers of the immediate future. These low-voltage MOSFETs, intended for use in the automotive industry, are protected from the application of over-voltages to both the drain and gate. The switch is also protected from over-current stress and excessive junction temperature.

A relatively simple extension to the process would make protected high-voltage versions of MOSFETs and IGBTs available to designers.

Such switches will not necessarily supersede the standard devices currently in use. Instead, they will

complement them and, in certain instances, will considerably reduce the development cycle time of new equipment. For example, the failure of power switches due to unstable control loops can easily lead to the development being sidetracked.

If protective devices are used in development, the designer can then choose to replace them with conventional devices once the design has been debugged. Or, they may choose to retain the protected switch for the greater reliability that it offers.

A tentative look further into the future shows a glimpse of wafer-scale integration, which will enable the hypothetical single-chip computer to become a reality.

Studies in such a level of integration show that such a computer could be fabricated today. However, a wafer-sized computer chip would still require a separate power supply and peripheral chips to allow it to communicate with the outside world.

The next step in the evolution of device integration will lead to the processor being powered from an adjacent area of the wafer, while other areas will enable the processor to talk to the outside world. It will, however, be the powered control processor that is more likely to evolve first.

The ultimate levels to which integration might evolve is limited not by how much might be included within the silicon itself, but by how much the silicon tech logist can be persuaded to omit. (Source: *Electronics Weekly*, 23 June 1993)

#### Telephone engineers use virtual reality

British Telecom (BT) has decided that its telephone network would run more smoothly if its engineers could see it in 3-D. Using a desktop virtual reality system designed by Dimension, BT has created an interactive 3-D model of its network which operators and engineers can literally "fly" through. With the complex cross-connected structure of the network elements, the ability to view nodes and data paths from a number of angles is expected to be helpful to the systems engineers on the lookout for trouble spots. The alternative is reading through data recorded on pages of computer printout. The first system has been installed by BT in Australia. With added intelligence the system could be used to set up alternative routing when errors are identified. (Source: *Electronics Weekly*, 17 November 1993)

#### NEC can magnify screen in parts

Hardware, which enables a computer display to magnify part of the screen while shrinking the rest, so that the entire image remains visible, has been developed by Japanese firm NEC.

The technology is designed to solve the problem managers of communications and other networks face when something goes wrong in part of the network.

They need to be able to zoom in on the trouble spot, while keeping an eye on the overall picture. Present windows-based systems result in the part of the image behind the window being blocked out.

The prototype system developed by NEC acts as if a magnifying glass has been placed over part of the screen. Called Dualquest, the system magnifies the important part of the image by a factor of four, while shrinking the surrounding image to a quarter of its original size, activated by clicking on the chosen area with a mouse.

Although distorted by the process, the entire image remains visible. It can handle a network with up to 400 nodes.

At present the system comprises a workstation running system management code, with two hardware image processing and memory peripheral boxes.

NEC aims to put the package on a single circuit board. It says it plans to produce a commercial network management computer based on the technology within two years. (Source: *Electronics Weekly*, 17 November 1993)

#### Harris MOSFETs can drive 100 W of power

Designers and audio specialists have told Harris Semiconductor that the company's 80 V H-bridge MOSFET drivers enable the development of 100 W Class-D audio stereo amplifier channels no larger than two decks of cards.

The key is the device's greater than 90 per cent operating efficiency, which eliminates 20 in<sup>3</sup> worth of heat sink per channel.

H-bridges made of four matched power-MOSFETs drive current through a load in one direction or the other. H-bridge controllers like the Harris devices provide an interface to control the MOSFETs in the legs of the bridge with logic-level signals. This approach allows diagnostic capabilities.

For example, designers can create start-up software to check the integrity of each MOSFET in the bridge individually before turning on one pair or the other and applying power to the load.

Beyond independent control of each MOSFET the four inputs provide a means of determining a switch's controllability before energizing the load.

Instead of individual inputs Harris provides an input comparator that receives an external triangle wave and a feedback signal from the bridge's output.

This lets a single pulse-width modulated input control all four MOSFETs. A third input can simultaneously enable or disable both upper MOSFETs.

This allows duty-cycle modulation of the signal being controlled by the input to the comparator, which is, says Harris, a handy way to achieve motor speed control.

The chips include input pins for variable turn on propagation delay to tune the bridge for different MOSFETs.

Harris has included logic that eliminates the possibility of shoot through and delay control that enables designers to tune their circuits to match the turn-off times of different MOSFETs. (Source: *Electronics Weekly*, 17 November 1993)

#### Commercial use for soliton pulses

Researchers at British Telecom (BT) and Imperial College, London, have made an important step in the commercial application of multi-GHz fibre optic transmission systems using picosecond soliton pulses of light.

An all-optical fibre technology based on commercially available fibres was used to produce a 60 GHz train of 2.2 ps soliton optical pulses. It uses a dual optical beat signal as the source of a periodic optical signal. The beat signal's half periods are transformed into optical pulses using non-linear propagation within the fibre. The BT approach, published in *Electronics Letters*, uses a dual-frequency 16 kHz erbium fibre laser to generate the beat signals.

It also uses a new technique for transforming the signal into the soliton pulses using a new type of fibre with a special comb-like dispersion profiled fibre. This fibre was designed using conventional standard optical fibres. It consisted of alternating lengths of dispersion shifted fibre and standard fibre spliced together.

The researchers expect it to be used for future high capacity transmission systems with data rates from tens of gigahertz up to a mind-boggling subterahertz system. The significance of soliton pulses is that their short duration and low phase noise means they will travel large distances through the fibre without being distorted by dispersion. (Source: *Electronics Weekly*, 17 November 1993)



## V. COMPUTER EDUCATION

### Tools and toys

#### *Learning about fuzzy logic*

To help students and potential users of the technology learn what fuzzy logic is, how it works, and what it can do for them, HyperLogic Corp. has introduced CubiQuick, a scaled-down version of its popular CubiCalc fuzzy logic shell. Prices of US\$ 179, with an academic price of US\$ 125, and even lower pricing for classroom use, should eliminate cost as a barrier to familiarity with fuzzy logic.

CubiQuick lets users define fuzzy rules with up to three input variables and a single output variable. Up to five fuzzy sets may be used to describe each variable. A built-in computation language preprocesses data taken from external files or simulates external responses to fuzzy control actions.

Results from the rules and from user-defined non-fuzzy computations can be plotted or displayed numerically. As HyperLogic president Fred Watkins put it, "You can solve real problems with CubiQuick, just not very big ones." Contact: HyperLogic Corp., 1855 East Valley Parkway, Suite 210, Escondido, CA 92027. Tel: 619-746-2765; Fax: 619-746-4089. (Source: *IEEE Spectrum*, September 1993)

### Interactive videodisc in India: high tech options for development communication

In India, a pilot project was conducted by the Education Development Centre, under contract with the US Agency for International Development, to see whether interactive videodisc (IVD) could help train the thousands of irrigation engineers India will need in the coming decade.

The project developed five IVD programs on irrigation management and trained Indian trainers in IVD development. The IVD programs covered topics ranging from technical content to "interpersonal skills." Programs "take" the engineers to the field without the expense of transportation. They provide training from top experts. They offer features that could not be provided in any other way.

For example, the program "Working with Water User Associations" lets engineers interact with water users over different issues, and see how farmers respond to the engineer's behaviour and communication style. The program provides feedback and guidance, and gives engineers an opportunity to "try out" different styles of working with water users and see the response.

The program "Diagnosing Maintenance Problems and Their Causes" sharpens engineers' ability to identify

maintenance problems and their causes in irrigation systems. The program lets the trainee "travel" along three irrigation canals, and diagnose maintenance problems in over 100 sites. The trainee can examine the canal both "wet" (with water flowing) and "dry" (without water) by simply clicking a button - a valuable experience that would be difficult to provide even with trips to the field. The trainee diagnoses the problems, gets information feedback for correct and incorrect answers, and a score that measures his/her diagnostic skills.

The response of the IVD programs has been enthusiastic on the part of the Indian training institutes and the Ministry of Water Resources. Upon reviewing the IVD programs, the Central Water Commission decided to house systems in New Delhi in order to make them more accessible to engineers from all over India. (Source: *Development Communication Report*, No. 81, 1993)

## VI. SOFTWARE

### Euro-software

Ten European computer and software firms have banded together to create the European Software Institute, a non-profit research establishment aimed at developing new techniques for writing computer software. It will employ 50 scientists and will be based in Bilbao, Spain.

The ESI includes companies that design software and companies that use it, in an effort to boost Europe's share of the market for large software packages dedicated to particular applications, such as industrial design. George Grunberg of the French computer firm Bull, the head of the ESI, says it will transform software design "from craft activity to engineering discipline". The ESI wants other European firms to join, and has set up a network of academic scientists and software users to advise on new techniques and needs. (This first appeared in *New Scientist*, London, 3 April 1993, the weekly review of science and technology.)

### Olivetti introduces wireless PC network systems

Olivetti has presented Net3 Net Cube, a new system that connects personal computers in a network using high frequency radio waves instead of cables.

Net Cube comes completely within the Olivetti strategy of making new-generation portable instruments available to meet the growing need for mobility both inside and outside the office, and to create a mobile and flexible infrastructure that makes better use of the space in which objects, people and information move.

The announcements made by Olivetti in 1993 confirm the faith the company has in the future of

telecommunications. In February the personal communication computer was announced. This solution allows various computers to be connected, and data, voice and images to be exchanged, making interpersonal communication active and multimedia. The Eo was announced in March. This is a personal computer that combines written communication with the oral communication functions of the telephone. March was also the time of the active badge, a mobile electronic recognition device that allows people and objects to be traced within a building or within an office complex. Now Net Cube, the first European local wireless network, developed by the Ivrea group [Olivetti Systems Engineering] on the basis of original technology, was the result of five years of research. Net Cube adheres to the Digital European Cordless Telecommunications (DECT) standards for local voice and data networks, created by the European Telecommunications Standards Institute (ETSI), with the backing of the European Community. DECT is already active in the United Kingdom, in Germany and in Holland, while in France and Italy it is still in the course of obtaining authorization.

Net Cube enables personal computers that are not necessarily produced by Olivetti to be connected together in a network without having to wire up the building that houses the machines. This means that the new system is particularly suitable for all those situations in which flexibility and mobility are of foremost importance. It can for example be used in buildings where historical or architectural constrictions making cabling impossible, or in temporary accommodation.

The new Olivetti product is based on the architecture of a star. It is made up of a fixed part and a card that is inserted into the personal computer.

The personal computer is then connected to a small box containing the radio that communicates with the radio base stations that are connected by a fixed network to a central control unit.

It is possible to communicate with 30 computers using Net Cube, over a maximum range of about 100 metres. The system allows for communications between the personal computers at a speed of 1 Megabyte per second. In the first installations that have been affected, this has been found to be sufficient to work in a network using the software applications in existence. It is in fact possible to connect wireless users to a local cabled network of the traditional type (standard Ethernet or Token ring).

Net3 has already been experimented by a leading financial services company, the Prudential Corporation of London. In Italy, it is being used in two surgical departments at the Policlinico Gemelli of the Sacro Cuore Catholic University in Rome. (Source: *Media Duemila*, July/August 1993)

### Electronics companies turning to 3D CAD software

Three-dimensional (3D) CAD systems, which were quickly introduced into nuclear power and automotive design, are starting to catch on among electronics companies in areas such as the design of AV products, metal patterns for products, and interior placement. Three-dimensional CAD opens up possibilities (impossible in two dimensions) for design with CAD's capabilities such as solidly representing curves on the screen. It also offers the advantage of shortening development and design lead times. However, characteristics such as the difficulty of inputting and the high cost of software are preventing a large-scale spread of 3D CAD.

The use of 3D CAD systems spread quite early in the nuclear energy field. Nuclear power manufacturers such as Hitachi, Toshiba and Mitsubishi Heavy Industries are making full use of 3D CAD in areas such as the design of piping. Hitachi has adopted it to the extent that it no longer builds mock-ups of nuclear power plants unless the customer demands it.

Electronic companies are putting this technology to use in various ways. Mitsubishi Electric took the lead by introducing a system into its Design Laboratory (Kamakura City, Kanagawa Prefecture) in 1982. Mitsubishi uses 3D CAD for the design of products and interior environments. In 1986 it switched to Kyatiya software developed by France Dassault and sold by IBM. About 35 per cent of the approximately 1,000 items designed by the laboratory in a year are designed using 2D and 3D CAD. Mitsubishi believes it can raise that level to 60 per cent in the future.

3D CAD is used when:

- (1) Items cannot be reproduced two-dimensionally;
- (2) Planning the integration of the design and mechanics of high density mounted products such as portable telephones and single-bodied video cameras;
- (3) There is a need for reproducing the virtual space in interior design.

Formerly when designing the metal pattern for a product, the actual metal pattern was constructed while creating and inspecting a model known as the profiling pattern. Now, when something is designed using 3D CAD, the data goes directly onto NC tape for creating the metal pattern. This helps compress development time.

Two years ago Mitsubishi increased the power of its system. It is running 14 workstations for 3D CAD use. Moreover, the Laboratory has a data link with its communications equipment, Kyoto,

Nakatsugawa and Mita factories. They can exchange 3D CAD information in real time. With plans for soon adding the Shizuoka and Guma factories, Mitsubishi is considering strengthening its terminals.

Toshiba has recently used 3D CAD for design of devices. 3D CAD was used for designing the device for attaching chips to print boards. However, currently no more than 5 per cent of the companies' CAD systems can use 3D CAD.

There is also a cost-performance issue, because most electronic products can be designed with 2D CAD and because 3D CAD software is high-priced and input takes time. Accordingly, the introduction of 3D CAD software which is less expensive, easy to operate, and has easy input is eagerly awaited. (Source: *Denki Shimbun*, 22 June 1993)

#### Company develops CAD/CAM/CAE software

Nihon Computervision, a software house, has developed and begun selling CADD55 Release 4, general-use CAD/CAM/CAE (computer-aided design, manufacturing and engineering) software appropriate for a wide range of design environments.

CADD55 is multi-platform software that operates on engineering workstations (EWS) from American companies Sun Microsystems, Digital Equipment Corporation, and Hewlett-Packard. Since the software targets a broad range of design situations, it can be used for dam design in conjunction with topographical data and for plant plumbing design, in addition to use for design of things such as machinery and electronics.

The software has the capability to automatically calculate for strength, shape, and other factors simultaneously with changes in measurements. The software offers improved performance for two-dimensional drawing. With this software it is also possible to get a better grasp on the process from individual part design to the finished product since the software can show the entire assembly process. The software shows strength in its concurrent engineering which unifies design manufacturing and analysis. It includes a support function to show operational content by using a cursor on a menu in order to reduce the burden on the operator. (Source: *Nikkei Sangyo Shimbun*, 20 July 1993)

#### Seiko Instruments develops improved version of "U-GRAPH" software

Seiko Instruments has created a new product by improving the capabilities of U-GRAPH, its leading CAD/CAM (computer-aided design and manufacturing) software. A distinctive characteristic of the product is that it is now possible to design machinery and electrical products by freely combining various methods, such as using multiple parts that have already

been designed. This software will be sold as manufacturing cost-cutter software since there is an increasing demand in the manufacturing industry for shortening development time and using interchangeable parts.

The new product will be called U-GRAPH: Version 10. It is based on CAD/CAM systems developed by the US's Electronic Data Systems, but it has been improved for the Japanese market. The product also incorporates CAE (computer-aided engineering) capabilities. It can be used to manage the process from design to manufacturing to quality control. Version 10 has multiple capabilities that could not be found before in one software package, including capabilities such as design based on methods and numerical values based on graphics. It is also possible to take plans designed using other software and to read it by automatically converting it into numerical values. (Source: *Nikkei Sangyo Shimbun*, 26 July 1993)

#### Lab develops CAD/CAM software

Miyazaki Prefecture's Miyazaki Prefecture Industrial Research Institute is aiming for nationwide dissemination of the CAD/CAM software it has designed for two-dimensional design and processing on a personal computer. The Institute has already registered its copyright with the software Information Centre (Tokyo) for making the introduction of CAD/CAM software easier for machined metal workers. It has concluded a software use contract with Cybertech, and expects to have developed and put on sale a more easily operable and more easily understood systems product based on the current software by late 1993. This kind of development from a public research institute is unusual throughout Japan.

The Institute aims to disseminate its software by copyrighting it and collaborating with software development companies within Miyazaki Prefecture, which has already won the cooperation of Cybertech, itself grappling with the development of a product for improved user interface. They will develop and put on sale a system with improved operability due to features such as the capability to choose command menus with a mouse and the addition of a help feature. OEM (manufacture under another's brand name) supply is also under consideration. (Extracted from *Nikkan Kogyo Shimbun*, 15 July 1993)

#### Chinese-English, Chinese-Japanese MTSS certified

The commercialized Chinese-English and Chinese-Japanese machine translation systems (MTSS) developed by the China Computer Software and Technical Services Corporation passed the formal technical appraisal conducted by MEF's Computer Department in September 1993. As tested by the experts, the Chinese-English MTS has an average translation time of 176 wpm with a readability/ understandability of 71 per cent, while the Chinese-Japanese MTS has an

average translation time of 201 characters/minute with a readability/understandability of 70.5 per cent. The Chinese-English MTS has been in trial use at three commercial firms, where it was employed to translate several hundred thousand words of scientific and technical documents. (Source: *Science and Technology Daily*, 15 September 1993)

#### Software that converts CAD data to NC data

Seiko Denshi Kogyo has developed dedicated software that converts CAD (computer-aided design) data into the NC (numerically controlled) data used by machine tools. Until now, data conversion has required that experienced operators use an automatic programming device. The dedicated software will save time and energy. The company aims to sell the software to small to medium-sized companies which are increasing their investment in CAD/CAM (computer-aided design and manufacturing).

Data conversion software virtually automates the process of taking data on coordinates and converting the attributes of design drawing into NC data as needed by the machine. Accordingly it is possible to increase automation of current manufacturing facilities without using CAM systems. (Extracted from *Nikkei Sangyo Shimbun*, 24 June 1993)

#### Electronic time-stamping

A surgeon "revising" a patient's records in the hospital computer system after a botched operation; a ruthless corporate climber backdating a memo to prove he warned his boss against the company's latest disastrous venture; the paperless world in which such things can happen in a keystroke is not far off. The problem of what to do about it has racked the brains of information scientists for years.

How do you establish trust in documents that exist only in the easily altered memory of a computer? So far, the answer has always been to take a paper copy of all important documents, but a more elegant solution may now be in prospect.

Digital time-stamping is an approach invented by US researchers, which makes it possible to prove that a particular document existed at a particular time, in a specific form, without resorting to hard copy. The secret? Instead of authenticating a piece of paper or magnetic tape, the new scheme creates a time-stamp *from the data themselves*.

Like an old-fashioned seal on an envelope, it can reveal if an electronic document has been tampered with since the seal was applied. However, as well as the time, the electronic time-stamp also certifies a document's content.

This is done via a mathematical procedure called a one-way hash function, which takes long strings of characters (which is what all computerized documents amount to) and boils them down into shorter, random-looking character strings.

A hash value contains no clue to its input. Publishing or storing a hash value at the time a document is created gives away no secrets. At the same time, however, each document's hash value is for all practical purposes unique, like a human fingerprint. Alter a document by even one character, and its hash value changes completely.

The researchers also came up with a secure way of storing the time-stamps, by attaching a copy of each document's hash value and time-stamp to the next document that is submitted for time-stamping.

Each document's time-stamp would then affect that of the next document, linking all of the time-stamps together and preventing anyone from slipping in a phoney, backdated document later on. In effect, the time-stamps join together in a computationally unbreakable chain that can only be added to at one end.

Patents have already been issued, and the method has been refined. One day, it is expected, time-stamping could become as routine with electronic documents as making a back-up file is now. (Source: *Science*, Vol. 261, 9 July 1993)

#### Interfacing activities in the Caribbean

A user-friendly interface, for use with CDS ISIS, has been developed at the Secretariat of the Caribbean Development and Cooperation Committee (CDCC) of the United Nations Economic Commission for Latin America and the Caribbean (ECLAC). It allows all databases to be viewed and facilitates search and printing activities while safeguarding the integrity of data.

In addition, a joint project of ECLAC and of the Latin America and Caribbean Centre for Health Sciences and Information (BIREME) aims to develop a Microsoft Windows application that will:

- **Facilitate** the creation, maintenance and management of standard and enhanced CDS ISIS information structures;
- **Create** an environment in which users can incorporate other types of data structures, including images, sound and multimedia, in CDS ISIS databases;
- **Develop** an application which could be distributed more widely, requiring minimal user training, since all Windows applications operate with a standard user interface.

The proposed application will be functionally compatible with CDS ISIS and will utilize CISIS, a library of functions developed in a portable "C" programming language specially designed by BIREME to interface CDS ISIS databases. The project is due to be completed in 1993.

For further information, contact: ECLAC Subregional Headquarters for the Caribbean, P.O. Box 1113, Port of Spain, Trinidad and Tobago. Tel: +1 809 623 5595/1969/5428/7623. Fax: +1 809 623 8485. (Sources: *Information Development*, March-June 1993, and *ECLAC/CDC Focus*, July-September 1992)

#### International software institute

The United Nations University (UNU) has established an International Institute for Software Technology at its office in Macau. The new Institute, which began operations in mid-1992 under the directorship of Professor Dines Bjørner, is the first international institute devoted to the software technology needs of the developing world. It aims to assist developing countries to meet needs and strengthen capabilities in:

- Usage of as sophisticated a variety of advanced software as reasonable;
- Software technology management;
- Development of software for domestic use and export;
- Development of university computing science curricula;
- Participation in international research.

The Institute engages in research and consultancy, publishes technical literature, offers courses and seminars and sponsors workshops and symposia.

For further information, contact: International Institute for Software Technology (IIST), United Nations University (UNU), Apartado 3058, Macau. Fax: +853 355519; E-mail: db@unuiist.cdu.

#### Just arrived: the ATM

New on the packet-switched-network market are cell-relay or asynchronous-transfer-mode (ATM) systems, which promise to change the face of Local and Wide-Area Networking. They will do this by introducing economical ways of using the same all-digital technology from the desktop all the way across the long-distance network, with consistent quality and speed.

ATM uses very small packets of a regular size, which do not require a great deal of computing power to generate or to route. Because the packets are regular in size, the system need not constantly adjust itself to packets of different sizes. (The packets contain 48 bytes of data, and information about the application that created it, as well as five bytes of header information for routing.)

With its standardized packets, ATM technology holds the promise of delivering greater efficiency, better throughput, and more capability than either the Ethernet or Token-Ring LAN systems, while requiring no major translation for entry into national and international networks. (Source: *PC Magazine*, 16 March 1993)

#### Lotus Notes

Lotus Notes is, by wide consensus, a front-runner in the new breed of software - "groupware" - that is taking the business world by storm. More easily definable in terms of what it is not, groupware is an encompassing word for a gamut of computer programs designed with the smooth operation of a group of workers, rather than the single unit, in mind.

The groupware phenomenon is geared towards the state-of-the-art 1990s organizational structure, where teams relate not as superior and subordinate, but as peers in a "flat" structure. A good example of how the model works is electronic conferencing, or "chatting", with software allowing small groups to participate in real-time conversations. The potential synergy arising from this type of group interaction raises it above the linear communication involved in electronic mail.

A very different type of groupware focuses on managing (accessing, collecting, parsing, sorting, storing, distributing) information. Into this category falls Lotus Notes, a distributed multi-user information management system with built-in wide-area connectivity, automated document routing and personal E-mail. It is thought to be particularly valuable to geographically dispersed organizations.

Information contained in Notes occupies several places simultaneously: information is passed from node to node according to a predetermined routing program. It is a multi-format information management system, providing different database templates for tracking, reference, discussion and information "broadcasting". It incorporates message transport (E-mail) and a programming language with functions to control everything from string manipulation through data validation to document routing.

All of this is built on top of technology that allows Notes to operate over virtually unlimited

geographical areas, in something approaching real time. All users of the system, whether at their desks or travelling with a laptop, have more or less concurrent access to the same information.

One important drawback, according to some critics, is the rudimentary searching and retrieval facilities offered by the package. What is more, the price is high. It is hoped that solutions to both problems will be found in the new release (3.0) of Lotus Notes, which was recently announced, with a new pricing strategy that may make it affordable for many offices. 3.0 will offer full-text searching. (Source: *PC Magazine*, 15 June 1993)

Germany: mathematics, EDP society develops image recognition system

A system supporting presentation graphics design has been developed by the "Human-Machine Communication" research team at the Mathematics and Data Processing Society (GMD) in St. Augustin. The "graphic designer's search component" makes it easier to find certain graphics in large files.

Since people often have only an inexact or incomplete recollection of graphics, their various parts - especially those typically remembered - are of special importance. Aspects of content are important, for example, in business graphics, a house plan, or a technical drawing. People also often remember particularly striking optical graphic impressions.

It therefore seems sensible to design a search component to assist a specific search for such striking features. It must recognize the appropriate aspects, appraising them as far as possible like the human user. Human perception is crucial here. Even if there are individual differences, especially with complex images, different people would concur to a large extent over simple presentation graphics, owing primarily to the human "visual apparatus".

The psychology of perception has been wrestling with this topic for more than a century. The special field of gestalt psychology deals with psychological laws of seeing and investigates how object is distinguished from background or the several parts are combined to form a "whole". Research findings have been developed into what are known as the gestalt laws. These include:

- The law of proximity, i.e., things that are close together are perceived as being closely related;
- The law of perpetual continuation, i.e., where there are several options for fitting a pattern part into a gestalt, the simplest and commonest is chosen;

- The law of completeness, i.e., missing parts of a pattern are supplied; and
- The law of similarity, i.e., like or nearly like are perceived as belonging together.

The "sense of things belonging" derives from a process known as perceptual grouping. In the past, practical use of the gestalt laws was hampered because they could not be explained theoretically or quantified (i.e., measured).

The GMD gestalt recognition system uses these gestalt laws by way of the transformational model of form perception developed by the two American psychologists, Michael Leyton and Stephen Palmer. Gestalts are calculated only on the basis of the spatial proximity of the image elements and the relationship between them. As this is often not sufficient, the GMD system uses two further methods. The multi-resolution approach processes an image several times, gradually enlarging the initially fine resolution. The objects "recognized" and grouped at a given stage and the ungrouped images are then processed at the next - poorer stage. Feature maps constitute the second additional process: the objects in a picture have many visual characteristics, on the basis of which the objects are categorized.

A system created on this basis can distinguish one-dimensional arrangements of elements, e.g., five very similar rectangles arranged regularly on a line, and also simple two-dimensional arrangements. (Source: *NTZ*, May 1993)

Multiprocessing made easier

An inescapable drawback of working with new technologies is the lack of a supporting infrastructure. The pioneer has not only to clear a lot of ground, but frequently also to make the necessary tools. To ease that situation for designers on the frontier of digital signal processing (DSP), 3L Ltd. of Edinburgh, Scotland, has introduced a parallel DSP library for developers of multiprocessing systems of DSPs.

To be specific, the library is optimized for 3L's Parallel C compiler for the Texas Instruments TMS320C40 DSP, which was designed by the Texas company for parallel DSP applications. For single-processor applications, the library is also compatible with TI's own C compiler.

Among the library's algorithms are routines for filtering, convolution, and general-purpose vector and matrix processing. These include Hanning, Hamming, Blackman, Blackman-Harris, and rectangular windowing functions; linear and cyclic convolution and correlation; finite - impulse response and infinite - impulse-response filter designs and a multitude of

spectral analysis functions. The library is priced at UK £965. Contact: 3L Ltd., 86-92 Causewayside, Edinburgh EH9 1PY, Scotland; Tel.: (44-31) 662-4333; Fax: (44-31) 662-4556; e-mail, threeL@threeL.co.uk. (Source: *IEEE Spectrum*, August 1993)

### Nice neural nets

Descriptions of what others have done by employing neural networks are enticing, but coming to grips with the complex concepts and software involved is daunting.

Propagator, a software package for Sun workstations and the PC and Macintosh, should end trepidation and accelerate application. The software, with its point-and-click interface, simplifies the training of neural networks, while the manual guides the novice through the fundamentals. Even experienced neural network engineers may find the software speeds their work.

To simplify the software, its originators have concentrated on supporting variations of only the most common learning algorithm: back propagation. Three main dialogue boxes control the set-up of neural network variables, such as learning rate, momentum, number of layers, transfer function, noise, initial weighting, and stopping criteria. Users can employ a validation set to see when to stop training because the network is starting to "over-learn", while three types of training graphs - error vs. cycle, error vs. output unit, and output unit vs. error - let users see how well network training is progressing.

The Sun version of Propagator, which runs under Solaris 1.X and 2.X, is available now, complete with free technical support and a money-back guarantee. The PC/Windows and Macintosh OS 7.X versions should appear later in 1993. Contact: ARD Corp., 9151 E Rumsey Rd., Columbia, MD 20145; Tel: 410-997-5600. (Source: *IEEE Spectrum*, August 1993)

## VII. COUNTRY NEWS

### Belgium

#### Genus collaborates with Belgian university

The Interuniversity Microelectronics Centre (IMEC), Leuven, Belgium, and Genus, Sunnyvale, Calif. are collaborating on studies aimed at the optimization of tungsten-based chemical vapour deposition (CVD) processes for use in manufacturing advanced circuits. The CVD work will be used for basic interfacial studies and for research on impurities in tungsten silicide.

IMEC was established by the Belgian Government in 1984 and specializes in submicron CMOS processing. (Extracted with permission from *Semiconductor International* magazine, June 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

### Brazil

#### Environmental information network linked to UN programme

The National Institute of Space Research (INPE) opened the first computerized global resources information data bank (GRID) in Latin America. The GRID is part of the United Nations Programme for the Environment. According to Gilberto Camara, chief of the INPE's image processing division, the data bank will be integrated with an international communication network furnishing data on the status of the global environment.

The network, covering nine countries, will have access to an extensive database containing information on the tropical forests of South America, especially in the Brazilian Amazon region, including data on deforestation, burning and changes in the region's climate. According to the INPE's general director, Marcio Nogueira Barbosa, the establishment of the Brazilian GRID was made possible through a cooperation plan signed with IBM of Brazil in November 1991.

As part of that cooperation agreement, IBM allocated \$4.5 million worth of equipment (donating 10 RISC-6000 workstations), and provided the entire infrastructure needed to support the project. The programme also includes the development of software to process geo-referenced information (Spring).

According to Nelson Ortega da Cunha, manager of IBM's Scientific Centre, the system furnishes the user with applications for digital earth modelling, spatial analysis, and access to the data bank, as well as image processing, map production, and cartographic projections. Spring was developed by INPE's image processing division, with support from Embrapa [Brazilian Agriculture and Livestock Research Enterprise] and from the IBM scientific centre in Rio de Janeiro. The activities associated with the agreement signed with IBM will continue until December 1994, but may be extended for a few more years.

The Brazilian GRID is a result of a memorandum of understanding signed between the Ministry of Science and Technology and the United Nations Environment Programme in June 1992, during the UN Conference on the Environment and Development. (Source: *Gazeta Mercantil*, 6 May 1993)

### Commercial software for satellite data ready

During the Congress on Remote Sensing in Curitiba, the National Institute of Space Research (INPE) launched the first commercial version of the Spring software, which speeds the processing of satellite images, maps, and cartographic data. The program was developed with the backing of the Environmental Monitoring Group (NMA) of the Brazilian Agriculture and Livestock Research Enterprise (Embrapa) and IBM's Scientific Centre, to replace two other older programs. The latter, also from the INPE are: the Image Processing System (Sitim) and the Geographic Information System (SGI).

In the Sitim, images of environmental satellites are filtered and interpreted to analyse soil use, plant cover, urban growth, the environmental impact of hydroelectric plants, and roads. In the SGI, all the cartographic information on a given region, i.e. road network, rivers and administrative boundaries, is digitalized.

However, Spring does everything that the other two do in a single machine and a single environment. It has the advantage of also being compatible with the existing market data bank managing systems.

Spring runs on UNIX at the IBM RISC/6000, Sun Sparc, and Silicon Graphics stations, and costs three times less than its foreign competitors. (Source: *O Estado de Sao Paulo*, 3 May 1993)

### Fibre optic network planned for coastal cities

By 1996, the Brazilian Telecommunications Company (Embratel) will invest \$703 million in the establishment of a fibre optic cable network linking Fortaleza with Porto Alegre. It will pass through all of the country's major cities located along the coast.

According to Embratel, the contract signed between RFFSA and Embratel is intended to establish the fibre optic system along the railroad in the section between Ponta Grossa, Curitiba, and Paranagua. Involving funds totalling \$50 million, it stipulates that the Railway Network must carry out the civil construction work, whereas Embratel will be responsible for installing the 36-fibre optic cable. The system will also cover Brasilia, Sao Paulo, Belo Horizonte and Goiania, apart from coastal towns. It will have a link, on the one hand, with the Unisor cable, which will interconnect the Mercosul [Common Market of the South] countries; and, on the other, with the "America I" fibre optic submarine cable, which will link Fortaleza with Florida, in the United States. (Source: *Gazeta Mercantil*, 16 April 1993)

## China

### China pursues high technology markets

China's economic growth has been nothing short of astounding over the past few years. In 1992, China's gross national product (GNP) grew 12.8 per cent, and is expected to expand approximately 10 per cent in 1993. The electronics market is advancing at an even faster pace as the industry's growth rate in 1993 matches 1992's 20 per cent.

Current business prospects are more promising for Western producers than at any other time in communist China's history. The Government is pushing for dynamic economic growth, and is lowering trade barriers to facilitate the flow of goods into the country. China's electronics imports reached an estimated \$5.1 billion in 1992 - a 33 per cent jump over 1991.

As a result of booming opportunities, many foreign firms, including computer, component, and telecommunications firms are aggressively pursuing the electronic market in China. According to the Ministry of Machinery and Electronics Industry, China produced 130 million integrated circuits (ICs) in 1991. By 1995, output is expected to reach 500 million ICs, but will still fall far short of market demand. IC demand will reach 1.2 billion units in 1995, and is forecast to soar to 2 billion ICs by the year 2000. In the battle to win market share, US manufacturers enjoy a significant advantage over other foreign competitors, particularly Japan. Many Japanese firms resist selling technology and equipment to the Chinese, for fear of eventual competition. (Reprinted with permission from *Semiconductor International* magazine, October 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

### China forages into new markets, plans satellite telecoms

China is redirecting its electronics investment programme away from products where markets are saturated, such as colour TVs, and into new areas including information displays and computer software. Wu Xiaolong, planning director of China's electronics ministry, has issued a directive stating that capacity has outstripped demand in TVs, video recorders, video cameras, telephones and digital switchboards. As a result, the directive says, no new construction projects will be ratified in these fields.

China is also considering the launch of a large capacity telecommunications satellite with 48 transponders to meet telecoms targets in its current five-year plan, which ends in 1995. The Chinese Government has already given the go-ahead to launch two 24-transponder Dongfanhong-3 satellites, one in 1994 and



the other in 1995. China now has 41 satellite telecoms transponders, 29 of which are for business use, according to a Chinese telecoms ministry spokesman. (Source: *Electronics Weekly*, 1 December 1993)

#### Heterojunction microwave power transistor cut-off frequency exceeds 10 GHz

According to a report from the NDSTIC Second Testing and Research Centre, scientists at the Beijing University New Devices Laboratory (BUNDL) have realized another pioneering achievement. The BUNDL researchers, led by Prof. Zhu Enjun and aided by an MBE technique perfected by colleagues at Fudan University's Surface [Physics] Laboratory, have developed an amorphous-silicon/silicon-heterojunction microwave power transistor with a cut-off frequency of 12,000-13,500 MHz [12-13.5GHz]. Such high-frequency performance has traditionally been available only with GaAlAs/GaAs and Si/GeSi heterojunction structures. This pioneering achievement forms a solid foundation for domestic development of 3 GHz-and-above microwave power transistors fabricated from silicon and for domestic development of silicon-based VHSCs. (Source: *China Electronics News*, 2 August 1993)

#### IEE breaks ground with branch in China

The UK Institute of Electrical Engineers is the first European engineering institution to establish a branch in China. The new branch in Beijing already has more than 400 engineers waiting to join. One of the main aims is to encourage the transfer of technology, which could lead to more industrial spin-offs for UK hi-tech businesses. (Source: *Electronics Weekly*, 27 October 1993)

#### First Chinese high-tech industry established in France

In order to market and globalize Chinese high-tech products, the first Chinese high-tech industry, the International Development Company, Ltd., has officially been established in Tulle Industrial Park in southern France. To bring the products directly into the European market, the company will take advantage of the superior environment and preferential policies offered by the park to develop, produce and sell Chinese high-tech products. With an initial investment of 1.02 million French francs, the company is to focus on development, production, and sales of such high-tech products as electronic medical instruments, electronic machinery and fine chemicals. (Source: *Chinese Science News*, 28 April 1993)

#### Xian-Lanzhou-Urumqi fibre optic cable under construction

Construction on the 3,200-km-long Xian-Lanzhou-Urumqi fibre optic cable trunk line is now under way. This follows upon the recent initial design certification conducted by the State Planning Commission and MPT. The Lanzhou-Urumqi segment construction is being funded by an Australian Government loan. Gross project investment is 739 million yuan, and scheduled operational date for the entire trunk line is September 1994. (Source: *Gansu Ribao*, 2 August 1993)

#### European Community

##### JESSI CMOS process for all European users

The major European semiconductor manufacturers have agreed to offer a new 0.5 $\mu$ m process developed under the JESSI collaborative project to all European users, including both design houses and universities. The process is available from SGS-Thomson Microelectronics, Siemens, Philips Semiconductors, GEC Plessey Semiconductor, Temic/Matra MHS, ES2 and Alcatel/Mietec. All of these companies have provided design rules that promise faster, smaller and lower power ICs in such fields as consumer products, telecommunications and automotive electronics.

The new process results from the JESSI CMOS logic project cluster. JESSI claims that this has enabled European IC manufacturers to catch up with their competitors in Japan and in the USA. (Reprinted with permission from *Semiconductor International* magazine, September 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

##### Focus of new ESPRIT framework

The vice-chairman of the European Commission, Martin Bangemann, has said that future ESPRIT programmes will be tailored to produce more commercial results and products.

The new fourth framework of projects to be awarded under the ESPRIT programme will "not only focus on technical challenges, but will ensure that the special activity will be noticed by the general public".

Bangemann, who is also the Commissioner in charge of information technology, was speaking at the launch of Goldrush, a powerful new computer from Britain's ICL which uses parallel processing technology

that was developed as part of an ESPRIT project called EDS. The Goldrush system is a database server that can have as many as 127 Hypersparc RISC microprocessors. (Source: *Electronics Weekly*, 27 October 1993)

## France

### French Government funds micro-electronics projects

France is helping its companies to introduce the latest electronics and microcircuitry. The use of customized integrated circuits (ASICS [application specific integrated circuits]) in small and medium-sized firms will be promoted through the Angers College of Electronics.

In cooperation with the Ministries of Research and Defence, the Industry Ministry has launched an 80 million franc programme to promote the spread of microcircuitry.

In the past, small and medium-sized firms did not use ASICS in their products because of the high failure risk. Although the use of these electronic chips is considered crucial for the competitiveness of many products, it was previously confined predominantly to large firms with the finance and personnel required to develop customized chips in-house.

Smaller firms, on the other hand, were and still are forced to have them developed to their specification outside and to commit themselves to buying ASICS in large quantities.

But often enough the first attempt fails because the purchasing firm does not give precise enough details of the chip's specific task.

The Western College of Electronics (ESEO) in Angers not only offers firms special training but also makes available instruments for computer-aided design and skilled personnel. The ASIC thus designed is then made by the firm ES2 at preferential prices.

Initial experience shows that this arrangement can cut the cost of making an ASIC from around Fr 500,000 to about Fr 60,000.

State support granted under the JESSICA (French version of Joint European Submicron Silicon Initiative) and PUCÉ [Products using Electronic Components] programmes can further reduce the costs for the firms involved to around Fr 20,000 per ASIC.

ESEO would like to undertake development programmes with about 10 small firms, starting with staff training and ending with chip production. Four processes are on offer, from the development of a simple programmable logic module to the design of a customized ASIC for serial production.

France also attaches great importance to microcircuitry. Potential applications are seen, for example, in car manufacturing (e.g. microsensors and actuators - control elements - for antiskid systems, air bags, etc.), mechanical engineering and instrument manufacture (micromotors), domestic appliances (intelligent sensors), medicine (micromanipulators, micropumps), the food industry and environmental engineering (sensors). The French State is giving some Fr 80 million in funding to make microcircuitry applications and the requisite production technologies accessible to the country's firms as quickly as possible and to translate the findings and experience gained in research laboratories into saleable products and processes.

The work of the CNRS [National Scientific Research Centre] Systems Automation and Analysis Laboratory (LAAS) in Toulouse is at the centre of these efforts. Together with the specialist firms Actia and Cita, LAAS, which has already developed micromotors and wear-free electrostatic control elements, recently founded the MCCT organization.

Its purpose is to assist small and medium-sized firms in the development, manufacture and application of microcircuitry products.

France has a second centre for microcircuitry in the Clock and Watch Industry Technical Centre, CETE-HOR, in Besancon. This organization has already developed a piezoelectric motor 5 mm in diameter and 1.5 mm tall to the production stage. This micromotor will be used not only in clock and watchmaking, but also to make microrobots, clinical instruments and the like. (Source: *Nachrichten fuer Ausenhandel*, 7 June 1993)

### SGS-Thomson sets up pilot chip factory near Grenoble

The State-owned Franco-Italian semiconductor group SGS-Thomson has produced the first 20 cm diameter silicon wafers in its Crolles development centre near Grenoble. The centre, which was built jointly with France Telecom at a cost of Fr 200 million and where researchers from Philips are now also working, has installed its first pilot plant producing 2,000 of these wafers a month. The capacity of the plant, which produces prototypes for the main partners Philips, Alcatel and Thomson, will be expanded in 1994 to 4,000 units a month.

SGS-Thomson is endeavouring to change from laboratory-scale to industrial-scale production as soon as possible, the target being in the region of 18,000 20 cm wafers a month. It will cost \$400-\$500 million to implement this project. According to press reports, SGS-Thomson deputy chairman Piero Martinotti said that the company could only raise this sum with the aid of its banks. This would appear to indicate that the

project to expand Crolles into a European centre producing advanced CMOS [complementary metal-oxide semiconductor] chips, announced only a year ago, has been abandoned.

Indeed, the latest news seems to suggest that SGS-Thomson could be in a position to make an investment on this scale by itself. Following the French Government, the Italian Government has also approved plans to increase the company's capital by about \$1 billion. What is more important, however, is that the company, which for years reported only losses, was able to balance its operating books in 1991 and even its overall accounts in 1992, in spite of debts of about Fr 9 billion.

The company announced a 28.1 per cent sales increase, a 91.2 per cent increase in bookings, and a profit of about \$24 million in the first quarter of 1993, evidently succeeding in consolidating its strong position in non-volatile EPROMs [erasable programmable read-only memories] and the promising flash EPROM.

The Crolles centre was founded with a view to developing large 0.5 micron silicon wafers for CMOS and 0.7 micron technology wafers for BiCMOS [bipolar CMOS] by the end of 1993. From 1994 onwards, Crolles will also develop CMOS with a 0.3 micron, and BiCMOS with a 0.5 micron, conductor width up to the production stage. (Source: *Nachrichten fuer Aussenhandel*, 11 June 1993)

#### French semi-automatic line produces multilayer ceramic circuits

A new semi-automatic production line for the manufacture of high-density multilayer circuits and multichip modules is now fully operational at the SOREP facility at Chateaubourg, near Rennes, France. It uses a low-temperature co-fired ceramic (LTCC) technology and has been built to meet the need for devices which have a higher component density and which are smaller, faster, lighter and cheaper than earlier products.

The LTCC technology is claimed to enable multilayer circuits to be made without the traditional cost penalty associated with other interconnect technologies. LTCC offers a low dielectric constant ( $K = 5.3$  to  $K = 8$ ) and a coefficient of thermal expansion from  $3.2 \times 10^{-6}/^{\circ}\text{C}$  to  $8 \times 10^{-6}/^{\circ}\text{C}$  that closely matches that of GaAs and silicon chips. It also enables both sides of each substrate layer to be used, blind vias to be accommodated, and specially-shaped circuits to be produced with IC cavities incorporated into the substrate.

This line is capable of producing the equivalent of up to two hundred thousand  $2.5 \times 2.5$  in. circuits of different designs per year. This corresponds to more than an annual one million square inches of high-

density multilayer circuits with an estimated value of \$3 to \$48 per square inch.

In addition to SOREP, the partners in this project include the materials supplier DuPont and the independent German hybrid manufacturer Siegert. In conjunction with the Italian equipment maker Baccini, the partners signed an agreement aimed at demonstrating the feasibility of LTCC technology for a wide range of new commercial applications. (Reprinted with permission from *Semiconductor International* magazine, September 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

#### France provides R&D funding

The French Government has approved funds of \$455 million for the SGS-Thomson Microelectronics five-year R&D programme. The French Ministry of Industry said that part of the cash will be used to develop 0.25  $\mu\text{m}$  processes, and products such as non-volatile memories, intelligent power devices, and dedicated bipolar products.

The Italian Government, as the other major partner in this State-controlled company, is expected to approve an equal funding. A cash injection of \$1 billion has recently been approved by the European Commission. (Reprinted with permission from *Semiconductor International* magazine, June 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

#### Germany

##### New facility for purer gallium arsenide crystals

At the beginning of July 1993 scientists at the Goettingen Centre for Functional Materials (ZFW) began operating a crystal-growing facility unique in Europe so far. The centre was founded in 1989. Researchers intend to use the DM 3 million pilot plant to produce single crystals of the semiconductor gallium arsenide. The purity of the crystals will - at the equivalent size - be 10 times greater than industrially-produced crystals. The scientists want to pave the way for this semiconductor in microchip production.

The Goettingen scientists are the first European working group to be testing the Vertical Gradient Freeze (VGF) crystal-growing method, which was developed from the so-called Bridgman method.

The focal point of the facility is a pipe-shaped crucible, which is surrounded by an oven. The gallium arsenide is melted at  $1,238^{\circ}\text{C}$  and seeded with a small crystal. Extremely slow cooling has the effect that the crystals grow from the bottom up. The crucible wall determines the size and the seed crystal the atomic structure of the gallium arsenide. While with the

Bridgman method the temperature profile is now mechanically controlled - by moving the oven or the sample - the VGF works with electronically regulated shifting. The sample and the oven are rigid, so that no mechanical vibrations disturb the crystal growth. So far the Goettingen scientists have been able to grow highly pure gallium arsenide crystals with a length of about 50 cm and a diameter of five cm using this method. The goal is a diameter of 10 cm however, which is already standard in industrial production.

In parallel, scientists at the Juelich Research Centre (KFA) are also experimenting with growing perfect gallium arsenide crystals. They use the Czochralski method, in which the growing crystal is grown out of the smelt. The arrangement of crucible and oven basically corresponds with that of the Goettingen facility. However, the seed crystal is dipped from above into the smelt and pulled out at constant speed. Gallium arsenide is thereby constantly crystallizing at the lower edge of the single crystal. A still new technique is used to keep mechanical vibrations at a minimum during crystallization. The pulling and crucible shafts rest on magnetic bearings which - because they are contactless - keep to a minimum any undesirable vibrations while pulling the crystal. The Juelich group is also already showing large, nearly perfect, gallium arsenide crystals. (Source: *Frankfurter Allgemeine Zeitung*, 14 July 1993)

#### Miele presents CFHC-free circuit board cleaning system

The ban on the use of materials containing CFHCs [chlorofluorohydrocarbons] from the start of 1993 has made finding alternative processes for cleaning surface-mounted printed circuit boards and solder frames urgent. Miele has now presented an industrial cleaning machine for this purpose.

Small and medium-sized firms are faced with the problem that replacing CFHC cleaning processes presents technical difficulties and requires heavy investment. They need a user-friendly plant that can be operated discontinuously and takes up a minimum of space.

With its IR-6000 washing system, Miele has developed a cleaning machine that uses a spray system to clean 560 to 600 printed circuit boards a day without using any solvents. Being microprocessor-controlled, it can be programmed in a variety of ways.

In brief, the spray system works as follows: for rosin fluxes and soft solder pastes cleaning takes place at 70 to 75° C. Each of the four washing stages uses only fresh pre-desalinated water. In the first phase, a non-ionic surfactant-based detergent is automatically added in a concentration of 0.5 to 0.7 per cent. The whole process, including drying, takes 60 to 75 minutes, the present European format having a capacity of

73 printed circuit boards. (Source: *Markt und Technik*, 14 May 1993)

#### Environment-friendly TV, VDU disposal plant opens in Berlin

The picture fades forever on 4 to 5 million TV screens and computer monitors a year in Germany. These appliances, which contain pollutants, are increasingly ending their days at recycling firms.

Two engineers from the Vicor company of Koeppenick, Berlin, demonstrate how the various glass fractions of scrap picture tubes can be kept separate and processed. They have designed a plant in which the screens pass not into a shredding mill, but into the experienced hands of television assembly workers. Now, employees at the pilot plant are stripping down what they previously assembled. "We call it production in reverse", says Vicor chief Reinhard Schmidtman.

The dismantling plant comprises a carousel with four stations. At first, the picture tubes are removed and automatically rotated into the correct position for a scoring device, which prescores the screen at the spot where it will be detached with a resistance wire at the next station, i.e., between the cone (the rear section of the picture tube) and screen glass. The dismantler at station two removes the cone glass in an upward movement like an umbrella, and conveys the part containing lead to a collection container. The next workstation removes the metallic "flat masks", through which the electron beams once had to force their way before they could make the phosphors on the screen light up. Finally, at station four, rotating brushes are inserted into the now open screen, loosening the phosphor coating from the glass surface and drawing off the two to three grams into a collection vessel.

After only four minutes, the individual parts of the tubes have been cleanly separated by type into collecting containers. The lead from the cone glass is salvaged by a glassworks in Saxony; the barium-containing screen glass serves as an ingredient for a hard building material called Magmavit; only 0.04 per cent of the former picture tubes, the two or three grams of phosphor containing zinc and cadmium, have to be disposed of as hazardous waste.

Because "production in reverse" at Koeppenick is completely future-oriented, the Vicor process has been awarded a prize for innovation by the Berlin Senator for Trade.

Depending on screen size, this environment-friendly dismantling costs between 12 and 18 German marks. This includes a proportion of the several hundred German marks that Vicor pays to the glassworks per ton of lead-oxide glass it takes. The Koeppenick company will have to take the screens from the whole of Germany to exploit fully its recycling

capacity of 600 items per day. This could change if the Electronic Scrap Order were to come into effect. All television sets and computers would then have to be taken back. The use of recycled picture tube glass in new screens could also bring Vicor a lot of work. Technically, this would present no problems, even today. "If only", says Vicor chief Schmidtman, "screen manufacturers would agree on standardized lead and barium oxide admixture dosages". (Source: *Die Welt*, 23 April 1993)

#### Information processing enhanced by virtual reality

The Fraunhofer Society has established a centre for the demonstration of virtual reality. Participating in this installation, which is the only one of its kind, are the Fraunhofer Institute IAO [Labour Management and Organization], IBP and IPA [Production Engineering and Automation] in Stuttgart as well as the IGD in Darmstadt. The Fraunhofer Institute for Graphic Computing at Darmstadt maintains a local presentation, information and learning centre especially for smaller and mid-size businesses.

Virtual reality marks a new possibility for understanding between man and machine. The user can by means of monitor, goggles and data gloves directly experience the information which is contained within the computer, "access" rooms and influence directly and intuitively the objects and actions pictured therein. The area of virtual reality does, however, put extremely high demands on hardware and computational algorithms to make it possible to present apparent worlds optically, acoustically and tangibly in real time.

Such procedures are already being used commercially today to demonstrate and evaluate construction plans. Architectural, city and infrastructure planning can thereby be made more graphic. Virtual reality may help in interior design as well as with the conceptualization of a product and the production plan. Interesting areas of application in the future will be teleoperation in medical technology as well as visual, driving and training simulation.

The demonstration centre is to serve as a starting place for questions dealing with the practical application of virtual reality. Here, the techniques and example applications are to be based on scientific technique and shown in practical application.

In summary, in addition to technical advice, the services offered by the centre also include training exercises, making the infrastructure available for presentations. Also offered are plans for and implementation of user seminars, feasibility and application studies as well as equipment and systems tests. Furthermore, the centre is involved with data modelling and conversion as well as with the

development of special solutions in the area of virtual reality. (Source: *Frankfurter Zeitung*, 11 March 1993)

#### JESSI develops cluster system to process microchips

The semiconductor silicon continues to form the basis of micro-electronics. However, the future of data processing requires additional new semiconductor materials that will make optical signal processing (photonics) possible. In particular, the efficiency of data processing equipment could be significantly enhanced by the use of light within the blue spectral region, rather than the red light used to date. For example, the storage density of CD disks could be quadrupled by using blue laser diodes, and such semiconductors would also represent major progress in information technology, metrology, and even superconductor memory units. The Institute of Semiconductor Technology at the RWTH [Rhineland-Westphalia College of Technology] in Aachen, in conjunction with other institutes in Aachen, Bremen and Duisburg, is developing optoelectronic light sources, circuits, memories and modulators. The Volkswagen Foundation is funding this research under its photonics programme.

The basic substances for these new materials are zinc sulphide and zinc selenide, which are applied to a gallium arsenide substrate, the crystalline structures being retained. One interesting aspect of these materials is that they frequently possess unique physical properties. The principal method being used by the Aachen researchers to produce them is epitaxial deposition of the desired layers by organometallic gas-phase epitaxy.

In the project funded by the Volkswagen Foundation, epitaxial layers, enriched by additional doping, will be produced with wide band gaps, and their structural, optical and electrical properties will be characterized and optimized. The technical problems that have to be solved to produce such heterostructures are immense, and intensive research is being carried out on them throughout the world. For example, to develop new optoelectronic components using quantum effects, the junction between two semiconductor layers must be atomically sharp. The layers must be less than 1 nm (0.000000001 m) thick, and new technologies must be developed for doping, i.e. the targeted addition of desired impurities - in this case, nitrogen and gallium - to modify their electrical properties. Very slight quantities, of the order of 1:10,000,000, are often sufficient. This research aims to achieve structures for modulators, electro-luminescence diodes and lasers that can be used as photonic and optoelectronic components in the blue and ultraviolet spectral regions.

As it is particularly difficult not only to produce, but also to characterize these new semiconductor heterostructures with precision, other research teams are

also involved. X-ray diffraction and Raman and infrared measurement carried out at the Aachen RWTH's Physics Institute I are making major contributions to explaining the structural and electro-optical properties of layers. Bremen University is investigating high-excitation and non-linear effects on the sets of layers produced in Aachen. These studies provide the basis for understanding and optimizing layers and optical circuits. A new process for characterizing the interfaces is under development at the Institute of Electrical Engineering Materials at Duisburg University and is being tested on the new heterostructures. (Source: *Technologie-Nachrichten*, 29 April 1993)

## India

### Initiatives in artificial intelligence

In 1986, the Department of Electronics (DOE) sponsored a nationwide initiative on knowledge-based computer systems (KBSCS). This project, supported by a \$5 million grant from the United Nations Development Programme (UNDP), was spread among seven nodal institutions, namely, NCST (National Centre for Software Technology), TIFR (Tata Institute of Fundamental Research), C-DAC (Centre for Development of Advanced Computing), IISc (Indian Institute of Science), IIT-M (Indian Institute of Technology - Madras), ISI (Indian Statistical Institute) and the DOE.

The topics taken up included human-aided machine translation, intelligent information retrieval, optimum resource scheduling, computer vision, pattern recognition and image processing, speech recognition for Indian languages, parallel computer architecture, natural language tutoring and medical diagnosis.

The first phase of the project is coming to an end. The national convention of the Computer Society of India held in Bombay, recently provided an opportunity to review the accomplishments. It was encouraging to learn that several packages based on artificial intelligence (AI) have emerged.

IIT-M, for example, has, in association with St. John's Medical College, Bangalore, developed a diagnostic and referral system, for monitoring the health of children in remote villages. It is now being tried out at Solor village near Bangalore. Another expert system has been developed for fault diagnosis of voltage stabilizers, the client being Alacrity Foundation. IISc has transferred to Advanced Technology Systems an expert system to configure PCs in parallel.

C-DAC has come out with a series of intelligent tutoring systems for different Indian languages. Using a multi-media mode (still pictures as well as speech interface), they are based on the proven intelligent

strategic learning model and are equipped with a series of interactive exercises, cultural notes, dictionary, usage clues and narratives, pronunciation and articulation assistance and a hypertext environment for lesson browsing. It simultaneously plays the role of a linguist, a psychologist and a critic - thus simulating a human tutor to the maximum possible extent.

The NCST has been working on two real-life projects in the resource scheduling domain: one on scheduling airline flights for Air India on the basis of traffic demand and the second on scheduling oil tankers for Indian Oil to distribute products to the various Indian ports. It is being field tested.

In general, resource scheduling using purely algorithmic methods is a computationally intractable problem. The vast majority of real world problems involve constraints that are usually hard to model within an Operations Research (OR) type of framework. To use any algorithm for mathematical optimization, some constraints will have to be simplified significantly or even completely relaxed. But this can lead to movements that are unacceptable to the users and the entire schedule may become useless.

In the AI approach used by NCST, a constraint-controlled heuristic tree search is used as the basis for tackling the problem. This method cannot guarantee globally optimal solutions but can offer near-optimal solutions. This is preferable to exact solutions to oversimplified versions of the problem.

Besides near-optimization, other benefits of the AI approach include systematic and quick schedule-making, reduction of possible human errors such as not using updated data and the ability to reschedule movements frequently, taking into account changes in the real world situation. The major strength of the AI-based approach is the flexible knowledge representation provided. This makes modification to such knowledge easier to handle.

Another interesting AI-based package developed at NCST is a text retrieval system which can be used to index, archive and retrieve text items (standard ASCII text file or WS file) in an intelligent, efficient and user-friendly manner. It is useful for handling large databases of text information which is unstructured or loosely structured.

The AI techniques used include canonicalization using morphological analysis and synonym lists. This allows intuitive, concept-based retrieval of information. It allows the administrator to create various domains (databases). Each domain can have various categories and subcategories. The administrator can tailor the list of stopwords, common phrases and synonyms for each domain. Every content word in every text item is treated as a keyword. The query for retrieval is given in terms of words or phrases of interest, specified as an

arbitrary Boolean expression, including logic operators such as AND, OR and NOT.

At the TIFR, considerable progress has been made on speech recognition for Indian languages using natural language understanding. The DOE has developed expert systems for income-tax assessment case retrieval and redeployment of Government personnel who have become redundant or surplus due to changes in policies. ISI has done significant work on using AI for extracting information from satellite imagery and fault analysis of printed circuit boards.

Besides application packages, the KBCS program has also involved considerable basic research and development of AI shells, embeddable expert system shells and system architecture.

Enthused by the success of the first phase of the program, the DOE is eager to launch the second phase. The budget for the second phase is expected to touch Rs. 18 crores, while the first phase involved an expenditure of only Rs. 8 crores. This time UNDP will not be involved and all the funds will have to be found from within India. So, the focus in the second phase will closely involve the industry. (Source: *The Hindu*, 1 December 1993)

### **Ireland**

#### Hitachi and Trinity College develop artificial eye

An artificial vision system that can recognize shapes and volumes analogous to the human eye has been developed by a research team from Hitachi's European laboratory and Trinity College, Dublin.

The researchers used opto-electronic techniques coupled with computers and neural networks to develop the Dublin Eye. According to its inventors, the Eye is the first device to combine the two techniques to create a sort of electronic-chip-based brain.

The system, designed by the teams of Professors J. Hegarty of Trinity College's Physics Department and Paul Horan of the Dublin Hitachi Laboratory (DHL), teaches robots to recognize objects much more rapidly than current electronic-vision systems do. The system can, for instance, distinguish between two models regardless of their position or movements.

The researchers say the system is based on using photon, rather than electron, transmission computers, for that is the only way to sufficiently speed up the analysis of moving shapes and objects. The use of this type of equipment in factories, where there are many robots and where automated vehicles get around through electronic vision, is considered one of the most obvious applications of the new system.

But the Eye would also improve speed of execution in many other fields, notably massively parallel computers (a series of small computers operating simultaneously), boosting it to the speed of light. The Dublin researchers also claim the invention could be applied in man-machine interfaces, which it would humanize by enabling machines to recognize facial expressions.

The development of this system in just three years is the most dazzling achievement of the collaboration between DHL and Trinity College's Physics Department. The study, which was launched in 1988, aimed to explore systems that might lead to a new generation of computers able to function like human brains and to replace conventional computers in the twenty-first century. (Source: *AFP Sciences*, 19 May 1993)

### **Israel**

#### Israel considers LCD industrial base bid

Israel is considering embarking on a \$300 million national programme to develop a large-panel active matrix colour liquid crystal display (LCD) industry, in collaboration with an as yet undetermined international partner.

The move would be run by a consortium led by Elbit, Israel's leading high technology company in industrial, medical, defence and communications electronics.

Elbit, based in Haifa, and its parent holding company Elron Electronic Industries are leading the campaign for a government-backed programme to establish an LCD industrial base. They argue that flat panel displays are a key technology which Israel must have, but acknowledge that Israel will not be able to break into the LCD business alone and are looking for international partners. (Source: *Electronics Weekly*, 1 December 1993)

#### Israeli firm puts squeeze on A4

An Israeli company has developed a data compression system which makes it possible to print 1 Mbyte of digital information on a single sheet of A4.

The digital information is represented as a pattern of dots that can be printed upon the paper.

According to Dr. Kafri, of Fontech, which developed the technology, the grid of black and white squares represents compressed data; black is a "0" and white "1". The system can get over half a million dots on a page. That is the equivalent of 20 kybtes of raw data, but Fontech uses JPEG compression to increase the amount of pictorial information which can be stored by a factor of 50.

The system will print up to 2 kbytes of information on a smart card and Fontech has already developed a smart card reader.

The system has been designed to work on fax telephone lines, and because of the likelihood of transmission errors a four to one redundancy is built in. Each A4 sheet can hold four versions of the same information so if part of the transmission is lost the image can still be recovered. The company claims the system had a 99 per cent success rate on the Israeli telephone system. (Source: *Electronics Weekly*, 27 October 1993)

## Italy

### Sensor developed for gas, fire detection

The prototype of a gas sensor that detects small quantities of carbon monoxide and measures one square millimetre has been developed by researchers at CISE (Centre for Data, Studies and Experimentation), coordinated by Fulvio Parmigiani and by the University of Brescia. The device consists of a thin semiconductor film in stannous oxide, doped with iron and produced by the same technique used for micro-electronic components. The gas absorbed by the porous surface of the sensor alters the electrical conductivity of the material and a small electronic circuit "translates" these variations into numbers for analysis or for alarm systems.

A prototype has already been developed for carbon monoxide, a toxic gas which in small quantities (0.01 per cent in the air, equal to 100 parts per million) causes headaches and becomes fatal within two minutes when 1.28 per cent is present in the air. The sensor, which detects a minimal quantity of gas, as small as a few parts per million, can also be used for detecting other gases, such as nitrogen oxides and methane or for detecting outbreaks of fires. The device is also to be used for environmental monitoring: due to its small dimensions, a personal gas and pollution warning system, the same size as a cigarette packet, could be produced. It will take three more years for the sensor to be produced on an industrial scale. (Source: *ANSA*, 18 May 1993)

## Japan

### Federation of Micromachine Technology launched to exchange information and cosponsor international meetings

A Federation of Micromachine Technology has been launched in order to unite various organizations involved in the research of micromachines. At the 4th Industrial Micromachine Exhibit, more than 28 organizations consisting of research and industry groups have reached an agreement to cooperate in information exchange and symposiums.

Included in the Federation are micromachine research groups from Tokyo and Nagoya, the robotics mechatronics department and two other departments of the Japan Society of Mechanical Engineers, two committees of the Japan Society of Electronics, the Japan Robotics Society, and the Japan Society for Artificial Organs. The Micromachine Centre will serve as their headquarters. Naomasa Nakajima, the Director of the Human Engineering Research Centre at Tokyo University, will serve as the Chair.

Various groups and committees have been engaged in the research of micromachine structure, basic process techniques, controls and related techniques since the 1980s. In 1992 the Micromachine Centre was founded under the guidance of MITI. Until now, however, the groups working independently of each other lacked coordination and presented symposium schedule conflicts and repetition of topics, according to Nakajima. One of the reasons for organizing the Federation is to prevent such communications problems. The group is planning to exchange information on developments and research in micromachines through the Federation, while recognizing the uniqueness of other members. Individuals can also participate through the Micromachine Research Group. The Federation will hold an international conference on micromachine systems in 1994. (Source: *Nikkei Sangyo Shimbun*, 22 April 1993)

### International Cooperation Centre for energy conservation, new energy technology transfer to developing countries

The New Energy and Industrial Technology Development Organization (NEDO) will open an "International Cooperation Centre" on 1 October 1993 to promote transfer of energy conservation and new energy technologies to developing countries. NEDO will set up a representative office in Bangkok especially for technology transfer to ASEAN (Association of South-East Asian Nations). As part of its effort to deal with global environmental problems, NEDO is focusing on technological cooperation with developing countries where technologies to cope with environmental issues lag.

The International Cooperation Centre will conduct research on oil-substitute energy technology, such as photovoltaic generation and efficient energy consumption, as well as training. They will focus heavily on widespread use of clean coal technology through which coal is processed to emit less polluted gas.

Many developing countries are using coal-fired power plants. Thus coal consumption is high and has become a major cause of acid rain. Desulphurization or denitration equipment is hardly used in developing countries.



The Bangkok representative office will investigate and collect information regarding technology transfer to ASEAN. NEDO has already begun joint research with a local government organization in Thailand on photovoltaic power generation. (Source: *Nikkei Sangyo Shimbun*, 7 June 1993)

## Russia

### Russia invests in its micro-electronics industry

Russia is to provide \$190 million of State aid for its electronics industry this year in a programme approved by President Yeltsin and the Supreme Soviet.

Priority will go to the micro-electronics field and to programmes for the conversion of military production into commercial work.

Zelenograd, 40 km from Moscow, is known locally as "Silicon Valley" where about a hundred new companies have been set up since the start of perestroika. Much of the government funding will go to this region. It was revealed that Russian companies can produce a 100 mm wafer for only \$35, whereas the equivalent cost in the West is some \$250. (Extracted with permission from *Semiconductor International* magazine, June 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

### Russians set up own version of Sematech

A Russian Sematech, called the Microelectronics Innovation Centre (MIC) backed by a 70 billion rouble (£70 million) government grant, is being set up to develop all aspects of sub-half micron micro-electronics development. It is seeking collaborative links with the US chip R&D consortium Sematech and Europe's equivalent JESSI.

According to Paul Sethi of the JESSI office: "The design area is where there could be a big cooperation in terms of systems knowledge - particularly in aerospace where the Russians have a lot of experience". Any cooperation between MIC and JESSI would have to involve, said Sethi, "an exchange of information on an equal basis".

Like Sematech, MIC will have its own headquarters including prototype fab lines for process development, pilot lines and testing facilities. Construction of the headquarters building has already begun. It will pool the Russian micro-electronics industry's R&D efforts in materials development, equipment development and process R&D.

The announcement of the project was made by Anatoly Andreev, Head of the State Committee on the Defence Industry. The Russian Government is meeting the entire set up cost but the companies involved,

which include all the major micro-electronics firms, will contribute the staffing and ongoing support. In total over 100 companies and research institutes will be involved.

The MIC was originally conceived as including all the former Comecon countries. Now it is confined to Russian companies and research institutes. It follows the model of Sematech which coordinated the effort of the US materials, equipment and semiconductor companies to develop a next-generation capability across the total micro-electronics food-chain. (Source: *Electronics Weekly*, 28 July 1993)

## Taiwan

### Submicron Device Technology

The Taiwan IC industry is now fairly mature, with the leading firms producing 0.8-0.6 micron ICs. ERSO's [Electronics Research and Service Organization] submicron plan is targeting 0.5 micron, for development of 16 M DRAMs and 4 MSRAMs. Initial development of 0.35 micron technology is set for 1994-1995. Scientists at the National Submicron Laboratory will cooperate with Tsing Hua University professors and several industrial firms in research on 0.35-0.25 micron device fabrication technologies.

This plan over the next three years will be embodied in the following eight sub-plans in four general areas:

In the area of multilayer metal interconnect technology:

- (1) Research on application of selective W-CVD for submicron ICs;
- (2) Research on diffusion blocking layers (TiW and TiN);
- (3) Smoothing of submicron-device fabrication;

In the area of device structure and fabrication technologies:

- (4) Use of high-energy ion beam implantation for ROM masks;
- (5) Research on high-energy ion beams for fabrication of 0.35-micron anti-diffused-profile double-well CMOS devices;
- (6) Research on electron-beam direct writing for development of 0.35-0.25-micron 3.3-volt-and-under devices;

In the area of polycrystalline Si thin-film transistors (TFTs):

- (7) Application of TFTs in high-density SRAMs;

In the area of Si and SiGe new materials and device fabrication technologies:

- (8) Use of CBE technique to research Si and SiGe amorphous materials growth and development of bipolar devices. Application of ultra-thin amorphous films in monolithic microwave ICs and digital ICs.

(Source: *National Science Council Monthly*, January 1993)

Chip design, fabrication centre opens

The National Science Council has established a Chip Design and Fabrication Centre, which formally opened on 20 February 1993. The centre was built with the following three objectives: chip fabrication realization, technological examination and study, and technology development. Services will be open to all Taiwan university and institute scientists and researchers, IC industry specialists, electronics industry specialists, and even representatives of foreign institutions. The centre is equipped with an ASIC [application-specific integrated circuit] database to encourage domestic IC designers to make use of the latest techniques. (Source: *National Science Council Monthly*, March 1993)

High-speed computing centre opens

The National Science Council's National High-Speed Computing Centre, one of the five major national laboratories, formally opened for operations on 12 February 1993. The centre currently has an IBM ES9000 960 supercomputer (operating speed exceeding 2 GFLOPS), a Convex C3840 as a front-end unit, graphics workstations, and various other computers and workstations. Services provided by the centre are as follows:

- (1) Training and consultation;
- (2) Interchange of knowledge and experience;
- (3) Computational chemistry and molecular simulation;
- (4) Scientific visual calculations;
- (5) Fluid mechanical calculations;
- (6) Distributed computing;
- (7) Ad hoc supercomputer use; and

- (8) Publishing of documents and other printed products.

(Source: *National Science Council Monthly*, March 1993)

**United Kingdom**

ECIF votes to merge with EEA

The British electronics equipment and electronic components industry is set to speak with one voice. At its AGM, the Electronic Components Industry Federation voted unanimously to dissolve the ECIF and merge with the EEA to form a new trade association for the electronics industry. The new body, with more than 300 members, will be called The Federation of the Electronics Industry (FEI). The next stage is for the members of ECIF to sign up for the new Federation. The new Federation will then become fully operational on 1 January 1994. (Source: *Electronics Weekly*, 14 July 1993)

IT and electronics top manufacturing table

The electronics and information technology (IT) sectors have won a glowing commendation from a report which claims that the United Kingdom has few world class companies.

The report, *Made in Britain, A True State of Britain's Manufacturing Industry*, also tarnishes the "quality" image of BS5750, which it says appears to make no difference to the quality of practice or the performance of a firm.

The report aims to create an effective benchmark upon which companies can test how well they match up to the best in the world. It showed that companies supplying the IT industry had practices and performance 10.5 per cent better than the average.

The depressing finding of the report, however, was that just 2 per cent of British firms could be said to be world class. The report, which was jointly carried out by the IBM Consulting Group and the London School of Economics, is the first part of an ongoing study into manufacturing.

Professor Chris Voss of the LSE said the analysis was carried out by finding out which firms performed well and which firms employed the best methods. While this pointed to a paltry 2 per cent of firms being world class, a promising large number of firms were close to being world class, he said.

Some of the more encouraging results came from the electrical and electronics sector which had good practices and performance. The IT industry in

particular came in for praise for its emphasis on customers and increasing moves towards alliances. (Source: *Electronics Weekly*, 16 June 1993)

British semiconductor market booms

The semiconductor market in the United Kingdom and the Republic of Ireland is set for a 19.1 per cent growth in 1993 and an additional 12.1 per cent in 1994 on top of 1992's figure of 12.1 per cent. This is the prediction of the Semiconductor Manufacturers' Association (SMA), a group within the Electronic Components Industry Federation (see table on page 70).

The figures have been compiled from both the 21 members of the SMA and non-members through an independent market analyst. Ray Ambrose of SGS Thomson Microelectronics and chairman of the SMA's statistics committee says that the semiconductor industry has well and truly moved out of recession.

The main market force is computer manufacturers who will buy 30 per cent more semiconductors than they did in 1992. The data processing market in Britain and Ireland will be worth \$1,500, this being 41 per cent of the total available semiconductor market. (Reprinted with permission from *Semiconductor International* magazine, June 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

**United States of America**

SIA maps out new goals for US chip industry

In a competitive call-to-arms, the Semiconductor Industry Association (SIA) has called for a major revamp of US high technology goals for the chipmaking industry.

Among SIA's key points: no new bureaucracies to exploit the technology. Instead, the SIA urges better use of existing high technology resources, in a recently-released White Paper.

The road map offers the US a way to earn "maximum value" for its investment in chip R&D, the report declares.

The detailed 15-year-plan was mapped out at an SIA Semiconductor Technology Workshop in Irving, Texas. It was hammered out by 179 of the "top US

semiconductor technology experts" from industry, government and the academic sector.

Key points:

- Improved cooperation between chip makers, their customers and suppliers to cut time-to-market;
- A commonly understood view of technology needs as the basis for improving US development efforts;
- An industry and government focus on collective technology needs;
- Support promising new ideas and inventions through their commercial development.

Government attention to "top-priority needs" should be encouraged, the SIA report also declares.

The SIA road maps anticipate a 250-fold increase in functional IC density over the next 15 years. The conference focused on 11 technologies: chip design and test, process integration, lithography, interconnects, materials and bulk processes, environmental safety and health, manufacturing systems, manufacturing facilities, process device structure CAD, packaging, equipment design and modelling.

At the conference, the SIA technology work group identified a "multitude" of technical obstacles that could impact the plan. Five, however, were termed potential "show stoppers":

- Patterning, materials and processes for device structures with dimensions below 0.25µm;
- Electrical interconnections, both on and off the chip;
- Electrical test - time, cost and capability;
- Design, modelling and simulation capability for all elements of IC technology; and
- Software capability, availability and quality.

If these five show stoppers are not resolved, the report maintains, the rate of progress will be slowed. In the extreme, the work group cautions, failure to overcome these obstacles will stop progress completely. (Reprinted with permission from *Semiconductor International* magazine, May 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

Table 1. U.K. and Eire Market  
Millions of \$, (Values all converted at \$1.58 = £1)

	1990	1991	1992	1993	1994	1995
Discretes: Value Growth	363	335 -7.8%	357 6.6%	373 4.4%	390 4.7%	408 4.5%
ICs: Value Growth	1,793	1,838 2.5%	2,165 17.8%	2,632 21.6%	2,980 13.2%	3,163 6.2%
Total: Value Growth	2,157	2,173 0.7%	2,522 16.1%	3,003 19.2%	3,370 12.1%	3,571 6.0%

### VIII. AUTOMATION

#### Tokyo Institute of technology researchers develop micro-robot

The research group led by Professors Iwao Hayashi and Nobuyuki Iwazuke at the Precision Technology Research Centre of Tokyo Institute of Technology and Kansei Engineering has developed a miniature robot which moves freely inside a small tube. It is expected to be used as an inspection robot in small gas lines and water pipes in houses. Other types of robots have been used in sewer pipes of over 150 mm in diameter, but this robot makes it possible for the first time to inspect tubings not only as small as 20 to 30 mm in diameter but with bends, 90 degree elbows and U-shaped turns.

The robot consists of three sets of rubber tyres made of O-rings, which are pressed against the inner surface of the tubing by torsion coil spring and support the main body at three points. Each axle is installed at an angle in the direction of movement. When power is transmitted from outside through a shaft, the tyres and main body move in spiral fashion inside the pipes. It can also move backwards. The design is kept simple by separating the main body from the motor. When snake wires or tubes are used as a shaft, the robot can move inside a bent tubing.

Assistant Professor Hayashi and his research group connected two robots of 6.5 mm diameter tyres and 25 mm diameter main body, and succeeded in moving them inside a 30 mm diameter (by 800 mm long) tubing at a speed of 30 mm/sec.

The robot measures 25 mm in diameter because it was made from parts that are readily available on the market. According to the research group, it can be made smaller with proper parts to fit in a 20 mm

diameter tubing. Equipped with CCD (charge coupled device) cameras, it could be used for inspections, cleaning and other tasks. (Source: *Nihon Kogyo Shinbun*, 26 March 1993)

### IX. STANDARDIZATION AND LEGISLATION

#### Standardization

##### PC challenge for NEC

NEC's dominance of the Japanese PC market is under threat as the IBM-Microsoft-Intel standard makes its most determined effort yet to establish itself as the new standard in Japan. NEC has 50 per cent of the Japanese PC market with its PC-9800 series. However, this could fall to a powerful combination of a new operating system from Microsoft called DOS V, which allows IBM PCs to run Japanese software; Microsoft's new Japanese version of Windows; and the endorsement of Fujitsu and Toshiba who are pushing to make DOS V the new standard with a range of PC-compatibles. (Source: *Electronics Weekly*, 27 October 1993)

##### JAMA's CAD data exchange standards

The Japan Automobile Manufacturers Association (JAMA) has created JAMA-IS as its version of IGES, the CAD data exchange standard created by the US Standards Association. In early 1994, 13 auto manufacturers will begin using JAMA-IS for data conversion between differing CAD systems.

This development will make it easy for data exchange between second- and third-tier manufacturers and it will improve the environment, in terms of CAD systems, for the increased number of transactions crossing keiretsu lines.

The scope of JAMA-IS specifications is limited to the elements of shape, such as curved surfaces and curved lines, which are most important in representing a car. At this point, JAMA-IS defines 20 out of 24 entities (elements going into the construction of a diagram). It does not include elements of drafting and drawing such as length. Paradoxically, if JAMA set uniform standards for entering length, that would make failed data exchanges easier. This is because the US Standards Association and Japan Industrial Standards differ.

Companies are currently anguishing over the exchange of shape data. Since second- and third-tier parts manufacturers cannot effectively obtain shape data, the quality of pattern dies made from prototype models and CAD data is worsening, cost increases become likely, and it is difficult to meet dates for quick delivery. Behind the establishment of JAMA-IS is - on the data receiving side - a strong demand from the cooperating companies for expanding the range of companies they do business with. This also appeals to the auto manufacturers because it will help them to obtain high-quality parts in a short time.

As domestic auto manufacturers expand their overseas production they are expanding their transactions with foreign parts manufacturers. Accordingly, in the near future JAMA will begin considering data exchangeability with the German automobile industry association (VDA). VDA has its own standards for the use of IGES.

STEP, an international standard promoted by the International Organization for Standardization (ISO), is another important development related to CAD data exchange standards. JAMA is investigating its response to STEP since STEP is very likely to become an international standard. However, JAMA has created JAMA-IS because JAMA believe that data exchange using IGES will be the mainstream method around the year 2000. (Source: *Nikkan Kogyo Shimbun*, 22 July 1993)

#### AIST preparing JIS standards for STEP data exchange standards

In conjunction with an anticipated 1993 establishment by the International Organization for Standardization (ISO) of STEP, an international standard for smooth exchange of data between differing CAD/CAM (computer-aided design and manufacturing) systems, MITI's Agency of Industrial Science and Technology has begun preparing a proposal for Japan Industrial Standards (JIS). The plan is for two out of twelve of the STEP's draft regulations to be established within JIS by mid-1994. This includes the regulation about using the EXPRESS language for describing product data. It is expected that design data exchange between companies will become more efficient if data exchange between differing machines becomes possible.

The regulations established by the ISO with the first version of STEP will be used for the exchange - between differing systems - of two-dimensional drawing information for products such as automobiles and ships. The regulations will include 12 points concerning items such as data description and drawings.

Recently the Nippon Computer Graphics Association began drafting a proposal concerning the two regulations on points such as descriptive language for product data. This draft proposal will be amended by the Japan Industrial Standards Institute, an advisory organ of the MITI Minister, and then established as a Japan Industrial Standard in mid-1994. It is thought that a draft proposal for an additional six regulations will be undertaken in FY94.

Currently, CAD/CAM systems are spreading inside corporations, but there are many types of systems, and data exchange between different systems is difficult. This is why 20 nations (including the United States, England and Japan) are promoting in the ISO's deliberations for the establishment of international standards for data exchange. AIST's creation for Japan Industrial Standards is also part of this movement. (Source: *Nikkan Kogyo Shimbun*, 22 July 1993)

#### New standard for abbreviations

The third edition of ISO 4: Information and documentation - Rules for the abbreviation of title words and titles of publications has been published in draft form by the International Organization for Standardization (ISO).

The rules contained in the standard, which is also published in French, are applicable to the abbreviations of the titles of serials and, if appropriate, of non-serial publications. They are intended to guide and assist authors, editors, librarians and others working in various fields of information transfer in preparing unambiguous abbreviations for the titles of publications cited, for example, in footnotes, references and bibliographies.

For further information, contact ISO, Case postale 56, CH-1211 Geneva 20, Switzerland.

#### SEMI standards aligned to national technology roadmap

The Standards Group at SEMI (Semiconductor Equipment and Materials International) has realigned its efforts to better mesh with the National Technology Roadmap developed earlier this year by the Semiconductor Industry Association. A draft of the SEMI Standards Group Roadmap for the next five years should be available soon.

The task of aligning the SEMI standards with the National Roadmap was the focus of an intensive four-

day planning meeting in May 1993, where standards committee volunteers from SEMI member companies, IBM, National Semiconductor, NCR Corp., Intel, AMD and the National Institute of Standards and Technology, AT&T Microelectronics, Texas Instruments and 11 volunteers from SEMATECH met to review every past, present and developing standard. From that meeting, key industry drivers were identified, and the challenges facing each Standards Division were established.

Efficiency, reliability and environmental safety and health issues are now driving the development of standards. In a recently released report, SEMI said that through its standards efforts, semiconductor manufacturers around the world are working with suppliers to bring down the cost of purchase and cost of ownership (COO) of equipment through industry-wide standards. Most aspects of the SEMI standards programme are now addressing COO in one form or another.

After COO, SEMI says software modelling of the virtual fab will be the second driver for the long-term development of SEMI standards. The goal is simple: software simulations will enable semiconductor manufacturers to evaluate fab designs, process recipes, materials substitutions and flexible manufacturing alternatives before breaking ground on an expensive facility. After the facility is built, software modelling will provide optimum performance data the computer-integrated manufacturing (CIM) factory control system can use to enhance the performance in real-time.

The standards required to link the virtual fab with the actual fab are far from simple, however. Standards must be created to model equipment, processes, materials and the facility itself. A common software simulation language must allow the virtual fab simulation system to link library data on optimum performance characteristics with real data coming from the fab's CIM system. Many participants believe it is unlikely such a matrix could be created before the year 2000.

The development of materials standards within each division include wafer specifications, wet and dry chemicals, gases, packaging materials and materials used in facility construction. Current standards deal with mechanical, chemical, electrical, crystallographic, surface and other properties of each material. SEMI reports that future directions will build on present activities and expand to investigate new materials and new metrology technologies needed for smaller geometries to advance integrated circuit performance and technology. The biggest hurdle to overcome, says SEMI, will be the lack of standards for diagnostics and metrology. These will be required to determine the effect of purity on yield. Close relationships between materials suppliers and semiconductor manufacturers must be forged to develop these essential standards and provide the technological capability before it is needed.

Current standards development work is intended to minimize business interrupts. Employee relations and education are becoming an important part of this process to ensure these standards are not created in a vacuum and are adopted in a timely fashion. Future standards work will strive towards a process to "design for the environment". At the present time, standards are being developed to reduce emissions to the air and water, exhaust of chemicals and noise. Future goals will press the industry to further minimize these emissions and expand efforts to reduce the environmental impact from consumers and conserve resources to minimize environmental impact. To meet these objectives, the current standards programme will expand to include the participation of environmental professionals.

The key to improving the COO by comparing a fab's optimum performance (the "virtual fab" model) to its actual efficiency level is metrology, SEMI says. Metrology is an area that will require much more emphasis and coordination to develop standards, because true metrology standards must cross several disciplines by evaluating both materials and equipment performance and interaction. (Extracted with permission from *Semiconductor International* magazine, October 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

## Legislation

### INTERNET gets a boost

Users of INTERNET will be pleased to know that the higher-education computing officials and the telephone companies in the United States have reached a compromise on legislation that could affect the future of the INTERNET.

Both these groups have endorsed a bill, which the US House Science Subcommittee approved in early June 1993, that is intended to help the INTERNET grow into a national information infrastructure linking all homes, schools, businesses, and hospitals. Creating such a web of networks is a goal of the Clinton Administration.

Copies of the Bill, known as the National Information Infrastructure Act of 1993, are available from the Superintendent of Documents in Washington, D.C. Excerpts are contained in the *Chronicle of higher education*, 23 June 1993, beginning on page A15.

### First patent for "glowing" silicon

A Duke University professor, Ulrich Goesele, has obtained what he believes is the first US patent covering glowing porous silicon, a material which - unlike normal silicon - can convert electricity into visible light. More than 100 different research groups are now studying the light-emitting properties of porous

silicon, which has potential applications in lasers, optoelectronics and colour displays.

Goesele has patented potential uses of porous silicon in semiconductor applications owing to its increased band gap. Porous silicon's increased band gap and its light-emitting ability at room temperatures were first described in 1990 and 1991 in *Applied Physics Letters*.

A major barrier to any widespread application of porous silicon is the lack of a reliable electrical solid state contact to keep the porous silicon glowing. Now, scientists typically make glowing porous silicon by bathing small pieces of normal silicon in hydrofluoric acid while using an electric current to control the degree of acid etching. However, once the devices are made, researchers have found that the small holes where light emission occurs are too small to connect to a power source with standard electrical contacts and get efficient light outputs. As a result, scientists like Goesele now must use conducting liquid electrolytes, such as acetic acid, to penetrate the holes and serve as contacts. Unfortunately, the electrolytes quickly form oxides with the silicon, which blocks the flow of current: the glow shuts down within minutes. (Reprinted with permission from *Semiconductor International* magazine, May 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

#### Computer programs and copyright

To settle debates about copyright and harmonize the law regarding the copying of computer programs a Statutory Instrument came into force on 1 January 1993 amending the previous laws on this subject. New permissions include some important ones which cannot be overruled by contract:

1. Back-up copies;
2. "Decompilation" or conversion of a program language from lower to higher level;
3. Copying or adaptation;
4. Use of "any device or means" to study, observe or test a program "in order to understand the ideas and principles which underlie any element of the program".

Naturally, a user may not make copies or adaptations otherwise than as a result of the above permissions or a contractual permission. The new provisions should now allow computer science legally to grow and develop via the cross-fertilization of ideas in similar fashion to other disciplines. (*Aslib Information*, Vol. 21, No. 4, April 1993)

#### A question of divided royalties

Nobody knows who will profit from patents covering the emerging standards of digital video until new equipment goes on sale, and patent holders make their royalty claims. Makers of products such as video CDs might have to pay new royalties on patents filed decades ago which they never knew existed - a replay of what happened with audio CDs.

Digital video signals contain so much information that they have to be compressed, leaving only essential information, before consumer equipment can handle them. The Full Motion Video (FMV) compression standard was recently agreed by the Motion Picture Expert Group (MPEG) of the International Standards Organization (ISO), representing researchers and manufacturers, and the International Electrotechnical Commission. Under rules laid down by ISO, all the negotiators had to declare their interest in the relevant patents. This stops someone promoting an idea, then surprising the industry with a royalties claim.

But MPEG coordinator Leonardo Chiariglione admits that nobody can know which patents will be effective until the products go on sale and claims for royalties roll in. The video compression technology on which FMV relies builds on work covered by patents filed over many years, often by inventors and companies not represented at MPEG meetings.

Ten years ago, when Philips and Sony developed the audio CD, the two companies pooled their patents on optical technology, and sold licences to companies which wanted to make CD players and press discs. But five years later, DiscoVision Associates of California and the Optical Recording Corporation of Toronto found they could claim royalties for patents which were not included in the Philips licence pool. Most manufacturers have now paid up. (This first appeared in *New Scientist*, London, 28 August 1993, the weekly review of science and technology)

### **X. RECENT PUBLICATIONS**

#### Alternative treaties available

The 46 documents developed as part of the Alternative Treaty process at the United Nations Conference on Environment and Development, held in Rio de Janeiro in June 1992, are now available in book form, with an introductory section outlining the background to the process. The full text of the book is also available on disk in a choice of formats. English, French, Spanish and Portuguese versions are available as a new, searchable, full-text database, which includes all the Rio agreements and alternative treaties, plus the Women's Action Agenda 21. For more information,

and details of prices, contact: Da Zi Bao, Synergistic Communications, Friendly Green Cottage, Cowden, Nr. Edenbridge, Kent TN8 7DU, UK. Tel: +44 342-850331; Fax: +44 525 405669.

Telecom terms clarified

If ever a field was overloaded with jargon, buzzwords, and TLAs, that field is electronic communications. So it is that a new "Glossary of Enterprise Networks & Telecommunications Acronyms & Terms for Users" is particularly welcome.

Containing more than 3,600 entries, the glossary is careful when dealing with multiple meanings. Under AA, for example, it says: "Active Agent is a PC running an unattended program, which is normally given the task of either monitoring for exceptional tasks or performing character or format swaps, backups, or delivery of wide area mail, etc. Also, Abort Acknowledge of Session PDU; also, Application Association; also, RS-232 Frame Ground circuit, Pin 1."

A single copy sells for \$39.95, but discounts reduce that price to \$34.95 each for two copies to as little as \$9.95 each for 101 or more. TLAs, for those who have not yet met the term, are three-letter acronyms. Contact: *Information Gatekeepers Inc.*, 214 Harvard Ave., Boston, MA 02134; Tel: 617-232-3111; Toll-free: 800-323-1088; Fax: 617-734-8562.

UNESCO databases on CD-ROM

The 1993 edition of the UNESCO Databases CD-ROM, giving access to 96,000 bibliographic references, is now available. Databases contained on the disk are as follows:

<b>UNESBIB</b>	UNESCO documents and publications
<b>AILS</b>	Worldwide literature on preventive education against AIDS
<b>DARE</b>	Institutions, periodicals and specialists in the social sciences
<b>ENERGY</b>	Institutions, periodicals and specialists in social sciences
<b>IAUDOC</b>	Worldwide literature on higher education
<b>IBEDOCs</b>	Worldwide literature on education (planning, literature, innovations ...)
<b>ICOMMOS</b>	Museums, monuments and sites
<b>ISISDIF</b>	National distributors of Micro CDS ISIS software
<b>UNESDATA</b>	UNESCO databases

**UNESIS** UNESCO Regional Offices Information Services

The disk runs on a PC-compatible micro-computer (equipped with a CD-ROM reader) with 640K RAM. Software required is Micro CDS ISIS plus HEURISKO interface.

The CD-ROM, which is updated annually, is available from UNESCO sales agents, or, in case of difficulty, directly from the UNESCO Publishing and Sales Division, 7, place Fontenoy, 75352 Paris, 07 SP France (Fax: +33 1 42 73 30 07).

Optical disks in libraries

Increasingly common in business, and seen as having great potential for libraries, optical disk technology is still under-used. A new report, *Optical disk technology and European libraries*, is a study of user and technical requirements, published by Bowker Saur. Authors Marc Fresko and Lynne Brindley based it on a report prepared for the Commission of the European Communities, Directorate-General Telecommunications, Information Industries and Innovations, as part of the preparatory actions for the libraries programme.

The report concentrates on the technological areas of scanning, encoding and storage, access and retrieval. Librarians from 12 European libraries contributed to the report by commenting on the extent of optical disk usage as well as related issues such as library skills, the suitability of library materials for optical disks, handling and storage, joint ventures, benefits and constraints.

Five potential scenarios describe ways in which libraries can exploit optical disk systems productively and efficiently. The authors also consider how the technology might be extended to cover other situations, recommending appropriate technologies in each case. The report (ISBN 185793 002 4), published in 1993, costs £35.

Library of Congress and the INTERNET

Users of the INTERNET can now gain access to the Automated Information Files of the USA's Library of Congress. The files, which have been available over the INTERNET since April 1993, contain over 28 million records.

The files to be offered by the Library include all LC MARC (Machine Readable Cataloguing) files; copyright files from 1978 to the present; public policy citations, from 1976 to the present; and federal bill status files. Both the technical processing, cataloguing system (MUMS) and the reference retrieval system (SCORPIO) will be available for searching over the INTERNET.



For more information, contact Craig D'Ooge, Library of Congress, Washington, DC 20541, USA. (Tel.: +1-202-707-9189)

### African Index Medicus

Initial steps have been taken towards the launch of an Index to African Health Literature and Information Sources. The project was initiated by the Association for Health Information and Libraries in Africa (AHLIA) at a recent meeting in Accra, Ghana, attended by AHLIA Committee Members, pilot site librarians from Ghana, Kenya, Nigeria, Zambia and Zimbabwe, as well as technical support staff from the World Health Organization (WHO).

The African Index Medicus, as the work is to be entitled, will eventually cover bibliographic sources, and contain databases on information experts and centres of excellence in health-related areas of African countries.

The project, which will be decentralized, includes the creation of bibliographic records of local health materials at national level, using the CDS ISIS software. These will be merged with records on health in Africa emanating from international sources, such as WHO'S WHOLIS and POPLINE.

The project is receiving technical support from the Library of the WHO Regional Office for Africa. Training and procedures manuals are being finalized, and on-site training of data-input staff in Ghana, Kenya and Zambia is expected to start in the near future.

Although the project is still at an embryonic stage, and as yet limited to anglophone countries, it is hoped that the end of 1993 will see the birth of a tangible pilot project. In the future, it is hoped that the African Index Medicus can be added to existing CD-ROMS.

Further support, in terms of data as well as finance, would be welcomed from other institutions. More information on the project is available from Ms. Lucilda Hunter, President of AHLIA and Librarian of the WHO Regional Office for Africa, BP 6, Brazzaville, Congo.

### Using advanced features of Micro CDS ISIS

Since the 1985 launch, by the United Nations Educational, Scientific and Cultural Organization (UNESCO), of the first version of CDS ISIS on microcomputer, the software has been introduced in a large number of libraries and information services (over 5,000 users were registered by UNESCO in 1992).

The success of Micro CDS ISIS is due to the relatively low investment involved (the software is available free of charge, and operates on small

microcomputers), but also to the possibility it offers of designing complex databases and using powerful data retrieval procedures with limited training.

A guidebook, prepared by Zbigniew M. Nowicki in collaboration with the Trade Information Service of the International Trade Centre (ITC) UNCTAD GATT, presents new features of Micro CDS ISIS, covering innovations introduced in versions 2.3 and 3.0. Version 3.0 was launched in May 1992, and has possible Local Area Network (LAN) applications.

Entitled *How to utilize advanced features of Micro CDS ISIS*, the guidebook is addressed to readers who are already familiar with basic functions of the package, and aims to provide them with information on advanced features, currently available within the package, that increase the scope of its applications and improve its user-friendliness. The most powerful new feature is the CDS ISIS PASCAL facility, enabling the user to extend the standard options offered by the package with new functions adjusted for a particular application.

For further information, contact Mr. Bernard Ancel, Chief, Trade Information Service, ITC UNCTAD GATT, Palais des Nations, 1211 Geneva 10, Switzerland.

### Industrial Development Abstracts now on diskette

Subsets of *Industrial Development Abstracts (IDA)*, a machine-readable source of information on United Nations Industrial Development Organization (UNIDO) activities on industrialization in developing countries, are now available on diskette.

The *IDA* database contains over 20,000 fully indexed records of UNIDO documentation. It includes descriptions of major UNIDO studies and reports, publications in series and selected articles; reports and proceedings of expert working groups, workshops and seminars; internal studies; and reports related to UNIDO technical assistance activities. The time-frame is from 1965 to the present day. New entries are added each month.

The database is maintained on UNIDO's mainframe computer, at the Organization's headquarters in Vienna, Austria. Selections of records can now be obtained, together with menu-driven search software, on diskette for use on PCs.

Subsets are available for the following industrial sectors: Electronics, electrical industry; Leather and leather products; Building materials, cement, ceramics; Industrial manpower training; Wood and wood products; Textiles and wearing apparel; Iron and steel, non-ferrous metals; Petrochemicals, chemicals; Food

processing; Fertilizers; Environment; Pharmaceuticals; Capital goods, machinery.

Each subset contains approximately 600 records and costs US\$ 35 (US\$ 25 for orders from developing countries and Eastern Europe).

To order, or for further information, contact: Chief, Industrial and Technological Information Section, UNIDO, P.O. Box 300, A-1400 Vienna, Austria. Tel: +431-211-31-5211; Fax: +431-23-07-584; E-mail addresses: GE QUICK COMM: AAO001HB@UNIDO.EARN:PKEGH@UNIDO1.bitnet.

#### Crime and justice update

##### Survey results published

The United Nations Economic and Social Council, in resolution 1992/22, acknowledged the importance of the United Nations surveys of crime trends, operations of criminal justice systems and crime prevention strategies, and called for their continuation and improvement.

Accordingly, the Secretariat issued a technical publication entitled *Trends in crime and criminal justice, 1970-1985, in the context of socio-economic change: results of the second United Nations survey of crime trends, operations of criminal justice systems and crime prevention strategies*. Results of the third survey have now also been published.

In addition, the data from all the surveys, covering 17 years starting with 1970, are available on diskette, free of charge, from the United Nations Crime Prevention and Criminal Justice Branch.

#### UNBIS country profiles on crime and justice

The United Nations Bibliographical Information System (UNBIS) of the Dag Hammarskjöld Library has created new country profiles on crime and justice in an electronic format. The profiles are to be updated periodically, with the assistance of the United Nations crime prevention and criminal justice institutes.

#### Computerized network on crime and justice

The computerized United Nations Crime and Justice Information Network (UNCJIN), which provides substantive databases on crime-related issues, as well as an electronic mail facility, is still being developed. Pending the planned transfer of the management of UNCJIN services from the State University of New York at Albany, to the Crime Prevention and Criminal Justice Branch, UNCJIN expanded its operational reach to more than 200 new members connected to it through the INTERNET, in addition to more than 60 on the Telecommunications Cooperative Network.

Information source: Economic and Social Council; Report of the Secretary-General; Social Development: Progress made in the implementation of Economic and Social Council resolution 1992/22; E/1993/10.

#### Library to send books on screen

Documents in the British Library in the United Kingdom will be available to readers all over the world at the touch of a computer key by the year 2000. Once the sophisticated remote access technology is in place, the aim will be to deliver six million items a year to people in their homes or offices screen to screen.

# VIRTUAL REALITY: AN EMERGING TECHNOLOGY

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## INTRODUCTION

Virtual reality is an emerging computer technology, which has enormous potential in engineering, medicine education and war. It is likely to revolutionize the way we design and engineer new products and services. I. Sutherland in 1965 suggested the use of 'ultimate display' as the ultimate form of interaction between human and machine [1]. M. Krueger termed this as 'artificial reality' and denotes the technology by which everything one perceives is generated by a computer that responds to movements with sights and sounds designed to make one think one is in another world [2]. In the last two years this technology has become a major product conceptualization and product visualization technology. According to a US Congressional Hearing of the Sub-committee on Science, Technology and Space, this new development in computer technology promises to revolutionize the way we use computers, namely

- the way we design new products
- the way we teach our children and
- the way we spend our free time [3].

It has the potential to change design and engineering practices. This article gives an overview of this technology and its importance to developing countries, though most of the present uses are in developed countries.

## WHAT IS VIRTUAL REALITY

Virtual reality is a breakthrough technology that allows one to step through the computer screen into a three dimensional artificial world enabling one to look around, move around and interact within computer worlds [4]. Virtual reality is no longer limited to scientific research centres. Desktop Virtual Reality computers present the basic building blocks for designing a virtual reality system using a desktop personal computer. The realization of this technology has been made possible through a number of new technologies such as

- real time image generation systems

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- head mounted display devices
- head tracking systems, etc.

With the fantastic possibilities and the promise of wide scale availability, virtual reality technology has been used in a wide variety of applications covering design, engineering, education, entertainment, medicine, training, etc. In 1993, virtual reality was used for design in a large number of industries making virtual reality a real tool for rapid product realization in the competitive context.

## VIRTUAL REALITY TECHNOLOGY

Virtual reality is a technology for generating an immersive experience in which participants wear tracked, head mounted displays, view stereoscopic images, listen to 3D sounds and are free to explore and interact within a three dimensional world. The three elements of virtual reality technology are

- Effectors: Kind of hardware that permits the experience of flying over hills, or moving and rearranging objects in a virtual room.
- Reality engine: The computer system and external hardware, such as sound synthesizing equipment, that supply effectors with the necessary sensory information.
- Application software: This software describes the context of the simulation its dynamics, structure and the laws of interaction between objects and the user.

Virtual reality, or cyberspace technology, takes alternate reality a step further by introducing a computer as a mediator or imagination enhancer. There are two types of virtual reality, namely immersive or desktop. A typical virtual reality system consists of (a) one or more input devices such as a joy stick, a steering wheel or a body harness; (b) several forms of output (such as light, sound and pressure) and a computer to manage all the data. For example, you may be sitting in the control room of a steel plant with your hands on the control panel, staring straight ahead at a computer panel as though seeing the steel melting furnace starting and providing liquid metal and leading to rolled products, using glove inputs as though you were operating the steel melting furnace.

The main virtual reality products are:

- **Glove input devices:** These use electronics to sense the position and orientation of the hand wearing it. As the hand moves around in three dimensional space, the glove sends a stream of electronic data to the computer in the form of three dimensional coordinates. The computer then uses the data to manipulate the object on the display. Figure 1 shows a typical glove input device.
- **Head mounted displays:** The most effective virtual reality input device is the head mounted display (HMD). This device, which can handle both the input and outside aspects of virtual reality, fits over the user's head like a helmet. The head mounted display monitors the side and up and down head movements, and sends a corresponding stream of data to the computer about its position. The computer uses this data to generate stereo images of the virtual world. The stereo images are then sent to the pair of miniaturized displays that are an integral part of the head mounted display. Because the stereo images are synchronized with head movements, the effect can be quite realistic, giving the impression of actually moving about in a virtual world. The head mounted displays also stimulate auditory sense through its stereo head phones, giving cues about the source and direction of the sound by presenting the sound to one ear a split second before the other. The head mounted displays also monitor head movements, feeding a stream of data to the computer about the head's position and orientation in three dimensional space. The computer in turn adjusts the display on the HMD, resulting in visual stimulation that is synchronized with the head movements. Head mounted displays contain monitors for each eye that generate stereo images.
- **Bodytracing devices:** These are small spatial positioning devices with multiple, six degree of freedom sensors

Figure 2 gives the elements of virtual reality system [1]. Virtual Reality devices allows one to see, hear, feel and interact with real or abstract data of the computer generated models. Figure 3 gives a schematic diagram of a comprehensive virtual reality environment [4].

## APPLICATIONS

The various elements of virtual reality (VR) tools allows one to see (visual displays), hear (audio systems), feel (force feedback devices) and position oneself in a virtual environment. Some of the emerging applications of VR technology are examined in this section

**Design:** Conventional computer aided design systems replaced the drawing board, with TV monitors allowing us to generate the same two dimensional projection as the first drawings. Through the use of VR it will be possible to experience three dimensional objects by walking around them and feeling them if they are small enough, or walking inside them or amongst them if they are large, such as buildings [5]. Virtual design provides the ability

to design products interactively, long before they exist in the real world. The main advantage of using virtual reality for designing and shaping objects is the ability to experience other attributes of the objects, not only the visual ones. The potential for virtual reality in design work is enormous. Engineers who would like to work on a computer screen could actually enter their product and once inside the computer model, they could check for ergonomics, move parts from one place to another and witness various tests and analyses as part of the device. Expensive and time consuming mock ups can be eliminated, with the virtual model being used to check that parts fit. Boeing is using virtual reality in design [6]. Sun Microsystems has introduced a virtual holographic workstation, which allows users to view three dimensional images that move as their heads turn, or they bend down to look under the image.

Apart from mechanical design, in drug design virtual reality is proving to be very cost effective and time saving. VR can be used in determining how a molecule fits into a receptor site of a protein enzyme. Stress patterns around objects can be visualized, flow pattern of gases can be shown, the acoustics of buildings can be experienced, the effects of lighting can be visualized and many other features important to design can be expressed in a form amenable for interactive design. Using VR, manufacturers are moving over to the artificial three dimensional world for help in designing new products. Caterpillar (USA), has been able to design cabs for loaders and wheeled shovels (earthmoving equipment) in about one week in contrast to the traditional cycle time of six months to one year [7]. Virtual reality is being used by a number of firms for design. Table 1 gives a selected list of applications of virtual reality in design. Design analysis and verification can be performed on the computer in real time with interactive modelling using these approaches.

**Prototyping:** Prototyping using virtual reality helps designers to virtually see the manufacturing process. The virtual prototyping promises to bring together the design engineer and the manufacturing engineer. Virtual prototyping allows firms to fabricate real parts for short production runs with the ease of printing out an engineering diagram. From a wire frame skeleton that the designer can stretch and bend, twist and shape, a rough form is crafted. Then the parts are given a skin and smoothed with a surface modeler or converted to solids with more traditional three dimensional computer aided design tools. The tools will eventually be available by speech command or whatever interface the designer wants. Virtual prototyping, allows for the reduction of design to manufacturing cycle time and also allows a variety of prototypes to be made quickly, thereby allowing firms to have a higher new product introduction rate and shorter time to market. Conceptualize and introduce new products. One of the first major commercial applications of virtual reality technology was by Matsushita Electric, Japan, to provide a Virtual Decision Support System (VDSS) for conceptualizing a kitchen [8]. The system has been designed to allow customers to design a kitchen based on over 30,000 products. This system allows the customer to sketch out the shape, size and structure of the present kitchen and then to remodel and select the new appliances,

floor, tiles, shelves, cabinets, colour, curtains and to have floor plans and countertops. The interactive nature of virtual reality provides for quick customer feedback. Hospitals and industrial layouts are also being reconstructed using virtual reality tools. Virtual prototyping has immense potential in designing and constructing buildings, bridge design, design of space stations, cars, ovens, sports equipment, aeroplanes, telephones, washing machines, cameras, etc.

**Training:** The most valuable application of virtual reality is in training operators to manipulate complex equipment, simulate real life situations and hazardous environments [9]. Virtual reality facilitates the training environment, especially in the following applications:

- situations in which training mistakes are costly
- situations in which the necessary environment cannot be experienced in the real world
- designing interfaces that are sensible and can easily be manipulated
- making training situations real
- to make the imperceptible perceptible.

Virtual reality simulators are the most commonly used application segment today. Mitsubishi Heavy Industry Co. has manufactured an active type simulator for fighter aircraft. Simulation is among the most successful real world applications of virtual reality. VR allows pilots and soldiers to take part in 'Virtual War'. NASA's Houston space centre started training astronauts for a mission to repair the Hubble space telescope using virtual reality for simulation of how objects behave in space. They wear helmets with screens inside that give a 120° view of a cartoon-like, but geometrically exact satellite in space, and by wearing gloves with sensors on their hands they simulate the maneuvering of a satellite. Power plant operation, chemical plant operation, etc. are not exclusive in the use of virtual reality. NEC of Japan has developed a virtual reality ski training system, which places users in a simulated ski environment, and which responds not only to physical movement but to the user's mental state. Yasukawa Electric, Japan marketed the tele-existence system for the first time in the world for simulating electric power distribution controls in large power systems. Virtual simulation is far superior to three dimensional simulation. A three dimensional simulation does not present the information in an ergonomic way since the users are passive observers. Virtual reality provides much better solutions. The operator, using a data glove and a head mounted stereo display can act in a virtual world. Even inexperienced test persons will be able to realize complicated movements. The learning is rapid and experiential.

**Education:** Virtual reality is penetrating not only operator training but school education as well. For a large number of children who cannot imagine what algebra is about, this colourful, noisy, three dimensional world is a perfect way to learn and understand [5]. Virtual reality is not only interactive as opposed to the passive world of television

and books, it accepts imaginative inputs from students. Virtual reality has the potential to revolutionize education at all levels.

**Entertainment:** Virtual reality entertainment has a large market potential. Large movie producers and video game producers are all at work to bring a new era in interactive entertainment to global customers. The "Mandala System" of Vivid Group, USA, captures your image in real time and projects it on a wide screen so that you can step inside a virtual world without having to put on any equipment or sit inside a cab. They also have created musical simulations where you can play virtual instruments by watching yourself in the virtual world and guiding your own movements. Virtual movies are on the cards. While games and entertainment experiences are already available, creators are already looking beyond these forms of enhanced video games [10].

Virtual reality overcomes the main difficulty in traditional three dimensional animation, namely, lack of three dimensional interaction. The new technologies allow us to immerse into the computer generated worlds. With the use of graphic workstations it is possible to display complex scenes containing several thousands of polygons at interactive speed, and with the advent of such new interactive devices as the 'Space Ball', 'Eye Phone' and 'Data Glove', it is possible to create applications based on a full 3D interaction mode in which motions are in real time. The virtual reality technology devices [4] with corresponding input data and applications are given in Table 2. Real time complex animation systems using virtual reality and simulation are invading art, music, advertising and theatre in a big way.

**Medical applications:** The future of health will be inextricably linked to virtual reality [1]. As improved medical techniques and drugs create an ageing population, so there will be an increasing demand for sophisticated medical services. The biggest contribution of virtual reality to medicine might be in improving the doctors' learning curve. In many medical situations, from surgery to training, the medical use of virtual reality technology might benefit less from head mounted displays and more from wide screen monitors and projected reality. Three ways in which virtual reality will help medicine are:

- Virtual reality is helping researchers to design new drugs through a better understanding of the structure and properties of large organic molecules while working with these molecules to understand receptor-drug interactions visually.
- Virtual human bodies can be viewed on surgical workstations.
- Increased use of telepresence interfaces and computer aided surgery.

**Business:** Virtual reality has already invaded the business management segment. 'Virtual spread sheets' allow executives to simulate the behaviour of their markets, products and firms. Virtual reality has already entered the stock market. Another type of artificial reality created by using

virtual reality software has been used by a few Wall Street traders to spot trends. Maxus System International, USA, has devised such a system. The 'Metaphor mixer' portrays the world's markets in three dimensions on a videoscreen grid. By looking at the visualization of the whole world of stocks, traders can spot trends and highly volatile stocks. Virtual reality is already beginning to change the way business works. It provides new ways to represent and communicate reality and abstract data by customizing it for our senses. NTT, Japan, is developing interactive systems, which will react to users' expressions and body language, as well as voice. Fujitsu, Japan, is developing 'Virtual Organisms'. These are imaginary living organisms capable of displaying complicated behaviour, depending on ever changing conditions, reacting to human presence and also capable of carrying on a dialogue. The potential of virtual reality applications are continuously on the increase.

## SIGNIFICANCE TO DEVELOPING COUNTRIES

The two major applications of immediate significance to developing countries are

- virtual design, and
- training.

As developing countries experience the forces of globalization they are devising ways of responding to global competition. The major imperatives for firms from developing countries to improve their intrinsic competitiveness are to train the technical people to improve the manufacturing competence and design competence [11]. Virtual reality based training is one step ahead of three dimensional simulation, as it permits interactive participation and full body participation. It eliminates the unexpected as much as possible and is closer to reality. Virtual reality can be the quickest way of cost effectively training operators for complex tasks. Virtual reality based design permits collaborative engineering where various experts can interact. It supports experiential prototyping, by which product characteristics can be experienced more realistically before the actual design. The use of virtual reality drastically reduces the time between design and manufacturing. This is of paramount importance for developing countries since design has been one of the basic capabilities that has been neglected. Only strong design capability can help the developing countries to achieve the transition from a non-industrial society to an industrial society. Virtual reality can facilitate the learning process and help in this transition.

Lastly, the services sector is also becoming technology oriented, especially telecommunications, financial services, building construction, electricity, supply, education, travel, etc. Virtual reality can help in improving the management of these services. Virtual reality makes experience a composable medium through rapid learning using virtual simulation systems. In other words, virtual reality can help developing countries to learn quickly. The imperative is to train people in virtual reality and accelerate the adoption of virtual reality use in the manufacturing, industries and services segment without much delay.

## TECHNOLOGY TRENDS

Virtual reality products are becoming more popular as the cost of systems decline. In 1992, about 150 head tracked fully immersive virtual reality systems were sold and in 1995 the market is likely to be in the order of 1000 systems. The total global market for virtual reality products in 1993 is estimated to be in the order of US\$ 35 million, and it is likely to grow to about US\$ 600 million by 1999 [1]. The major applications of virtual reality during this decade is likely to be

- training and simulation
- entertainment
- scientific visualization
- design and modeling
- information and
- communication.

A large number of firms are investing in virtual reality in order to create a competitive edge. Toshiba has developed a virtual reality based design platform. VPL Research has introduced a low cost VR system, which will go a long way to increase the diffusion of virtual technology. NASA has developed a virtual wind tunnel, which uses virtual reality, a supercomputer, high speed distributed networking and highend graphics. Marconi Simulation has introduced a 'Virtual Cockpit', which is a visually coupled airborne system simulator. This is a helmet mounted display onto which is projected an exact simulation of the world around the aircraft. Using two displays the scenario is developed using information from all sensors to allow night vision, visibility in poor weather or clouds and visual modification of threats and targets mapped onto the real world simulation. To drastically reduce the design cycle time for ships, Lockheed Missiles and Space Corp., USA, is using virtual reality and virtual prototyping involving high resolution graphics, stereovision, 3D-cursor, a data glove for manipulating graphic objects, and spatially located sound. National Advanced Robotics Research Centre, UK, has a project, namely VERDEX (Virtual Environment Remote Driving Experiment), which is a programme for developing tele-presence and virtual reality technologies in the design of human-system interfaces. The Massachusetts Institute of Technology Scientists have developed a walking, talking, and virtually living tool, which can communicate with virtual actors.

Japanese firms are investing large sums of money to use virtual reality for such wide ranging applications as

- controlling construction robots
- creating computer programmes
- designing molecular models

NEC is developing a virtual reality based three dimensional computer aided design system. Fujita is developing systems, that can operate construction robots using communication lines [12]. Dai Nippon Printing Co., and Intel Japan are using digital video interactive along with virtual reality. Tokyo Electric Co., is developing an electric power distribution system based on virtual reality. Ishikawajima-Harima Heavy Industry is developing remote control technology for next generation space robots.

using VR technology. Autonomous control function will be achieved using remote control functions based on virtual reality technology and integrating it with the skillful actions of the operators.

## CONCLUSIONS

Virtual reality offers us a new version of reality that can suit our whims, and is a technology with enormous business opportunity. Virtual reality removes the boundary between artificial reality and physical reality. Developing countries can use the enormous application potential of this technology for simulation, design, education as well as entertainment. Low cost virtual reality systems are entering the market and developing countries can use these. Immediately steps should be taken to introduce virtual reality technology in industries, research institutions training institutes and educational institutions. Design and training provides for intrinsic competitiveness and virtual reality allows for collaborative design and rapid prototyping. The developing countries have to improve their design competence by using new product realization technologies such as virtual reality to create and sustain industrial competitiveness in emerging industries, traditional industries as well as in services.

**Table 1: Virtual Reality Applications in Design**

Firm	Application of Virtual Reality
Boeing, USA	Virtual reality engineering system for design verification
Burroughs Welcome, USA	Drug design
Calibre Institute Netherlands	Allows prospective buyers of buildings to walk through them
Caterpillar, USA	Evaluate design performance
Ford, UK	Virtual prototyping
Lockheed Missiles & Space Corp., USA	Designing complex ships by 3D graphic manipulation
Marconi Simulators, UK	Design of virtual cockpit
Matsushita, Japan	Designing virtual kitchen
NASA, USA	Virtual wind tunnel for flow visualization
NEC, Japan	Virtual design network for collaborative design
Rolls Royce, UK	Computer design of high thrust aeroengines using VR images
Rover, UK	Virtual prototyping
Tokyo Electric, Japan	Power flow visualization for power system control design
Valencia, USA	Virtual prototyping
Virtual Presence, UK	Virtual CAD for product manipulation
Vickers Shipbuilding & Engineering, UK	Use of virtual submarines for design verification

**Table 2: Virtual Reality Devices**

Virtual Reality Device	Input	Application
Data Glove	Positions, orientations, trajectories, gestures and commands	Hand animation
Data Suit	Body positions, gestures	Body animation
Six Dimensional Mouse	Positions, orientations	Shape creation
Space Ball	Position, orientations, forces	Camera motion
MIDI Keyboard	Multidimensional keyboard	Facial animation
Stereo Display	3D perception	Camera motion, positioning
Head Mounted Display (Eye Phone)	Camera positions and trajectories	Camera motions
Force transducers	Forces, torques	Physics based animation
Real Time Audio Input	Sounds, speech	Facial animation of speech

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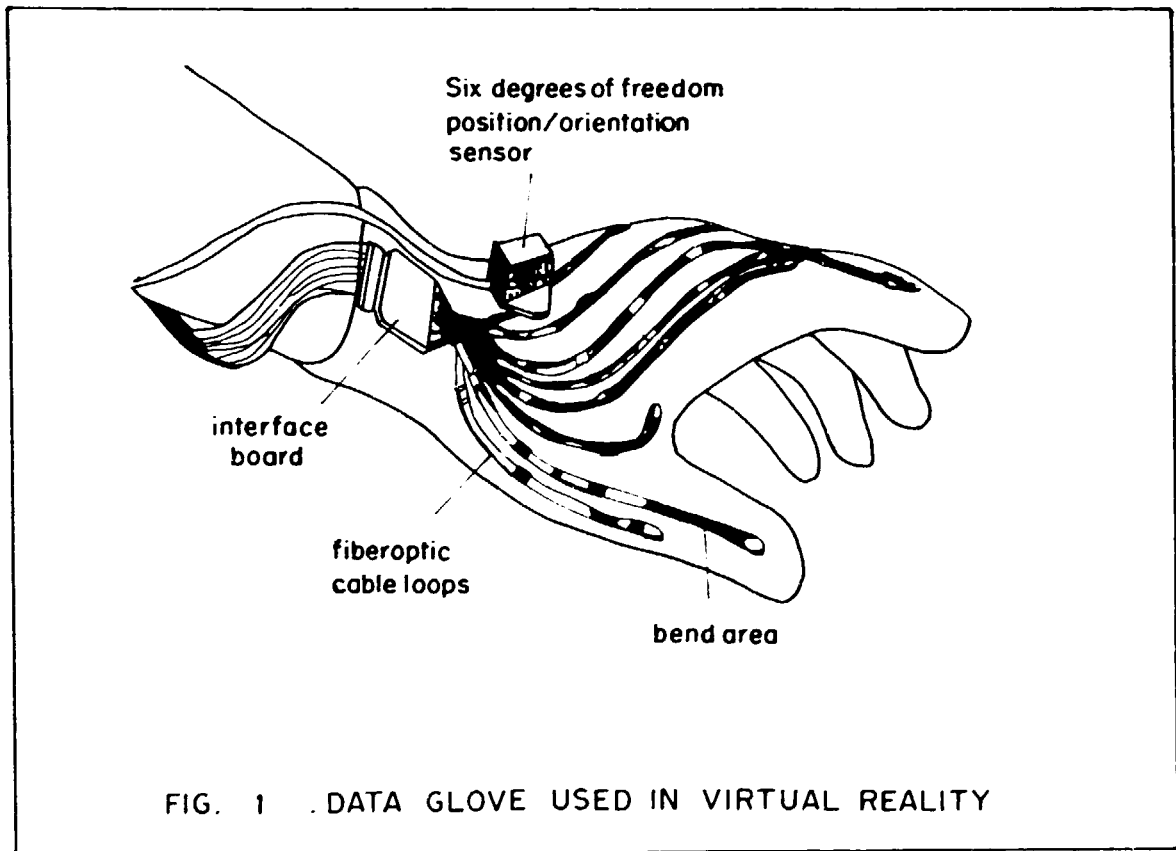


FIG. 1 . DATA GLOVE USED IN VIRTUAL REALITY

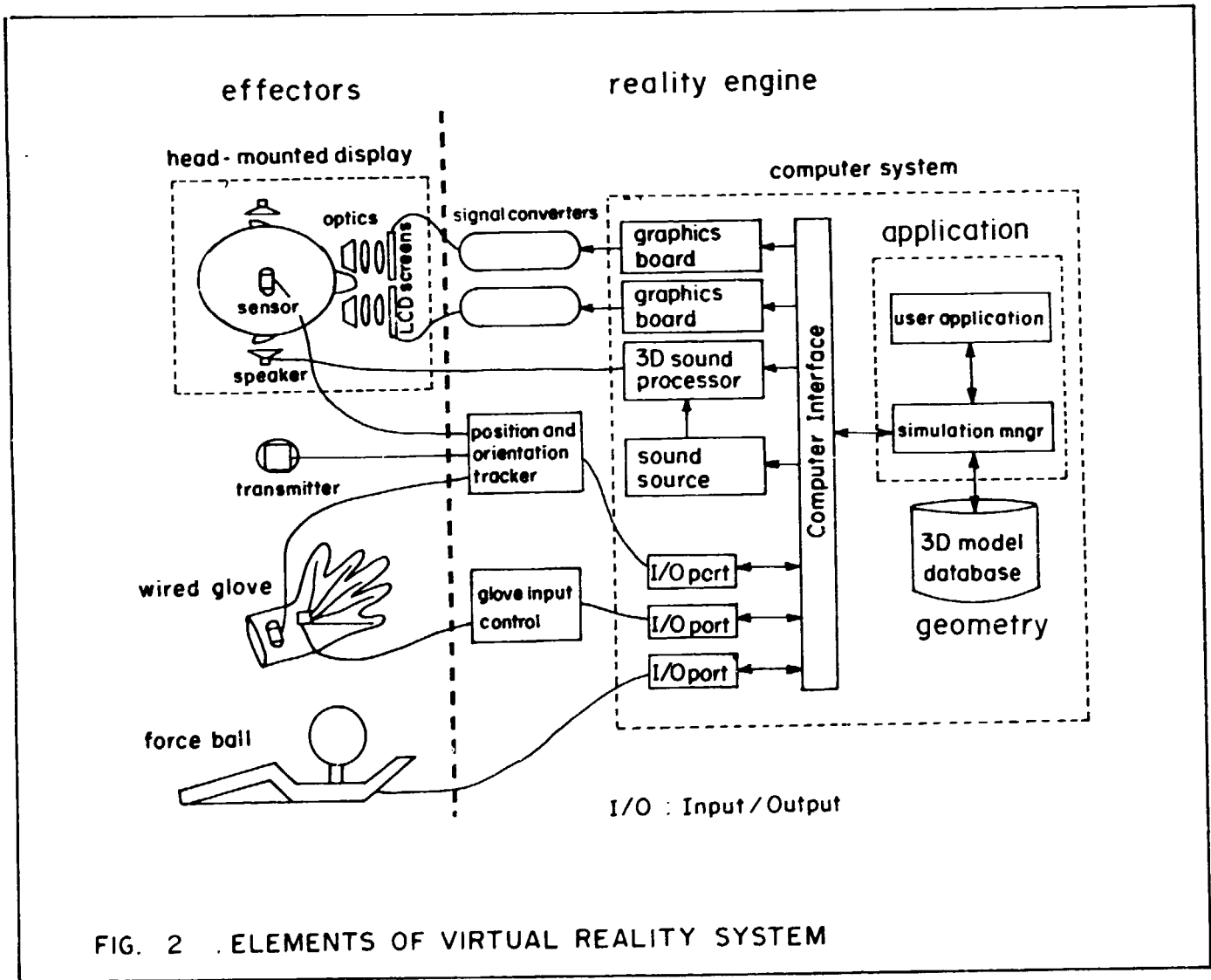


FIG. 2 . ELEMENTS OF VIRTUAL REALITY SYSTEM

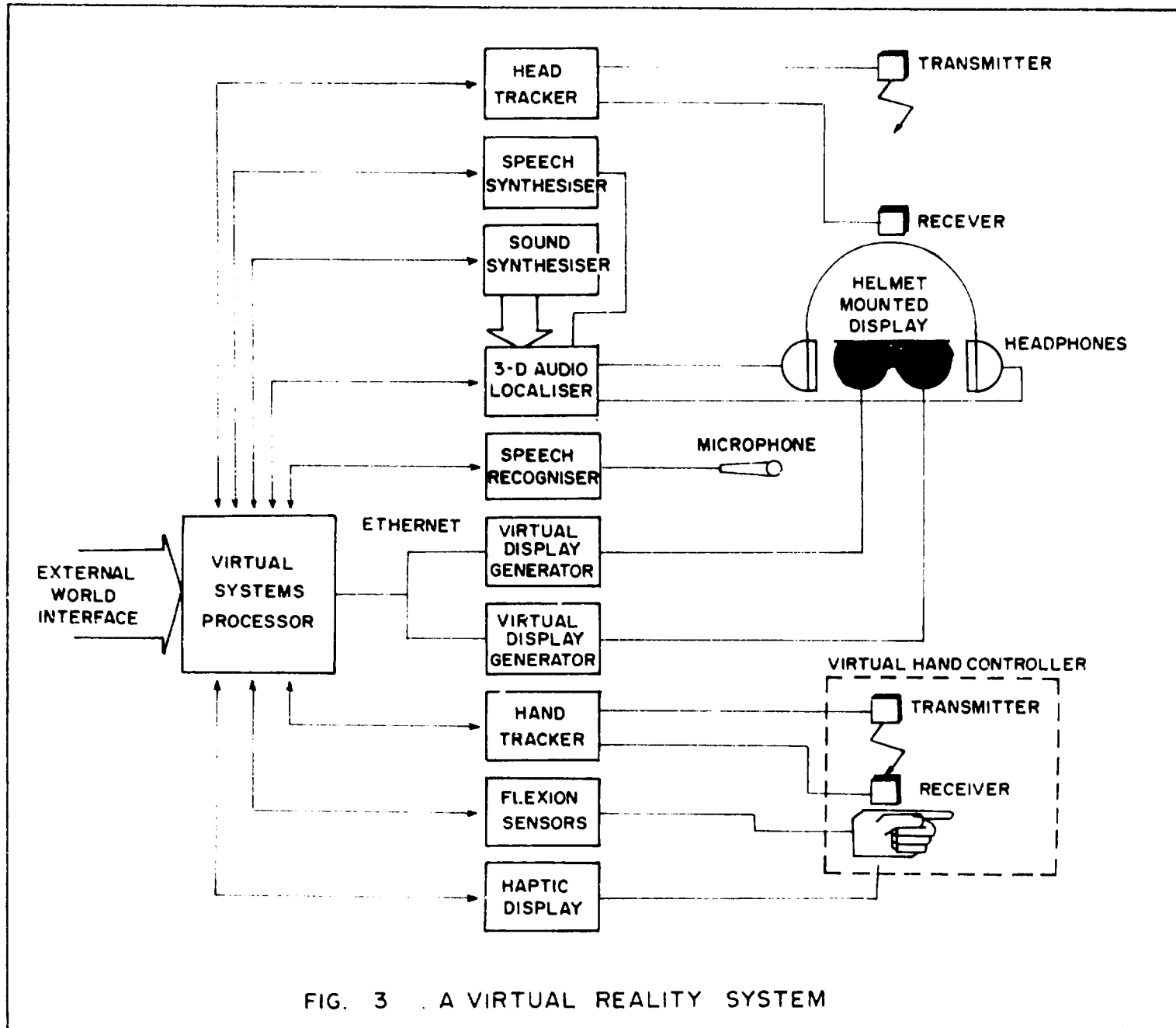


FIG. 3 . A VIRTUAL REALITY SYSTEM