OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

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

20736

MICRO-ELECTRONICS MONITOR

Double issue 45/46 1993

This issue carries two special articles - one on design, tropicalization and manufacturing of telecommunications equipment in Latin America by Dr. Arturo Serrano Santoyo, and the second on parallel computers and their industrial applications by Dr. Boleslaw K. Szymanski.

Distributed free to a targeted audience in developing countries

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

I. NEWS AND EVENTS

Consultative Group on Informatics Technology (COGIT)

In an effort to coordinate the activities of organizations and professional groups active in the area of informatics technology for development, the UNIDO Secretariat convenes biennial meetings of the Consultative Group on Informatics Technology (COGIT). These meetings bring together professionals from the field of informatics, identify possible areas of cooperation and consider a mechanism for keeping mutually informed and for formulating joint programmes.

In the past years, the UNIDO Secretariat has promoted the concept of software as an industry and the actions that developing countries could take to promote that industry. The concept has been elaborated through several studies dealing with software development and applications for developing countries, the approach to software production in those countries, and guidelines for organizing software houses. They include studies on the promotion of software links to industry for specific applications relevant to developing countries.

Software production is an industry, nowadays essential for the growth of the economies of developing countries and the launching of programmes to promote strong indigenous software industries. Producing for export is also a priority task.

In the foreseeable future labour will remain the priority input to the software development process. In the majority of developed countries the availability of qualified people to produce software has not kept pace with the growing needs of the software sector. Developing countries may therefore have a comparative advantage in software production based on their lower labour costs for highly qualified manpower. This advantage will, however, decrease in the course of time, due to a variety of reasons. The software production process is rapidly becoming more automated and increasingly tool-intensive. Both these aspects essentially contribute to maintaining a high level of productivity. Also, the hardware and software platforms are being transformed so rapidly and on a continuing basis that high levels of capital inputs are needed in order to remain up to date in the business.

The major obstacles for software export faced by developing countries are the difficulties of entering the global software market without efficient marketing and distribution channels. Developing countries also face additional problems concerned with image building and maintenance, credibility and acceptance by users, etc. The quality of software produced and marketed is now becoming a new issue to be coped with by developing countries. Increasingly, accreditation by authorized accrediting agencies is a prerequisite to competing in the global software market. There is a danger that this requirement may become an institutionalized trade barrier to developing countries unless the issues involved are handled with tact and fairness. New mechanisms may need to be created to deal with the quality accreditation process (as far as software marketing is concerned), objectively and fairly, and affordable by developing countries.

Resulting from the experience gathered, and the articulated needs of developing countries, UNIDO is now concentrating on assisting these countries to create an infrastructure and work out modalities for indigenous software production with an emphasis on export possibilities to industrialized countries. An important factor towards achieving this goal is the establishment of a clearing-house for the collection and dissemination of information on methodologies, means of production, existing resources and opportunities to create North-South software production/marketing ventures, as well as to disseminate the strategies of different developing countries in regard to software export.

It is in this context that the COGIT Meeting held in Vienna, 22 to 24 November 1993, was convened. The formal objectives of the Meeting were:

(a) To review practical experience in software production and export strategies and to identify concrete measures for cooperation at the international level, including cooperation among developing countries;

(b) To suggest a programme of action for UNIDO, in particular for activities related to promotion of software export from developing countries.

After reviewing the current trends in software as an industry in the context of informatics technology as well as the needs of developing countries in that respect, a number of conclusions and recommendations relating to inputs to the UNIDO programme in this area were adopted.

Some past UNIDO initiatives and current trends

The setting up of REMLAC, the network to promote cooperation in informatics and microelectronics in the Latin American and Caribbean Region; the starting of the UNIDO/NIHERST project to assist Trinidad and Tobago to develop an indigenous software industry; assistance to RITSEC in Egypt to support the provision of software development and services assistance in Egypt and the Arab Region; cooperation with CRAT, the African Regional Centre for Technology; are some of the successful initiatives that UNIDO has already pursued.

Since the last COGIT Meeting held in Vienna in 1991, the major changes in the world software scene that have come about are the following: the dramatic fall in prices of the hardware and software platforms and the

consequent improvement in their accessibility the world over; the growth in the concept (and general acceptance) of a global market for software; the emergence of economies in transition, such as those of the East European countries and Russia, with a strong determination to compete in the world market; and the starting of new international software technology centres, such as the International Institute for Software Technology (IIST) under the United Nations University in Macau.

The People's Republic of China, Egypt, India, Mexico, Russia, East European countries and the Latin American countries, are already adequately equipped in terms of software development expertise, training of the required skilled persons in design and implementation, and access to hardware and software platforms. For these countries the urgent need is to acquire skills in market penetration, to improve software development methodology to assure quality and standards, to acquire software quality accreditation, etc.

On the other hand, countries in the Caribbean, African and similar regions, because of their size, the limited nature of their internal markets and the small size of their software industry players, require additional assistance to prepare themselves to compete effectively in the world market.

Keeping these backgrounds in mind, the Committee made the following specific recommendations.

Preparation and dissemination of information

UNIDO should prepare and disseminate a Certification Handbook containing all the information needed by software companies in developing countries to start the certification process for software quality systems.

UNIDO should compile and disseminate information required for the political level in developing countries to integrate the accreditation certification bodies into their national legal systems as well as to interface appropriately with certification bodies in other countries. This should be done through the preparation of a handbook as well as through advisory services, workshops, seminars, etc.

Studies and workshops

UNIDO should commission a series of studies on the following topics:

(i) Quality management in software development emphasizing international best practices for software engineers;

(ii) Software process improvement, quality auditing; and certification;

(iii) Intellectual Property Rights (IPR);

(iv) Legal and contractual aspects of software development and marketing;

(v) Management training for software industry;

(vi) Improvement of export capabilities of developing countries (e.g. marketing, strategic alliances, financing mechanisms, etc.).

The above studies could be used to organize company-specific training programmes and workshops. These workshops could be aimed at:

(i) Government officials, industry associations, banks and financial institutions, policy planners, procurement agencies, etc.;

(ii) Certifying agents involved in accrediting, licensing, etc.;

(iii) Software developers, project managers, implementers, etc.

Regional and country assistance

Developing countries, not already members of relevant ISO bodies and other international standards organizations, should be advised/persuaded/assisted by UNIDO to take steps to become members, take part in task forces, study groups, etc.

UNIDO should consider establishing, jointly with appropriate organizations, regional or other certification/accreditation mechanisms to make this process less expensive, more accessible, and not act as an entry barrier for international trade.

UNIDO should provide mechanisms and assistance in cooperation with ITC for developing countries to penetrate niche markets, to form strategic alliances, etc.

UNIDO should support the creation of software industry associations in developing countries and strengthen links and joint activities between such bodies.

Additional assistance to countries less prepared for software production

UNIDO should help and provide assistance in software personnel training, acquiring access to relevant hardware and software platforms, etc.

UNIDO should assist in IT policy formulation, establishment of training/coordination centres for software industry, and help in achieving national and regional cooperation at the industry level.

UNIDO should encourage and assist in the transfer of technology and technical know-how in software development marketing to the less advanced developing countries in cooperation with professional and industry associations in the more advanced developing countries.

Other general recommendations

UNIDO should continue to use its influence to persuade developing country governments of the export-earning potentials of software and services. UNIDO should ensure that the promotion of exports and the collaboration in the export of these services form part of all country programmes and projects concerned with export promotion and trade development.

UNIDO-ITC collaboration to the above end should be continued and expanded.

A forum should be set up for software exchange and protection to promote and build awareness of fair software production and commerce.

Every effort should be made to strengthen and make more readily accessible telecommunication infrastructure specifically to facilitate software development for marketing. It is recommended that collaboration to this end between UNIDO and the ITU should be continued and strengthened.

CeBIT eyes up the single market

Europe and the completion of the Single Market are the focus of this year's CeBIT '93 in Hannover, Germany. Within the framework of the 5th International CeBIT Forum, members of the business, political and scientific communities from east and west laid the foundations for a broad spectrum of collaborative business ventures. For the average visitor, CeBIT offered a comprehensive array of telecommunications technology and mobile communications equipment.

Analysts welcomed the emphasis on telecom as they say it is the only market set to experience continued double-digit growth. (Extracted from *The European*, 18-21 March 1993)

BT signs deal to complete teletext chain

France Télécom and British Telecom (BT) have signed a deal that gave telephone subscribers in France and Britain access to each other's teletext systems, and to the ever-growing lists of professional and personal services they carry.

French users of the popular Minitel home terminal can finally tap into more than 200 services on Britain's Prestel network, and vice versa.

Setting up the continental network was not easy. Although teletext is highly developed in France, it was less so in other countries. Luckily, Minitel's reputation has spread abroad since it was first introduced in Paris in 1984.

Today, both French and British teletext systems offer more or less the same services: electronic directory assistance, banking and stock exchange data, rail, airline and theatre reservation, weather forecasts, games, and myriad ways to shop without ever leaving the telephone.

The powerful home-shopping services pressured BT, ever in search of new markets, to link up with France, where six million Minitels are in use. Prestel's 60,000 subscribers can access all of Minitel's 20,000 public and professional services.

Of these, the most important remains the electronic phone directory - faster than going through an international operator, and more certain of finding a number since teletext offers automatic alternative spellings.

Both companies are currently putting their marketing plans in place. (Extracted from *The European*, 18-21 March 1993)

EC revises HDTV plan

The European Commission is to refocus its efforts to create a high-definition television (HDTV) system, concentrating on wide-screen technology and programme production. The new impetus follows the failure of its eight-year campaign to promote a European broadcasting standard. Both European and Japanese transmission systems have been overtaken by work in the US on digital HDTV.

Denmark is working on a revised proposal for an action plan to boost HDTV production, despite a further reduction of the proposed volume of EC aid to ECU 400 million over four years.

The Commission's original 1991 proposal, offering the industry ECU 850 million aid was scaled down last year to ECU 500 million during a four-and-a-half year period. However, this is still being blocked at ministerial level by the UK.

Potentially the biggest losers, Europe's largest television manufacturers, Thomson of France and Philips of the Netherlands, insist that their efforts have not been in vain, although attempts to promote a broadcasting norm based on the Mac family of transmission standards have run into problems.

The past eight years of research have, they say, already produced major advances in the technology used

in the new generation of enhanced-definition wide-screen television sets, digital CD-quality sound and the signal compression techniques which are needed to transmit the vast quantities of data required to provide sharper pictures. (Extracted from *The European*, 18-21 March 1993)

New chip cuts cost of HDTV

A consortium of companies, headed by NEC Corp. of Tokyo, has completed the joint development of a 19-chip LSI set for high-definition television sets that conform to Japan's Hi-vision standard. The chip-set is a second-generation MUSE decoder. The MUSE decoder standard was established by NHK, Japan's public broadcasting company, which began HDTV broadcasting on an 8-hour a day schedule in 1990. (Extracted from *Electronics*, 8 March 1993)

Write-once optical disk storage

In simple terms, Write-Once Read-Many (WORM) disks operate by data being permanently written to the disk by a write laser as a series of optical discontinuities. This data is then read from the disk by the use of a less powerful read laser, which reveals the discontinuities to a sensing device. Generally WORM disks have been used as high-capacity data storage devices. The following is a list of UN organizations that currently are using or planning to use WORM technology for optical storage.

Organization	Status	Application
Economic and Social Commission for Asia and the Pacific (ESCAP)	Using	Backup to magnetic disk storage on PC/workstation, alternative to magnetic tape for mini/mainframe backup
Economic Commission for Africa (ECA)	Planning	Document image processing, text, desktop publishing, backup, network mass storage, computer output to laser disk, distribution
Food and Agriculture Organization of the United Nations (FAO)	Planning	Managing desktop publishing files, database development and maintenance, document storage
International Atomic Energy Agency (IAEA)	Planning	Document image processing
International Civil Aviation Organization (ICAO)	Planning	Document image processing, management of text files
International Trade Center (ITC)	Planning	Data distribution
United Nations (UN) - Geneva	Using	Document image processing, data distribution, access to United Nations documents
United Nations Centre for Human Settlements (Habitat) - UNCHS	Using	Aerial photographs, GIS applications
United Nations Department of Humanitarian Affairs (UN DHA) - Geneva	Planning	Text files, backup to magnetic disks on PC/workstation, network mass storage
United Nations Development Programme (UNDP)	Using	Archiving/storing on-line data processing application
United Nations Population Fund (UNFPA)	Using	Text files, desktop publishing files, multimedia publications
United Nations University (UNU)	Planning	Document image processing, text files
World Food Programme (WFP)	Planning	Desktop publishing files, data distribution
World Health Organization (WHO)	Planning	Data distribution
World Intellectual Property Organization (WIPO)	Using	Document image processing, text files, network mass storage or client-server system

(Source: *ACCIS Newsletter*, 10(6), March 1993)

Directory of e-mail addresses

With more and more UN system staff communicating by electronic mail, the need for an accessible, on-line central e-mail directory has arisen. In March 1993, the e-mail addresses of staff of 11 UN organizations were posted on TIES (Telecom Information Exchange Services), the Geneva-based on-line information exchange service of the International Telecommunication Union (ITU).

The 11 organizations are: the Economic Commission for Europe (ECE), the Food and Agriculture Organization of the United Nations (FAO), the General Agreement on Tariffs and Trade (GATT), the International Labour Organization (ILO), ITU, the World Bank, the United Nations Development Programme (UNDP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations, the World Health Organization (WHO) and the ACCIS Secretariat.

The directory is being run as a pilot project by the ACCIS Technical Panel on Information Management Standards and Strategies (TP/IMSS). The panel hopes to recommend to ACCIS that the pilot be developed further towards an implementation of the CCITT X.500 recommendation.

Users can query the directory interactively (TIES option 37) or by e-mail. A PC or other equipment supporting a VT terminal (e.g. PROCOMM, KERMIT) is required for connection. To connect using TIES VTX option 37:

Dial-up: +41 22/733 7575
X.25: 228 4 6811 1112
Internet Telnet: TIES.ITU.CH

Use INFO as user name; there is no need for a password. Once the main menu is displayed, select option 37 and follow instructions.

To connect via e-mail:

E-mail queries are sent to the auto-answering mailbox WHOIS. Messages with one query per line should be sent to one of the following addresses:

Internet address: whois@itu.arcom.ch
X.400 address: S=whois; P-itu;
A-arcom; C=ch

Messaging profiles are also available on TIES for e-mail and interactive access.

Additional information on the pilot directory can be obtained from the ACCIS Secretariat. Arrangements are also being made to provide on-line access to the following ACCIS data bases via TIES (Telecom Information Exchange Services - the ITU on-linehost):

- Register of Development Activities of the United Nations system;
- Directory of United Nations Databases and Information Services;
- Directory of United Nations Serial Publications;
- Books in print of the United Nations System. WALKER@UNICC.BITNET.

(Source: *ACCIS Newsletter*, Vol. 10, No. 6, March 1993)

The challenge of decentralization

In January 1990 the Special Unit for TCDC began an experiment in decentralizing the TCDC-INRES database by creating outposts of the system in the field. Since that date 12 outpost centres have been established. They will regularly send diskettes back to New York, containing new or revised entries. This information will be used to update the central database, which will periodically be redistributed to the field on CD-ROM (compact disc, read only memory). In addition to the main outposts, three associated centres will use the system for a smaller range of activities.

In principle, decentralization appeared to offer many attractions. INRES could be brought closer to end-users in developing countries, it would become better known, its response time in answering inquiries would be decreased, usage of the system could be expected to increase and better quality could be achieved by calling upon the special knowledge and skill available in the various countries for the purpose of identifying good institutions for registration. Moreover, INRES is a large system containing detailed records on institutions from over 100 countries. Registrations in INRES are in English, French and Spanish, and the use of three languages for data entry places special demands on data entry operators. By distributing a part of the workload to the outposts, the Special Unit felt that it would be possible to update records more frequently and efficiently, while adding to the number of registered institutions.

Decentralization of a large, complex database such as INRES proved to be challenging. INRES requires a relatively advanced computer system and, because of its size, at the time when decentralization was started it could only be distributed on tapes.

Initially, the system was placed in three countries: Ghana, Haiti and Algeria. These were selected with a

view to seeing how safely and efficiently the system could be operated on a decentralized basis and whether the anticipated advantages could be realized. In Ghana and Haiti, the outposts were set up in UNDP offices. In Algeria, the location was a government office.

Decentralization at the individual country level continued, with new locations being created in Tunisia, Cyprus, Iraq, Thailand and Pakistan. At the same time the Special Unit decided to begin concentrating on international, regional and subregional installations, since it was felt that this approach would be simpler yet more efficient and cost-effective than country-level decentralization. Agreements were reached with the United Nations Industrial Development Organization (UNIDO) and the Food and Agriculture Organization of the United Nations (FAO) to house the system.

At UNIDO a major effort is under way to ensure that the INRES database includes all the major developing country institutions with strong capacities to provide training and/or expertise in industry and technology-related fields. UNIDO's training branch is also studying ways in which it can use the INRES system to automate the annual production of its directory of training opportunities in the industrial and technology sectors. It is hoped that a similar effort to upgrade and update INRES data on agriculture-related sectors may be installed at FAO. SELA is providing invaluable support in updating information on its 26 member countries. Many users of INRES may not be aware that all of the outposted locations can carry out searches and respond to queries for information. Users are encouraged to contact whatever centre they find it most convenient to use.

Based on recommendations of evaluation studies carried out during 1991, and on accumulated experience, future INRES outposts will be set up only in regional and subregional locations and international organizations. While one of the original motivations for decentralization was improved data quality, experience suggests that this can better be attained (a) by increased use of locally recruited consultants to identify institutions and collect data, and (b) by concentrating efforts to expand the database on fewer and higher priority sectors. Nevertheless, the desire of users, particularly those in developing countries, to see INRES further decentralized at the country level continues unabated.

The Special Unit will respond to this demand by publishing a special version of INRES (called INRES-Lite), which is currently under development. This version can be run on inexpensive hardware platforms and on networks. It can be used in many locations where there is no necessity to operate a full version of INRES capable of data entry and complex data processing. The INRES-Lite system will still be of a size that limits its distribution to the CD-ROM medium. It is not anticipated that this will be a serious limitation, as CD-ROM has already acquired the status of the "database publishing medium" of choice for the foreseeable future, particularly in developing countries. The cost of CD-ROM readers continues to drop steadily as use of computer CDs spreads. This creates excellent prospects for the Special Unit for TCDC to use INRES much more widely to promote and support the spread of TCDC.

Directory of INRES outposts

Ministère de l'Economie
Centre National d'Information et de Documentation (CNIDE)
B.P. 65
Cité du 5 juillet, Bab-Ezzouar
Algeria
Tel: 213-2-751210
Telex: 64266 CNIDE DZ

PPD/ECDC
UNIDO
Vienna International Centre
P.O. Box 300
A-1400 Vienna
Austria
Tel: 43-1-21131
Fax: 43-1-237401
Telex: 135612
Cable: UNIDO VIENNA

UNDP
P.O. Box 5605
Nicosia
Cyprus
Tel: 357-2-303194
Fax: 357-2-366-125
Telex: 4861 UNDP CY
Cable: UNDEVPRO NICOSI

UNDP
P.O. Box 1423
Accra
Ghana
Tel: (874) 772-837
Fax: (874) 150-5362
Telex: 2195
Cable: UNDEVPRO ACCRA

UNDP
Boite postale 557
Port-au-Prince
Haiti
Tel: 509-1-23-1400
Fax: 509-1-39340
Telex: 203-0091
Cable: UNDEVPRO

UNDP
P.O. Box 2048 (Alwiyah)
Baghdad
Iraq
Tel: 964-1-887-4321
Fax: 964-1-886-25-23
Telex: 212271 IK
Cable: UNDEVPRO BAGHDAD

The Planning Institute of Jamaica
39-43 Barbados Avenue
Kingston 5
Jamaica, WI
Tel: (809) 926-1480
Fax: (809) 926-4670
Telex: 3529 PLANJAMJ

Dept. of Technical and Economic Cooperation
Krung Kasem Road
Bangkok
Thailand
Tel: 662-281-6360
Fax: 662-280-1248
Cable: DEPTECO

Agence Tunisienne de Coopération Technique (ATCT)
34, Rue d'Iran, B.P. 34
CEDEX 1080, Tunis
Tunisia
Tel: 216-1-286-617
Telex: ATUCOP 13990

TCDC-INRES
Special Unit for TCDC
UNDP
304 East 45th Street, FF-1208
New York, NY 10017
USA
Tel: (212) 906-5741
Fax: (212) 906-6429
Telex: 422862
Cable: UNDEVPRO

(Source: *UNDP Forum*, 1992)

Green PCs

Intel will launch its latest "S" series of power conserving microprocessors shortly. This comes hot on the heels of power saving chips for laptops and "green" computers from the major PC makers.

US semiconductor manufacturers have been fighting a series of negative images, polluted groundwater, toxic working conditions, but now they are hoping that a growing trend towards building more environmentally sensitive computer systems will help cast them in a better light.

The trend towards "green PCs", computers that can be recycled and use much less power, is a growing market opportunity, especially since it also includes US Government help. The US Environmental Protection Agency, (EPA) last year launched its Energy Star programme, which encourages computer manufacturers to develop more energy-efficient computers. The EPA estimates that a typical desktop PC consumes about $100 worth of electricity per month. This represents about 5 per cent of all power consumption in the US and could rise to 10 per cent by the year 2000.

Even small energy savings of 20 to 30 per cent, could dramatically reduce the need for new power stations and prevent the release of millions of tons of carbon dioxide and other pollutants. The goal of the EPA's programme is to encourage computer manufacturers to produce PCs that will consume as little as 1⁄3 per cent of their current power consumption or 30 watts, and systems that can switch to a "sleep" mode when not in use.

Such systems will be blessed with an EPA "Star" showing consumers that the system meets or exceeds minimum EPA specifications. So far, much of the movement towards low-power components and energy efficient computers has come from the incredible growth in portable computer markets. The limitations of current battery technologies has meant that portable computers, ranging from laptop to pocket designs, have had to use low-power consuming chips wherever possible to extend their use beyond a couple of hours.

IBM demonstrated a "green PC" at the Comdex/Fall trade show in 1992. Several other major computer manufacturers have promised to build similar systems, and the EPA has signed up more than 20 manufacturers to its programme.

The first Green PCs are expected to be introduced this summer.

Intel's involvement is particularly important since according to market research firm Dataquest, more than 80 per cent of PCs built, use Intel microprocessors. AMD, which is the biggest producer of Intel clone components, can also make a big contribution to Green PCs and it already has a line of 3.3V microprocessors and other PC components.

Other US semiconductor manufacturers will also offer low-power consuming components. Cyrix already offers a 2.5V microprocessor. The Semiconductor Industry Association, has adopted a 15 year technology road map that will produce even lower power consuming components. One of the plan's goals is to produce 1.5Vt chips containing more than 1 billion transistors.

While microprocessors and supporting logic chips play a major role in conserving power, computer monitors can easily consume more than one half of a desktop system's power. Yet since conventional monitors are not tightly integrated with the main system, it is

difficult using current technology to switch-off monitors or place them in a sleep mode.

The monitor must be able to determine if the user is looking at its screen and then it must still keep its CRT filament warm so that it can instantaneously display an image when woken.

While US semiconductor manufacturers can see potentially lucrative markets in supplying builders of Green PCs with low power components, the real test will be the customer. Will they pay more for a greener PC? (Source: *Electronics Weekly*, 5 May 1993)

IT Environmental practices

Earth Day offered an opportunity to reflect on the information technology industry's environmentally sound and sorry practices:

Green kudos

- The EPA's Energy Star programme has enlisted a slew of manufacturers committed to building energy-efficient computers and laser printers, including Hewlett-Packard Co., Compaq Computer Corp., Unisys Corp., Digital Equipment Corp., Intel Corp. and NCR.

- IBM's San Jose, California manufacturing facility ended its use of chlorofluorocarbons (CFC) more than a year ahead of schedule and five years after the site was declared the country's worst CFC emitter.

- The chemical coating of fax paper prevents it from being completely recycled. Partially recycled thermal fax paper, however, is made by TechRite Unlimited in Marblehead, Massachusetts. And it promises to match the price of paper made from virgin pulp.

Green barbs

- Microsoft Corp. has launched an alarmingly wasteful 10th anniversary celebration of its Word application by mailing thousands of instantly disposable heavy-duty folders, each devoted to the news of a single year of Word's decade-long run.

- The Silicon Valley remains one of the biggest Super-Fund toxic cleanup sites in the country. The worst offenders: semiconductor companies.

- Laser printers and photocopiers gobble up the equivalent of about 238 million trees a year, according to estimates from the Conservatree Paper Co., a San Francisco-based recycled paper distributor.

- The energy drain caused by PCs that are always on is becoming substantial. According to the EPA, PCs consume more than 5 per cent of the commercial electricity output in the US.

(Compiled by James Daly, *Computer World*, 26 April 1993)

AT&T early on CFC ban

AT&T said it would stop using all ozone-depleting chlorofluorocarbons (CFCs) in all of its manufacturing operations by 15 May 1993, more than two years before a world-wide ban takes effect.

The company says it used its own research scientists and invested more than $25 million into a research programme to find substitutes for CFCs, which are widely used in electronics manufacture.

AT&T developed a water-soluble flux cleaning substance based on orange juice. The company says it also developed improved soldering methods that leave no extra flux residue and thus do not need cleaning.

AT&T's efforts in eliminating CFCs have been recognized by the US Environmental Protection Agency, which bestowed upon it the 1992 Stratospheric Ozone Protection Award. (Source: *Electronics Weekly*, 21 April 1993)

Free rehabilitation CD-ROM

The German producer of a CD-ROM on the vocational rehabilitation of disabled people is keen to publicize the fact that it is available free of charge.

Updated twice a year, REHADAT includes case-studies, details of aids to the disabled, training courses, literature citations and abstracts, etc. Sponsored by the State to produce this material, the Cologne-based Institut der Deutschen Wirtschaft is now building additional databases on relevant research projects and the products of sheltered workshops. It is also broadening its scope to cover Europe in general, and translating its current information into English. For details contact the following telephone and fax numbers: TP+49 221/37655 13; Fax+49 221/37655 55. (Source: *Information World Review*, February 1993)

Network training set for developing countries

In conjunction with the Inet 93 Conference in San Francisco, 17-20 August 1993, the Internet Society sponsored a workshop for networking training for representatives of developing countries. The workshop was held at Stanford University on 10-16 August 1993.

The workshop specifically targeted the needs of people from developing countries who play or will play an important part in introducing and extending networking in their countries. Attendees were involved in establishing a networking presence in their countries, in institutionalizing its operation, and in assisting the country's schools and universities, governmental agencies, non-governmental organizations, local firms, and residents in learning about and exploiting the range of services available through such network connectivity. Staff members of international and bilateral technical cooperation agencies, as well as professionals involved in international technical and development assistance also attended.

Europe drives smartcard spec

Transport electronics specialists have started work on a European specification for smartcard technology that can be used in electronic road pricing and navigation systems.

The research group has been set up as part of the European Commission's electronic road-pricing project, called ADEPT.

Its aim is to produce the specification for an advanced smartcard with increased processing power and memory capacity.

This will be welcomed by semiconductor suppliers uncertain about future developments in the smartcard market. Many are waiting for a signal before investing in new sub-micron chips.

Smartcard performance and memory capacity may need to be increased if it is to be used to process transaction data as the car passes a roadside microwave beacon at speeds up to 60 mph. (Source: *Electronics Weekly*, 21 April 1993)

II. NEW DEVELOPMENTS

Augat switches into super telecoms

Connector maker Augat is working with unnamed telecommunications specialists to develop a fast orthogonal telecommunications switch that uses a high-speed connector that Augat designed for use in supercomputers.

An orthogonal switch dispenses with a backplane, which can eventually cause a bottleneck and slow down the transmission of signals. Instead, boards are connected to each other in a criss-cross (or orthoganol) pattern.

This allows signals from one board to be passed directly to any one of several boards attached perpendicularly to it via edge connectors. These boards can themselves be attached to other boards arranged parallel to the first so that an array of intelligent boards is set up.

When boards are not contiguous, signals can be passed via a number of routes, which cuts down on congestion and eases bottlenecks.

As system speeds increase, transmission problems such as signal reflection, cross-talk, rise-time degradation and signal skew can arise.

Augat's Electronically Invisible Interconnect (EII) device can handle signals up to 2GHz without impairing data integrity.

The EII connnector provides an impedance-matched link between the two boards. Gold dots on the printed circuit board are linked to connector traces on a flex film on the connector.

The standard impedance of the EII is 50Ω, but this can be varied at the manufacturing stage to get an exact impedance match by varying the thickness of the connector traces, or the distance between connector pins and the ground plane. (Source: *Electronics Weekly*, 3 March 1993)

Thermal management

The drive to ever smaller computing and communication devices such as notebook computers and the new breed of "personal digital assistants" (PDAs) presents designers with ever larger headaches in terms of controlling heat.

To help manage the problem Kingston-based Flomerics has released a new version of its thermal management product. Flotherm applies computational fluid dynamics techniques specifically to the problems of electronics design.

The new version includes automatic calculation of fan power ratings and a specialized function for the analysis of air flow through tilted equipment such as VDU monitors. Users can manually set heat transfer coefficients for plates, external walls and cuboidal blocks. Graphics facilities now include automatic duplication, zoom for highlighting and enlarging specific areas of a model and hidden line graphics.

Among the first customers for Flomeric Version 3.1 is Apple Computer which is building a PDA device called the Newton. Although Flotherm will operate on a 386 PC or Unix workstation Apple is

running it on a Cray supercomputer in its design simulation technology centre. (Source: *Electronics Weekly*, 3 March 1993)

Start-up develops parallel processing codec

Massively-parallel processing modules aimed at applications such as digital television coding and decoding could be on the market by 1995, thanks to world-beating technology developed by a British company.

Aspex Microsystems, based at Brunel University, is already working on at least four real-world projects with its unique ASP (Associative String Processor) technology, including participation in Europe's VADIS programme to develop digital TV applications.

Aspex is developing pocket-sized wafer-scale modules containing several thousand individual processors. A commercial version of an ASP module could be developed in two years.

In theory ASP hardware could handle the entire digital coding process in digital TV, from frame grabbing through compression techniques to encryption and multiplexing of the final signal ready for transmission to viewers. The technology could also enable broadcasters to perform a huge range of complex manipulations on digital TV images in real time, in line with transmission.

Aspex has developed parallel versions of the discrete cosine transform (DCT) algorithms that lie at the heart of most digital image compression techniques. It is now working on motion estimation.

The company believes a 16,000-processor board could generate compressed digital TV signals at a broadcast rate of 10 Mbit/s, the target rate for the MPEGII compression standard now being developed. (Source: *Electronics Weekly*, 3 March 1993)

Start-up beats mobile chip giants

Californian start-up Pacific Communications Systems Inc. (PCSI), has developed a five-chip chipset for the next generation of digital phones. PCSI, which completed its merger with chip maker Cirrus Logic, has designed the chipset for world-wide standards such as DECT (Digital European Cordless Telephone) and GSM (Groupe Services Mobile) in Europe, PCS (Personal Communication Systems) in America and PHP (Personal Handyphone) in Japan.

The PCSI chipset does all the baseband processing on a single chip and the RF function, including the synthesisers, on four chips.

PCSI's chipset, a mix of gallium arsenide, CMOS, bipolar and CMOS technologies, is the most highly integrated solution yet seen and was partly developed in the UK at PCSI's seven-man (largely ex-Imperial College) R & D team in Camberley. The chipsets address the emerging markets around the world at 1.9GHz. That includes DECT, GSM, PHP and PCS.

DECT products will burst on the European market this year as PSCI leads silicon suppliers with new low cost and highly integrated silicon designs, which can be used in Japanese PHP as well as European DECT equipment.

No other suppliers are proposing this level of integration for DECT silicon. National Semiconductor and Sierra Semiconductor have worked together on a nine-chip DECT design. (Source: *Electronics Weekly*, 3 March 1993)

Speed record for chip

The fastest chip ever made was shown by Siemens at the 1993 International Solid State Circuits Conference in San Francisco. It was a silicon bipolar demultiplexer circuit capable of 40 Gbits/sec data transmission rate.

Siemens demonstrated that key components in high speed digital transmission, such as decision circuits, time-division multiplexers (MUX), demultiplexers (DEMUX) and frequency dividers, can operate at the multigigabit transmission rates demanded by fibre-optics communication systems.

The Siemens chips were made in bipolar silicon technology using a 0.8-micron process resulting in an effective emitter width of 0.4-micron.

With the single exception of a GaAs frequency divider operating a 39.5GHz at the 1992 Gallium Arsenide Symposium, they demonstrated the fastest data rate of any chips made in any technology.

The significance of the Siemens chips is that they give the lie to the idea that only gallium arsenide is capable of handling the multigigabit-per second data communications requirements of fibre optic communications networks.

Until now silicon has been used for transmission up to 10 Gbits/s and it was expected that more expensive gallium arsenide would take over from 20 Gbits/s upward.

The chips are made using a bipolar technology with selective epitaxial growth of the active base and collector region. (Source: *Electronics Weekly*, 3 March 1993)

Self-refresh DRAMs

Aiming to reduce the power consumption of its DRAM line, Hitachi America is sampling a line of

parity-check DRAMs with an energy-saving "self-refresh" mode.

The self-refresh mode for the HM51S400A/AL and HM51S4280A/AL DRAMs, in 512k x 9 and 256k x 16 configurations, reduces their power consumption by as much as 80 per cent and extends battery life by up to three hours, Hitachi said.

The DRAMs have an extended refresh duration of 125 microseconds.

Hitachi has plans to build self-refresh mode into all its DRAMs.

The firm will target the parity DRAMs at desktop PCs and mainframes in addition to notebook PCs. (Source: *Electronics Weekly*, 3 March 1993)

Semiconductor development

A South Korean scientist has developed a new semiconductor material, which is believed to be cheaper than existing materials, but better quality. The material, called PMC-102M, was invented by Professor Kim Young Gil of The Korea Advanced Institute of Science and Technology. Both Motorola and TI are to use the material in their semiconductors, and other major producers are to follow suit. (Source: *Electronics Weekly*, 25 March 1993)

Innovative university

One of the most innovative chips at the '93 ISSCC, which blurs the bounds between hardware and software, came from Tohoku University on the last day of the conference.

Tohoku's paper described a real-time reconfigurable logic chip using neural network techniques. Tohoku call it "soft-hardware logic" or SHL, and unlike normal logic chips which cannot change their functions after fabrication, this chip can alter its logic function in real time according to external control signals with no hardware modifications.

The chip has a multiple-input functional MOS transistor which simulates the function of the neurons in a human brain. The neuron MOS transistor is an ordinary MOSFET. (Source: *Electronics Weekly*, 25 March 1993)

Three wireless phone functions on single chip

For wireless communications to become widespread, handset costs must decline. That means increased integration of the transceiver. Qualcomm Inc. of San Diego, California, has introduced an ASIC that combines three chips into one.

Called the Mobile Station Modem application-specific integrated circuit, MSM ASIC for short, the chip performs the transceiver function for a CDMA (code division multiple access) radio using spread spectrum broadcasting techniques.

Packaged in a 1 millimetre-thin quad flat pack, the 20 mm square IC cuts power requirements 50 per cent and allows for a smaller, lighter handset. (Source: *Electronics*, 8 March 1993)

Electric vehicle goes 725 km on one charge

While most electric vehicle (EV) and battery makers consider that a vehicle is doing well if it goes 150 km on a charge, an engineer named Joe LaStella has driven his converted 1992 Geo Metro an astounding 724.5 km without recharging.

The key to the distance record, LaStella explained, is not the car, which is powered by an off-the-shelf dc motor from Advanced DC Motors, Syracuse, New York, but its 340 kg of New Generation batteries.

The batteries were designed by LaStella's company, BAT (Battery Automated Transportation) International Inc. of Salt Lake City. They operate at room temperature, are non-toxic and non-hazardous, and can be recycled.

While not doubting the distance record, some industry experts are unimpressed by it, explaining that it could easily be accounted for through the use of a silver-zinc battery. When LaStella sees fit to disclose what type of battery he used, therefore, the significance of his record to practical EVs can be assessed. (Source: *IEEE Spectrum*, March 1993)

Artificial photosyntnesis

Plants may have the edge when it comes to harnessing solar energy but scientists are not too far behind. Researchers in the US have designed an improved artificial photosynthetic system for converting light into chemical energy.

Prabir Dutta of Ohio State University believes that his work with Marion Borja is a "chemical strategy" for "converting sunlight into fuel". This is comparable to plants where electrical energy produced by photosynthesis is stored and ultimately used to drive chemical reactions.

Plant photosynthesis produces electrons, which are transferred away from the light-absorbing centre. Artificial systems face the problem of preventing charge returning to the donor or light absorbing molecule. Dutta and Borja claim their system effectively quenches this back-reaction. Other advantages over previous

systems include simple design and readily accessible photochemical products.

Dutta and Borja use trisbipyridine ruthenium as the donor and propylviologen sulphonate in solution as the acceptor.

The team believe their system does more than just hinder the back-reaction - it actually promotes charge separation. They believe that charge transfer occurs at the zeolite-viologen solution interface. Photo-excitation produces a negatively charged viologen radical, which is repelled by the anionic zeolite framework, so the charges are separated.

Two hurdles remain before the design may be put to practical use, says Dutta. "Efficiency must be increased" as presently the team reports low product yields, probably because only entrapped ruthenium molecules with direct access to viologen species can take part in the photochemical process. Secondly, the system must be tied in with fuel production, for example converting water into hydrogen. Dutta hopes that his team will have tackled these problems "in the next few years". (Source: *Chemistry & Industry*, 15 March 1993)

Options for hydrogen generation

Growing concern over environmental degradation has spurred the search for a clean and renewable source of energy which could cater to the rising demand for both electricity and a transportation fuel.

Amongst the newer fuels now receiving attention are those based on methanol and hydrogen. Hydrogen is regarded as a very clean fuel and considered more advantageous since it emits no carbon.

The only pollutant in this case would be nitrous oxide present in very small traces, which could be controlled to tolerable limits.

Brazil's experience with methanol as a synthetic fuel has not yielded much success. Methanol is mainly derived from sugarcane which needs a vast area for cultivation.

Hydrogen can be produced in various ways, beginning with the age-old electrolysis process, although passing electric current through water to produce hydrogen on a large scale is not feasible due to the high cost of batteries and maintenance.

But in a country like India where sunshine is available in plenty, solar photovoltaic (PV) power could be used to run the electrolyser for decomposing water into its constituents - hydrogen and oxygen.

Crystalline silicon-based PV panels are expensive at present. With the commissioning of an amorphous silicon (a-Si) cell facility in Haryana recently, a-Si modules are expected to hit the market soon.

The modules, when produced to full capacity, may cost below Rs. 100 per peak watt as compared to Rs. 240 per peak watt payable for the single crystal silicon option.

However, performance reliability of a-Si panels needs to be ensured in the field prior to their use.

Biologists have long been considering powering electrolysers using sunlight, modelled on photosynthesis. The basic process is based on a chlorophyll-containing membrane. Since the natural process is unstable and regenerative, it needed a stable and durable, long-term alternative.

This led Ti Tiens and co-workers at the Membrane Biophysics Department of Michigan University to replace the organic membrane with an inorganic semiconductor made of cheap amorphous or polycrystalline silicon. The Tiens cell combines solid state physics with membrane biophysics to yield a new design modelled after natural systems. These cells are popularly known as semiconductor septum cells (SC-SEP).

Another simple way to obtain hydrogen is through conventional photoelectrochemical cells known familiarly as PEC cells. These cells are in the initial stages of commercial development and are less efficient than the solid state cells.

PEC cells need a liquid electrolyte sandwiched between the cathode and anode. Premier effort in this direction began with the Sturt Litchs group at the University of California, which has produced a 17 per cent efficient laboratory device using cadmium selenide as a semiconducting compound.

Photo-assisted electrolysis known as photolysis is also one of the selectively researched routes of obtaining hydrogen now.

Amongst developed countries, Germany has the most ambitious hydrogen generation project. For example, its Hysolar project in the desert of Saudi Arabia has been operating for the last five years with no problems. It uses a 350 kWp photovoltaic concentrator system employing a PV-powered electrolyser. Fresnel lenses made of plastic concentrate the sunlight onto high efficiency silicon cells. Similarly, many small-scale PV electrolyser systems are installed elsewhere.

Germany is now contemplating setting up big photovoltaic farms in North Africa, from where the hydrogen generated could be piped into Germany via Italy. Germany also plans a $50 million technical feasibility study on this project.

In India, 23 projects under the Department of Non-Conventional Energy Sources (DNES) which focus on techniques of hydrogen production, system design and development, and storage, are in operation at the Indian Institute of Technology and a few university laboratories.

Premier effort in hydrogen generation is reported from Prof. Srivastava's group in the Department of Applied Physics at the Banaras Hindu University (BHU). Here, the use of hydrogen obtained via the photoelectrochemical route has been demonstrated in a motorbike. This motorbike utilizes hydrogen fuel carried in a cylinder fixed on one side of the vehicle. The capacity of this fuel cylinder is being increased to enable the bike to run over 50-miles at one go.

The Indian Institute of Technology (IIT), Delhi, is concentrating on the design and development of an internal combustion (IC) engine operated on hydrogen. In IIT's mechanical engineering department, work on hydrogen-operated diesel generators is on. These generators, used mainly for agricultural applications, are being tested in the field using a trolley-mounted system.

At the IIT, Madras, the focus is on energy-efficient hydrogen engines.

Although there exists good scope for using hydrogen as a replacement for liquid petroleum gas in cooking and in portable electrolysers, use of this fuel in the automobile sector is top priority.

Conventional automobile engines do not need drastic changes to adapt to hydrogen fuel and hydrogen fuel could prevent fossil fuel depletion and environmental degradation. (Source: *Deccan Herald*, 18 January 1993)

DSP chip performs 300 functions a second

GEC-Plessey Semiconductors (GPS) has made a demonstrator digital signal processing (DSP) chip that can perform 300 million multiply and add functions a second. The chip uses a novel technique that was jointly developed in a DTI-funded precompetitive research project by Queen's University, Belfast and the Defence Research Agency at Malvern. It is a pipelined infinite impulse response filter that performs calculations on most significant bits first, thereby gaining maximum benefit from its pipelined architecture. It uses 30,000 logic gates, can operate at clock rates of 30 MHz and can implement 16th order filters. (Source: *Electronics Weekly*, 31 March 1993)

ECL has 21.5 ps gate delay

An emitter-coupled logic (ECL) transistor with gate delay times of 21.5 ps and operating at switching currents of 0.31 mA has been demonstrated by Fujitsu researchers. The speed-up comes from reducing the area of the base layer, and therefore the path electrons must travel, by a factor of four and by reducing the parasitic capacitance - which would otherwise degrade the performance of such a fast device - by 30 per cent. The new transistor depends on what Fujitsu calls polysilicon sidewall base-electrode transistor (POSET) technology. This involves making a polysilicon sandwich between two layers of silicon dioxide, drilling a 0.5-micron hole through the three layers and coating the sidewall with polysilicon to make an external electrode. (Source: *Electronics Weekly*, 31 March 1993)

New process for 1 Gbit DRAMs

Key chip-making technology needed for the production of 1 Gbit DRAM memory chips has been developed in Japan. Ultrafine semiconductor features just 0.2 microns across have been successfully etched using a new photolithographic process developed by Japanese consumer electronics firm Matsushita. Matsushita researchers used an argon fluoride excimer laser to print a pattern with features measuring 0.2 microns or less onto a single layer of photoresist. The 193 nm wavelength laser projects a master mask pattern at a reduction ratio of four. The new photoresist contains a polymer and an acid generator. (Source: *Electronics Weekly*, 31 March 1993)

Ultra-low power satellite broadcasting receiver

An ultra-low power satellite broadcasting receiver has been developed using oxide high-temperature superconductors in Japan. It is an important application of a superconducting thin film with conventional semiconductor devices which achieved a 100-fold cut in power saving in a 12 GHz down converter. Scientists at the Superconductivity Research Laboratory in Tokyo have integrated a Josephson junction, using a YBaCuO superconducting thin film, with a HEMT - high electron mobility transistor - 1 GHz amplifier cooled to below 40°K. (Source: *Electronics Weekly*, 17 March 1993)

Scientists recover clock signals

Researchers at BT have pioneered a new technique for recovering clock signals from high bit rate data streams which uses only optical components. It is part of what BT claims is the first all-optical telephone signal repeater. It uses a mode-locked laser and an erbium fibre cavity to derive a stream of picosecond optical pulses which are synchronized to the input optical data stream. The incoming 1.54-micron pulses are coupled into dispersion shifted fibre, which is part of an erbium fibre ring laser. The non-linear refractive index of the fibre sets up a periodic phase modulation in the cavity, which mode-locks the laser. This generates an optical clock signal of 1.56 micron pulses which is used to synchronize the amplified data signal. The ability to regenerate optically a telephone signal without first needing to convert it into an electrical signal, according to BT, will open the way to 100 Gbit/s data rates in the

public switched telephone network (PSTN). (Source: *Electronics Weekly*, 17 March 1993)

Shallow ion implantation with gas cluster system

A gas cluster system that allows extremely shallow ion implantation down to less than 1 micron has been developed at Kyoto University. These clusters are formed from gases such as argon. Using these gases changes the atomic energy and scatter angle influencing the atoms implanted into the substrate. A gas pressurized to several atmospheres is jetted out of a 0.1 mm diameter nozzle and converted into atoms and molecules, which are then ionized by an electron beam. The beam is further accelerated with a voltage and irradiated against the silicon substrate. This means it is possible to perform shallow implantation of less than 0.1 micron. (Source: *Electronics Weekly*, 17 March 1993)

Single electron cells look beyond 64 Gbit

New electronic devices will be needed within the next 15 years as conventional semiconductor physics starts to run out of steam, according to leading semiconductor experts from Hitachi and Cambridge University.

Chips incorporating technology that can control individual electrons rather than large clouds of particles will be needed as circuit feature sizes shrink towards 10 nm (0.01 microns), according to the researchers who are part of the team that reported the development of a single-electron memory cell.

Beyond that the rules governing conventional semiconductors will break down since quantum mechanical effects will make it impossible for devices to accurately control the very few electrons that are able to run through such small circuitry.

The proportion of inherently uncontrollable electrons in an electron cloud rises dramatically as the cloud shrinks - from a few per cent of a 1,000-strong cloud to 99 per cent of a 10-strong cloud.

There are around 500,000 in a 16 Mbit DRAM memory cell and this will shrink to less than 1,000 in a 16 Gbit DRAM cell, according to Dr. Kazuo Nakazato of the Hitachi Cambridge Laboratory. (Source: *Electronics Weekly*, 24 February 1993)

Neural network chip is "most advanced"

Samples of a second generation, digital, neural network chip - "one of the most advanced ever developed" - were delivered to the Pentagon in February 1993 by two US firms.

The 1,024-neuron processor was built for the Defense Advanced Research Projects Agency (DARPA) by chip maker Intel and neural network pioneer Nestor.

The three million transistor Ni1000 device is aimed at applications such as target recognition, sonar listening, voice recognition and robot-vehicle control, according to Intel.

The Ni1000 has been implemented in digital rather than analog logic and uses a standard microprocessor bus interface. The device is designed to fit onto a plug-in neural accelerator card for personal computers (PCs).

It is capable of neural processing at 20 billion integer operations per second - several hundred times faster than a conventional PC microprocessor running neural software.

The device runs neural software on an on-chip 16-bit microcontroller while a large block of on-chip flash memory is used to record what the chip "learns" through neural processing. (Source: *Electronics Weekly*, 24 February 1993)

Using silicides as a diffusion source

Silicide-as-diffusion-source, or SADS, may turn out to be the best choice for forming ultra-shallow junctions. The technique has been shown to be a viable way to reduce junction depths to 0.1 μm, with a low thermal budget. In the SADS process, the dopant is implanted into a self-aligned silicide and then diffused into the underlying substrate.

The advantages of SADS, according to researchers Qingfeng Wang, Carlton Osburn and Christopher Canovaid of North Carolina State University and the Microelectronics Center of North Carolina, are many. First of all, the ion implantation-induced damage is totally confined within the silicide, which allows the use of lower thermal budget processing which, in turn, minimizes dopant motion, redistribution and evaporation. Secondly, the silicided junction is conformal to the silicide/silicon interface, which reduces the possibility of junction penetration and allows the silicide to be a large fraction of the total junction depth. Finally, higher surface concentrations of dopant can be obtained, as determined by its solid solubility, which results in low contact resistance.

Recently Wang and co-workers fabricated ultra-shallow p^+/n and n^+/p junctions using SADS processing of 45 nm $CoSi_2$ films, with a low thermal budget. The best junctions were made by moderate (10 sec) RTA annealing at 800°C, where the total junction depth,

counting the silicide thickness, is believed to be under 60 nm. (Reprinted with permission from *Semiconductor International Magazine*, January 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

Conductive polymers studied

Thanks to substantial improvements in the stability and processing characteristics of available materials, interest in electrically conductive polymers for microelectronic devices is now on the upswing. Already demonstrated for both field effect transistors (FETs) and light emitting diodes (LEDs), conductive polymers are inexpensive, can be fabricated as thin films over a large area, and have properties that are easily tailored for particular applications. They seem particularly well suited for fabricating FETs for flat panel displays.

The most promising polymers, which are made conductive by reacting them with an oxidizing or reducing agent to create charge carriers, typically fall into one of four categories: polythiophenes, polyarylene vinylenes, polyanilines and polypyrroles.

According to Dr. Howard Saunders, a chemist at Westinghouse Electric (Pittsburgh, Pennsylvania), initial FET work employs a set of metallic contacts deposited on silicon with the conductive polymer deposited on top of the contacts. The main limitation here has been the low carrier mobility of the conductive polymers, although this could possibly be overcome by using a gate insulator with a high dielectric constant.

The advantages of polymers for LED applications are their low cost and low power requirements. The typical LED device structure is a sandwich of a transparent, high work function electrode (such as indium-tin oxide) coated with the conductive polymer, and a low work function electrode (such as Al) deposited on the polymer film. Such devices are reported to have substantial charge injection at fields of 2×10^6 V/cm applied to the polymer film with light output approximately linear with current over quite a wide range. (Reprinted with permission from *Semiconductor International Magazine*, January 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA)

Japanese engineers look at "super-resolution" photolithography

Japanese engineers at Hitachi's Central Research Laboratory (Tokyo, Japan) have looked at a way of getting "super resolution" out of photolithography. This is the work of Hiroshi Fukuda, Ryoko Yamanaka, Tsuneo Terasawa and Shinji Okazaki.

The engineers have come up with a pupil filter for projection lenses. Dubbed FLEX, it is a high-spatial-frequency frequency-enhancing filter with optimized annular illumination. In their work, these engineers also combined FLEX with phase-shift masking, calling the combined method Super-FLEX.

Reportedly, the filter produces a flat, smooth spatial frequency response, which is necessary for mask-pattern fidelity and image uniformity. The practical result is that with FLEX the researchers achieved high-resolution results on non-random patterns to which phase-shift technology is difficult to apply. Where repeating patterns better facilitated the use of phase-shift masking, Super-FLEX extended optical lithography down to 0.2 μm practical resolution, with increased depth of focus.

In their work, the Hitachi researchers also found a relationship between practical resolution and resist performance with various image-enhancing methods that have been introduced recently, including Canon's QUEST, Nikon's SHRINC, annular illumination and FLEX. For example, with four-corner illumination methods, such as QUEST or SHRINC, it is preferable if the resist process has an image contrast > 70 per cent. On the other hand, FLEX works best with a resist that accepts an image contrast of about 60 per cent. (Reprinted with permission from *Semiconductor International Magazine*, February 1993. Copyright 1993 by Cahners Publishing Company, Des Plaines, IL, USA)

GRINM grows largest silicon ingot in China

Engineers at the General Research Institute for Non-Ferrous Metals (GRINM) in Beijing, China, have grown the largest semiconductor grade silicon ingots ever grown in China. The 150 mm ingots were produced using Kayex Corporation's Hamco CG6000 digitally-controlled, fully automatic crystal grower. Elwyn G. Roberts, general manager of Kayex, a Unit of General Signal's Semiconductor Equipment Group said that this achievement by GRINM was significant and represented the Institute's objective and capability of becoming both a domestic and export supplier of silicon wafers. (Reprinted with permission from *Semiconductor International Magazine*, February 1993. Copyright 1993 by Cahners Publishing Company, Des Plaines, IL, USA)

Key found to storing solar power?

Chemical engineers at the Weizmann Institute of Science in Israel are piloting a process they see as being the key to transporting vast quantities of solar power from desert regions to distant industrial areas.

Their "chemical heat pipe" concept makes use of what is believed to be the first methanator specifically designed for solar energy applications. The process converts solar radiation into chemical energy in the form of syngas (CO/H_2).

The energy-rich gas can be stored and sent by pipeline to the point of use. The energy present in the syngas can then be recovered by converting it back to methane. The process releases high-temperature heat, to be utilized as required.

The methane may be returned to the solar plant to be reused for the production of syngas. This completes a closed-loop system that neither uses any fossil fuel nor emits gases to the atmosphere. The process has been demonstrated on a complete cycle at a 10 kW power level. Work has now begun on a "chemical heat pipe" loop of some 450 kW throughput.

The process is being developed jointly with the Canadian Institute for the Energies and Applied Research. (Source: *European Chemical News*, 1 March 1993)

Room temperature FET fabrication demonstrated

Researchers at the Weizmann Institute of Science (Rehovot, Israel) have recently demonstrated a simple room temperature procedure for making a transistor. The technique, in which a high electric field is applied across a homogeneous piece of semiconductor, requires no impurity implantation or heat-curing steps. It was initially applied to the experimental semiconductor material copper indium selenide.

Dr. Konstantin Gartsmann of the Weizmann Institute reported that electric fields were used to break down the uniform space distribution of component ions of the semiconductor, avoiding the need to introduce foreign ions such as through ion implantation. The stable charge distributions formed in the material resemble those obtained with normal doping processes.

Dr. Gartsmann suggested that this previously unknown charge reorganization effect may be due to a combination of ion migration and the formation of physical crystal defects resulting from the transient high currents and high voltages provided by the electric field. Moreover, very localized heating produced by current flow may also contribute to this unusual process. (Reprinted with permission from *Semiconductor International Magazine*, February 1993. Copyright 1993 by Cahners Publishing Company, Des Plaines, IL, USA)

Computers model doped buckytubes

Scientists at North Carolina State University (Raleigh) report using supercomputer simulations to show the feasibility of doping buckytubes - cylindrical variants of C_{60} fullerene molecules - without adversely affecting the molecules' structure. The work suggests the potential of doping buckytubes to alter electronic properties for semiconductor applications. (Source: *Chemical Week*, 3 February 1993)

Liquid crystals switched by light

Researchers at Tokyo Institute of Technology (Yokohama) report using light to rapidly switch liquid crystal films. Normally, the orientation of liquid crystal molecules is switched, using electrical fields to modify optical properties. The Japanese scientists used light to reorient films of ferro-electric liquid crystals that had been doped with a photo-sensitive chemical. The process is reversible and repeatable. (Source: *Chemical Week*, 10 February 1993)

NEC "smallest memory"

Researchers at NEC have developed an electronic memory cell with a surface area of 0.54 square microns, which they claim is the smallest in the world. Built using 0.25-micron design rules, the cell will be used to make 256 Mbit DRAMs.

NEC described the techniques employed to make the cell at the International Electronic Device Meeting in San Francisco in December 1992. A split-level diagonal bit line allows for construction of a two-level bit line, rather than one-level bit lines used in existing memory cells.

For trench isolation, a buried oxide in the shape of an inverted triangle is used. Another technique makes use of a cylindrical capacitor with hemispherical grained silicon to increase the surface area, and therefore the capacitance, of cylindrical capacitors without needing extra space. (Source: *Electronics Weekly*, 13 January 1993)

Million gate CMOS

Mitsubishi Electric has developed a CMOS gate array with a million gates. It operates at 3.3 V and is built on a 0.5 micron process with three layers of metallization.

The combination of low voltage and narrow line widths produces a gate delay of 85 ps. This is one-and-a-half times faster than 5 V arrays and nearly two-and-a-half times faster than 3.3 V arrays made in Mitsubishi's existing 0.8 micron technology.

The M60100 series has three speed power options, the lowest of which has a power dissipation of 0.9 μW/MHz/gate. The arrays will start sampling later this year. (Source: *Electronics Weekly*, 13 January 1993)

CDV grows diamond thin films

Thin diamond films may help improve the lifespan of aircraft sensors and stop fast microprocessors from overheating, according to scientists at engineering giant GEC's Caswell research centre near Towcester.

Caswell researchers have developed a way of growing thin films of diamond about 2 cm across and 20 microns thick by depositing carbon atoms on a substrate using chemical vapour deposition (CVD) techniques.

One application will be to coat optical windows on military aircraft heat sensors - used in night vision and target designation systems. Another possibility may be to carry heat away from hot spots on printed circuit boards.

Another GEC scientist pointed out that the high thermal conductivity of such diamond films allows them to carry heat away from hot spots very efficiently and pointed out that this may find uses on printed circuit boards sporting high-speed microprocessors. (Source: *Electronics Weekly*, 3 February 1993)

Rechargeable lithium battery

Sony has developed a rechargeable lithium battery, which could shrink the size and weight of mobile telephones, camcorders and CD players. The lithium ion rechargeable battery is claimed to have four times the total output energy of current nickel cadmium rechargeable batteries. Its operating voltage is 3.6 V, three times that of NiCd cells, and it is smaller and lighter than equivalent cells, but expected to cost 30 per cent more. (Source: *Electronics Weekly*, 20 January 1993)

2.5 inch 264 Mbyte hard disk drives

NEC Corporation has developed a 2.5 inch hard disk drive (HDD) featuring the world's largest storage capacity of 264 Mbyte and has started distributing samples primarily to domestic computer manufacturers.

Fierce competition is being waged among electronic equipment manufacturers to develop the 2.5 inch HDD, triggered by the ever increasing performances of personal computers. In November 1992, Toshiba introduced a 213 Mbyte version, while Fujitsu Ltd., Victor Company of Japan, Limited and other manufacturers are developing large-capacity versions of 200-250 Mbyte for marketing in early 1993.

The new 2.5 inch HDD was developed by the company jointly with NEC Ibaraki Limited and achieves this large storage capacity due to the introduction of a newly-developed thin-film head and sputtered hard disk enabling high-density recording, and by increasing the density of the disk periphery by introducing a technique called the multi-zone recording technique.

The HDD, which mounts three disks, is 19 mm thick and has a width of 70 mm and depth of 100 mm. The mean access time for reading data is as fast as 12 ms. The company also developed two other versions with storage capacities of about 180 Mbyte and about 90 Mbyte, respectively.

The company plans to mount the new HDD on its own electronic systems and, at the same time, to market the new HDD on an OEM basis to personal computer and workstation manufacturers. Further information available from NEC Corporation, Public Relations Office, 5-7-1, Shiba, Minato-ku, Tokyo 108-01, Japan. (Source: *JETRO*, January 1993)

Experimental 2.5 x 1.6 cm DRAM holds 256 MB

One of the first such devices in the world, an experimental DRAM stores 256 MB, equivalent to 16 million characters or 1,000 newspaper pages, in a 2.5 x 1.6 cm body. Fujitsu Limited developed the device, which is 64 times larger than a 4 MB DRAM. The company intends to release the DRAM commercially in 1996. Using a recently developed technique for producing 0.2 µm lines, the engineers cultivated an extreme level of integration for the chip. The device has the potential to render memory equipment more compact and lightweight than ever before. The company envisions the DRAM in palm-sized, miniature multimedia equipment combining functions for telephones, faxes and personal computers. (Source: *AEU No. 1 / 1993*)

Measurement of brain auditory mechanism using SQUID

Nippon Telegraph and Telephone Corporation (NTT) has used a superconducting quantum interference device (SQUID) to measure the faint cerebral magnetic fields generated when the brain's nerve cells are activated, and confirmed very accurately that the brain processes vowels, language sounds primarily on the floor of the left Sylvian fissure, and pure tones primarily on the floor of the right Sylvian fissure.

The brain's superb information processing mechanism is an ideal model for computers, so it is attracting keen attention in the medical field and even the field of information science. The human brain is an intricate network of innumerable nerve cells which become active when man sees, hears or strives to recognize or understand an object or a phenomenon. When these nerve cells become active, a current flows inside them.

Methods for investigating the brain without inflicting any adverse influence include observing brain waves by measuring the nerve cell currents as a potential difference with an electrode fitted on the head. However, since the measurement is performed through the skull, which is an insulating body, the potential is distorted preventing very accurate observations.

The SQUID is a superhigh-sensitivity magnetic flux meter that utilizes the characteristic of a

tunnel-effect current, flowing between a pair of superconductors sandwiching a thin insulating film, sensitively changing with a magnetic field. By using SQUID and conducting measurements, the conventional belief that the language sounds promoting more elaborate activities than simple sounds are processed by the left hemisphere was confirmed.

NTT observes that this measurement method will help acquire the principles for designing future computer systems modelled after this cranial information processing mechanism, and plans to continue this brain magnetic field measurement approach to elucidate the mechanisms of the brain's information processing activities that are as yet unknown. Further information available from Nippon Telegraph and Telephone Corporation, Press Relations, Public Relations Department, 1-1-6, Uchisaiwai-cho, Chiyoda-ku, Tokyo 100, Japan. (Source: *JETRO*, January 1993)

Liquid crystal response analysis system

Toshiba Corporation has developed an analysis sytem for investigating the high-speed response and other characteristics of liquid crystal materials used in liquid crystal displays (LCDs). Precision analysis has become possible by irradiating an infrared beam on a mixed liquid crystal consisting of over ten kinds of molecules.

The high-speed response and elaborateness of the LCDs used in TV sets are the factors determining the quality of pictures. To expand the temperature range of the liquid crystal used in LCDs, molecules not directly linked to liquid crystal performance are incorporated in the liquid crystal. At present the influence of these extraneous molecules on the LCD response speed and definition cannot be known until the display is actually fabricated.

The new system applies the two-dimensional correlation infrared spectroscopic method to investigate what kinds of molecules display actions similar to other molecules when a mixed liquid crystal is operated by applying it with a voltage.

The company plans to use the new analysis system for developing excellent liquid crystal materials featuring both fast response and clear vision. Further information is available from Toshiba Corporation, Public Communications Office, 1-1-1, Shibaura, Minato-ku, Tokyo 105, Japan. (Source: *JETRO*, January 1993)

Magnetic disk system with vertical recording system

Fujitsu Laboratory Limited has developed a disk and head for a vertical recording system that effectively increases the volume of information stored in magnetic disks.

Commercial recording systems include the horizontal recording system in which the two head magnetic poles create magnetic fields horizontally and the disk surface recording layer is magnetized laterally for information write-in. With this system, the magnetization of adjacent information demagnetizes the other to limit high-density recording, so studies are in progress on the vertical recording system for applying the magnetization vertically.

With the new vertical magnetization system, the disk material and the structure of the head for information storage were improved to enable vertical magnetization applying on the recording layer. A larger ratio of chromium was used in the material comprising the disk surface recording layer to enable recording with ease, while the poles at the head were changed into a single pole assembly to enable magnetic field applying vertically.

In addition, vertical recording is better with the head pole and disk surface closer, so a system was introduced for information storage with the pole and disk surface in contact. To minimize frictional wear, an extremely thin head support spring 8 mm long, 0.5 mm wide and 20 μm thick was used, allowing a recording density of 2 Gbpsi (Gbit/in^2).

As a result, it will be possible to increase the storage capacity to over 10 times compared with conventional systems of the same size. A 1.8 inch disk will store 500 Mbyte of information, equivalent to the contents of one year's newspapers (in character equivalent, 1 day's newspaper content is 1 Mbyte = 15 columns x 86 rows x 13 characters x 2 byte x 30 pages). Further information is available from Fujitsu Limited, Public Relations Department, 1-6-1, Marunouchi, Chiyoda-ku, Tokyo 100, Japan. (Source: *JETRO*, January 1993)

Multiple memory using photochromic compounds

Matsushita Electric Industrial Company, Limited has developed an optical multiple recording medium featuring a recording density that is more than 10 times those of existing systems. It is produced by laminating five types of spiropyran aggregates, which have sharp absorption bands at different wavelengths, and a remarkable high recording density has been attained by using five polarized laser beams. The stored information can be erased by heating the medium and irradiating with a laser beam of separate wavelength, and repeated readout of more 10,000 times is possible.

The newly synthesized spiropyran aggregate is a photochromic substance. It is normally colourless but becomes red when irradiated with a light beam. Using the chromatic change will enable the creation of new optical recording media. The company discovered that

even the same types of spiropyrans react to different wavelengths when bonded to chlorine or sulphur, or when the hydrogen bonding length differs. By actually developing five spiropyran aggregates sensitive to wavelengths of 485-650 nm, a new type of photochromic recording medium was developed. Further information is available from Matsushita Electric Industrial Company, Ltd., International Publicity Group, 1-1-2, Shibakoen, Minato-ku, Tokyo 105, Japan. (Source: *JETRO*, January 1993)

Parallel processing type single-chip fuzzy processor

Oki Electric Industry Company, Ltd. has developed a single-chip fuzzy processor MSM91U112 capable of parallel processing, and has started distributing samples of the processor. The processor features a remarkably fast inference speed of 25 kFLIPS (fuzzy logic inferences per second).

In general, the parallel processing system is identical to the mechanism of the human brain for processing information obtained through the eyes and ears in parallel with numerous brain cells. The new chip has many arithmetic elements made after the brain cells, on a chip for integrated parallel processing. The parallel processing system architecture was established with the cooperation of Kumamoto University. The chip was developed by applying the company's unique CAD technology and 1.2-μm CMOS process technology

Previously the fuzzy chip incorporated software for the fuzzy inference function, but the new chip incorporates the function in the hardware. Therefore, the user simply sets the rules matched to the purpose, and there is no need to use an operating system (OS) or applications software (AS). Therefore, the chip is ideal for use in industrial equipment and information processing requiring high-speed, real-time processing. Further information is available from Oki Electric Industry Company, Ltd., Public Relations Department, 1-7-12, Toranomon, Minato-ku, Tokyo 105, Japan. (Source: *JETRO*, January 1993)

Superlattice device with electron confinement effect

Professor Y. Shiraki of the Research Centre for Advanced Science and Technology of the University of Tokyo and a research team from Hitachi, Limited, have jointly fabricated a superlattice device that can confine (and release) electrons in semiconductors inside a uni-dimensional quantum wire.

The quantum wire is a fine wire with a width of less than 100 nm. The development of devices using the unique behaviours of confined electrons are under research in various countries. Research is in progress to actually create fine passages, but this research project is distinct in that the passage is narrowed electrically. With the new superlattice device, numerous fine GaAs and nickel wires are arranged alternately on a semiconductor laser of single quantum well (SQW) structure using a gallium-arsenide (GaAs) semiconductor as the wafer. The aim is to control the motions of electrons inside the device by a voltage, using the fine nickel wires as the electrodes.

With the semiconductor laser, light is generated by recombining electrons and holes. Quantum wires, the width of which is comparable to the electron wavelength, not only change the energy states of these carriers but also improve the recombination efficiency. Therefore, if the formation of quantum wires can be controlled by applying a voltage, the performances of lasers such as lasing wavelength and efficiency are very much improved.

With the prototype device, the wavelength of light from SQWs is changed by the magnitude of the voltage due to electron and hole confinement, suggesting that the wavelength of the laser beam to be oscillated can be controlled by the applied voltage.

The research team observed that the confinement of electrons inside the fine wire structure improves the laser light generation efficiency, and the electron mobility, so this phenomenon appears applicable to semiconductor lasers and processing devices. Further information from Research Centre for Advanced Science and Technology, The University of Tokyo, 4-6-1, Komaba, Meguro-ku, Tokyo 153, Japan. (Source. *JETRO*, January 1993)

Optical computer

Computer designers have long been dazzled by the lustre of light. For a start, photons (particles of light) move more rapidly than electrons, so optical computers are quick thinkers. They can also think of many different things at once - an ability known as parallel processing that is much in favour in computing circles.

A team at the University of Colorado in Boulder has developed an optical computer that keeps all its information on the move all the time. Its memory comprises 5 kilometres (3 miles) of coiled glass fibre. Pulses of light about 4 metres (12 feet) long race around this spool 50,000 times a second. Each one represents a single bit of information. Precisely timed control beams from other lasers route the pulses from the memory in and out of the computer's processor. This precision is achieved by passing the control signals through shorter fibre-optic loops. Since light always travels at the same speed, synchronizing the pulses is merely a matter of routing them through loops of the right length. But, though the scheme is simple - and familiar to anyone who remembers the delay lines used in old-fashioned electronics - in this incarnation it has a disadvantage. When each bit is 4 metres long, 5 km of fibre gives room for only a meagre 1,024 bits of memory.

The Boulder machine's memory allows it to store and execute a computer program just like a conventional desktop PC - as long as the program is tiny. Conventional processors are built from transistors, each of which can be either on or off, and each of which can influence the actions of those it is connected to. Because photons do not affect each other, though, it is hard to make an optical switch that will do the job of a transistor. As a result, most optical-computer researchers convert photons into electrons for switching purposes.

The Boulder computer is exceptional in this, too, according to Harry Jordan, one of the project's leaders. The machine uses 66 highly modified AT&T switches originally designed for fibre-optic communication systems. The switches are made of lithium niobate, a transparent solid that can change its refractive index - a measure of the material's ability to bend light.

Although the switches are quick, the cables which feed them can provide data only one bit at a time. The optical computers developed by Bell Laboratories and Scotland's Heriot-Watt University use slower switches that depend more on electronics, but have the advantage of not needing to have their signals ferried in and out by fibre. They switch laser beams in free space, allowing them to handle many at a time and thus do work in parallel. (Extracted from *The Economist*, 27 February 1993)

Evolvable hardware

A group of Japanese engineers is letting the electrical hardware of the computer evolve by itself. Tetsuya Higuchi and his colleagues at the Electrotechnical Laboratory in Tsukuba are wiring together a group of chips that alter their own circuitry to adapt to their environment. In this electronic world, the equivalent of a chromosome is a sequence of ones and zeros known as a bit string. Each bit string defines the configuration of the electrical connections within a chip by holding some switches open and some closed, thus changing its architecture. The chips are tested to see how successfully they perform a certain task, such as moving a robot's arms. The "chromosomes" of the more successful chips reproduce more frequently in the next generation and are thus allowed to reconfigure more chips. Except for brief test periods, the robot arms move according to the instructions of the preponderant chip. Random mutations and the exchange of sections between bit strings - electronic sex - help to ensure that the population does not become too inbred.

Because the final result is a chip wired in the best way, the approach should be much faster than working out the best software solution to a problem, and running it on an all-purpose chip. Also, the design should tolerate the sort of small faults that sometimes develop in hardware, since the chips would be continuously rewiring themselves to improve their performance.

To pack so much circuitry together will require the latest in integration technology. But as chip circuitry becomes ever more minute, the large amount of hardware needed to play this electronic version of survival of the fittest may be more than compensated for by increased versatility. (Extracted from *The Economist*, 13 February 1993)

Pulsed laser deposition technology

The Los Alamos National Laboratory and Neocera, a Maryland-based start-up, have developed a novel pulsed-laser deposition system that is currently being used to coat superconducting thin films on to crystalline sapphire-based wafers for devices used in microwave communications.

However, the technology is eventually expected to be used in the construction of memory chips, transducers for optical fibres, smart sensors and superconducting wires.

Thin films deposited by pulsed laser deposition need no additional processing and the superconducting material grows in a crystalline form of very high quality.

Previously the only way to deposit superconducting material on to wafers involved evaporation, sputtering and chemical vapour deposition.

The first devices produced using the new technique were made on 2 inch sapphire wafers because of the demand for such wafers in military and satellite microwave devices.

Although sapphire and the superconducting material do not bond well, the laser system can be used to deposit a special metal oxide buffer layer that has been proven compatible with sapphire. (Extracted from *Electronics Weekly*, 20 January 1993)

Russians have new superconductors

Scientists at Moscow State University report novel superconductors made of mercury-barium copper oxide that are superconducting up to 94 K. The researchers say the compounds are potentially easier to make than existing superconductors, such as thallium-based materials. The new compounds contain only a single layer of metal oxide separating the superconducting copper-oxide planes. The smaller separation, compared with thallium compounds, could mean improved current-carrying capacity in a magnetic field. (Source: *Chemical Week*, 24 March 1993)

Logic could oust DRAM

Logic chips could replace DRAMs as the industry's basic technology driver as it begins to look possible that microprocessors will be made on 0.35 micron processes before 64 Mbit DRAMs, says a new report from Dataquest.

Leading edge process technology is first introduced to production with a DRAM and is adopted by logic sometime later.

Dataquest has been looking at the plans of AMD and Hewlett Packard to have a 0.35-micron logic process in production by 1995 and comments: "If AMD is able to transfer their 0.35-micron logic process to production in 1995 as stated, it could beat the 64 M DRAM to production". (Source: *Electronics Weekly*, 10 February 1993)

A model polymer

The problem with computer-aided design of engineering components is that however good the software, you have still only got a picture on a computer screen. A recent technique, called light moulding, solves that problem - the computer "slices up" the three-dimensional model in its memory, and the image of each slice is projected, using a scanning laser or through a mask, onto the surface of a bath of a liquid polymer, which hardens when illuminated. The top 4 mm of the liquid are solidified and lowered into the polymer, then the next slice is projected onto that one, and so on until the entire model has been formed. Any excess polymer is then discarded.

The polymers used in this technique, however, are far from perfect. They tend to be very brittle, which limits the size of the model that can be made, and many of the monomers used are toxic. Robert Pfeiffer of Du Pont has now developed a non-toxic, flexible photohardenable polymer. It is based on a mixture of a polyurethane oligomer, containing two acrylate- or methacrylate-functionalized units and a polyglycol ester with the formula $H_2C{=}CH(=CH\text{-}C(O)\text{-}O\text{-})C(O)\text{-}O(CH_2\text{-}CH_2\text{-}O)_4\text{-}(OC)HC{=}CH_2$. The mixture contains a photoinitiator - a compound that forms free radicals when hit by light - and fuses together after irradiation into a "clear, tough three-dimensional object" which has none of the disadvantages of the previous polymers. *European patent application 0525578.* (Source: *Chemistry & Industry*, 15 February 1993)

Light-powered computers

For years, computer researchers have been chasing the elusive goal of a computer powered by light instead of electricity. By avoiding the electrical bottlenecks in a conventional silicon-chip machine, such an all-optical computer could bring a giant leap in speed and performance. Two years ago, researchers in the USA built an optical-processing unit capable of doing simple calculations. Now, engineers at the University of Colorado at Boulder have taken another big step: constructing the first general-purpose optical computer.

The machine uses an array of lasers and devices that perform computer logic by switching light beams from one path to another. But the real breakthrough in this device is said to be its optical storage. Its predecessor was not a fully optical computer because it relied on electronics for memory. In the new computer architecture, data and computer instructions are stored as light pulses that continually zip through loops of optical fibres. The machine can be programmed for simple multiplication and division, but the researchers envisage its first use as a high-speed switching system for telecommunications networks. (Source: *Business Week*, 1 February 1993)

BPSG film low-temperature reflow technology developed

The Matsushita Electric Industrial Semiconductor Research Center has developed a new low-temperature reflow technology based on improved hydrophobia in BPSG (boro-phosphosilicate glass) surface films.

One effective way to lower reflow temperature is to increase the concentration of B and P in the BPSG film, but this causes deposition of foreign matter. Matsushita analysed the foreign matter with secondary ion mass spectroscopy (SIMS), and identified the principal component as $B(OH)_3$, H_3PO_4. In addition, the amount of the material deposited increases with exposure to air, and therefore is a key factor in increasing BPSG film water absorption.

Based on these results, they modified the BPSG surface characteristics from hyrophilic to hydrophobic, and developed a low-temperature BPSG film reflow technology with low foreign matter deposition.

The new technology makes possible low-temperature reflow, with foreign matter deposition cut to about 1/50th even in 850°C heat processing. Matsushita has developed a three-dimensional simulation technology that can predict surface step shape with high precision based on B and P concentrations in the BPSG and the reflow temperature, and applies it to optimize B and P concentrations in use.

The lower process temperatures possible with this technology also make possible the formation of shallow junctions such as sources and drains. (Reprinted with permission from *Semiconductor International Magazine*, March 1993. Copyright 1993 by Cahners Publishing Company, Des Plaines, IL, USA)

AND flash memory cell developed

Hitachi Ltd. has developed a new AND flash memory cell that makes it possible to combine low voltage, high speed and high integration levels. The cell uses the tunnel write method and a contactless array structure, which achieves a flash memory cell area as small as 1.28 μm^2. Write is possible in small block units to support low-voltage, high-speed operation.

Up until now flash memory has used NOR and NAND write methods. With NOR the read speed is a fairly fast 100 ns and write in small block units was possible, but because the hot electron effect was used for write both 3.3 V and 12 V supplies were needed. NAND, on the other hand, supports higher integration levels than NOR because of its smaller cell size, and also has a single (5 V) supply for lower voltage, but write blocks are large and read speed low. For applications like replacement of HDD, low voltage, high speed and small write block size are needed, which made NOR and NAND inappropriate.

The new Hitachi AND cell combines the advantage of both of the other two. Cells are arrayed in parallel like NOR for high-speed, small block write, but embedded diffusion layers with ~100 cells apiece have cut the number of contact holes by 99 per cent. When used with a 0.4 µm process, the cell footprint is dramatically reduced. Injection and discharge of electrons at the floating gates uses low-current tunnel write, reducing the current to 1/500,000 of the 500 µA/gate used in NOR. An internal voltage rise circuit allows operation with a single 3.3 V supply. Because cell data is defined opposite that of NOR, low-voltage read is also possible.

Hitachi plans to use the technology from their 64 Mb flash memory and develop NOR cells for chips through 16 Mb. (Reprinted with permission from *Semiconductor International Magazine*, March 1993. Copyright 1993 by Cahners Publishing Company, Des Plaines, IL, USA)

A strong see-through magnetic material

A new transparent magnetic material has been developed at Xerox Corporation's Webster Research Center in Webster, New York. Now available as a solid, a water-based liquid, and in film form, its potential applications include colour imaging and printing, digital information storage, magnetic refrigeration, leak-free sealing, mechanical-oscillation damping, sensors and magneto-optical devices.

According to the developer, senior research scientist Ronald F. Ziolo, all the forms of the material are based on crystals of gamma ferric oxide (Fe_2O_3), which have been used for decades as the magnetic coating for audio and video recording tapes. But the crystals take on greater transparency and different magnetic properties in the new material because they are only 2-10 nm across - at least an order of magnitude smaller than the crystals now in use.

To be sure, transparent magnets have been known for years. But in its densest form, each gram of Ziolo's new ferric oxide nanocomposite has a magnetic saturation (the value to which the material can be magnetized in a magnetic field) 15 times greater than that of the next strongest but very transparent material, iron borate. At room temperature, one gram of the new nanocomposite has a magnetic saturation of 50 electromagnet units, or about one quarter the magnetic saturation of one gram of pure iron. But at ordinary temperatures this material is not a magnet outside a magnetic field, Ziolo pointed out. That is because the nanocrystals of ferric oxide have magnetic properties different from those of bulk ferric oxide. Because of the nanocrystals' small size, the ferric oxide is no longer ferrimagnetic: that is, the crystals cannot be permanently magnetized. Instead, the nanocrystals have become superparamagnetic, in which state they will be magnetic only in the presence of a magnetic field, adhering strongly to a magnet but not to one another after removal of the magnet.

That superparamagnetic property might be useful in magnetic refrigeration and in the toner for copying machines, Ziolo said. (Source: *IEEE Spectrum*, April 1993)

Parallel, circular beam shines from solid-state laser

Semiconductor lasers to date have produced a beam that is elliptical in cross section and diverges by about 30 degrees. But the beam of a redesigned semiconductor laser is nearly cylindrical, and diverges by less than half a degree. Optical-fibre communications and optical memories both stand to benefit: the narrower and the more circularly symmetric the beam is, the more light can be coupled into the core of an optical fibre or the smaller the spot it can write.

The team that designed the laser and demonstrated it last year included groups from three institutions, all in New York State. Dennis G. Hall and his colleagues at the University of Rochester's Institute of Optics directed collaborators from IBM Corporation's Thomas J. Watson Research Center in Yorktown Heights and Cornell University's National Nanofabrication Facility in Ithaca.

In the new laser, the optical cavity is two-dimensional instead of one-dimensional. The resonator is defined not by mirrors at opposite ends of a long

optical cavity, but by a concentric-circle grating on top of the upper cladding layer. The gratings, with the circles just 0.25 μm apart, are defined on masks by electron-beam lithography, and then transferred to the semiconductor by chemically assisted ion-beam etching.

In the active layer below the grating, light propagates as circular waves outward from the centre rather as the water in a pond ripples outward from the plop of a stone. The circular etchings that define the grating reflect the radially outward-going circular wave to produce a radially inward-going circular wave, and vice versa. With each expansion and contraction, there is gain.

In addition, the new device is a surface-emitting laser instead of an edge-emitting laser: the light shines through the circular grating from a broad area on the top of the structure parallel to the active layer (instead of out of one edge of the active layer). The grating collimates the beam so that it is circular in cross section and has 1/60 the divergence of a traditional edge-emitting laser.

The group is working on developing practical techniques of making the gratings more precisely circular with constant line widths, and on ways to pump them electrically, as would be necessary for a commercial device. (Source: *IEEE Spectrum*, April 1993)

New method to make computer chips

Cornell University (Ithaca, New York) and IBM scientists have developed a base-catalysed method for making computer chips that they say is less vulnerable to contamination than the conventional chemical amplification process. Computer chip makers have increasingly used acid-catalysed technology - developed in the 1980s - to amplify the image on a polymer photoresist, but the Cornell/IBM group says its technique is the first base-catalysed chemical amplification process. (Source: *Chemical Week*, 7 April 1993)

Alkali metals make super-buckyballs

By adding alkali metals, researchers at AT&T Bell Laboratories (Murray Hill, New Jersey) have been able to turn carbon-cage buckminsterfullerenes - buckyballs - into superconductors with higher transition temperatures. The researchers produced a new superconductor with the formula $(NH_3)_4Na_2CsC_{60}$ that switches from insulator to conductor at 29.6 K, nearly three times higher than the ordinary buckyball. (Source: *Chemical Week*, 7 April 1993)

New technique heralds nanoelectronic chip devices

The Age of Nanoelectronics - when the features on chips are measured in billionths of a metre rather than today's millionths - has been brought a little closer by Georgia Institute of Technology.

An electron-assisted etching technique which allows the fabrication of nanometre-scale chip devices without causing surface damage was announced in March 1993.

The technique uses low-energy electronics (10-500 eV) in combination with reactive hydrogen gas (H_2) to cut the required electronic features through the patterning process.

Because the electronics are lighter and carry less energy, the electron-assisted technique does not produce the same types of damage to the semiconductor surface.

By guiding the beams through masks the team has been able to successfully transfer the patterns to a silicon substrate. (Extracted from *Electronics Weekly*, 21 April 1993)

Superconducting brainwave gives researchers some food for thought

Brain scanning research in Japan has indicated for the first time the possibility of "reading" human thought before it is articulated into speech.

The ability to interpret what is becoming known as "silent speech" is not restricted to high-tech researchers. Fujitsu Laboratories and the Research Institute for Electronic Science of Hokkaido University have jointly reported the first step towards "silent speech" recognition by isolating the brain wave changes associated with communication even without speech.

The term "silent speech" is used to distinguish mental states, which are the precursor to actual speech from idle thoughts. The Japanese group is the first to record this brain activity by measuring small changes in electrical potential around the skull.

The experiment consisted of measuring the brain wave distribution of subjects thinking the sound of the vowel "a" in response to optical triggers. The subject had to be kept artificially motionless during the tests because any voluntary activity such as head movement or swallowing would have created brain activities which swamp the silent speech patterns.

Eight subjects were tested up to 100 times and results have identified a potential change of 1 μV at the back of the head 0.3 s after the subject was shown the optical trigger. At 0.42 s the brain activity shown by potential changes moved to the front of the head. As the frontal lobe of the brain is the action centre this was interpreted as the progress from thought into the action of speech.

Research has not progressed to the level of discriminating between the vowels "a" and "i", or to understanding the meaning of the words thought in the mind.

The first phase of this research utilized standard neurological measurement methods consisting of 12 electrodes mounted on the head.

The next phase will be to use high accuracy brain scanning technology known as the superconducting quantum interference device (SQUID). The SQUID will make it possible to have more accurate readings of exact brainwave location. Unlike the electrodes, the SQUID does not require direct contact with the head. (Extracted from *Electronics Weekly*, 21 April 1993)

Planar displays double substrate technique

A novel double-substrate technique that overlaps blue, red and green phosphors enabling full colour displays to be made more simply has been developed by Planar Systems, the Finnish/American display maker.

Electroluminescent (EL) display works by applying a voltage across a phosphor compound that emits light when excited. The advantage of electroluminescent technology is that it produces good quality flat screen displays with high contrast and wide viewing angles. A disadvantage is that full-colour screens are not yet commercially available because of the difficulty in making white or blue phosphors.

The experimental full-colour display uses three phosphors - red, green and blue - with the blue phosphor attached to a glass substrate overlapping the red and green phosphors fixed to a second lower substrate. The blue phosphor is made from an alkaline thiogallate compound.

Planar's president James Hurd hopes to be sampling products by the end of the year. The advantage of the overlap technique, he says, is that the geometries of the phosphors need only be shrunk by a half to move from monochrome to full-colour displays.

Placing the three phosphors side by side would require the geometries to be shrunk by one third to produce colour displays with similar resolution to monochrome ones.

Another way to produce full-colour displays would be to filter the light emitted from a white phosphor. However, using blue filters dissipates a lot of power because of the brightness needed to shine light through them. (Source: *Electronics Weekly*, 12 May 1993)

III. MARKET TRENDS AND COMPANY NEWS

Market trends

Highlights of 1992

Some of the 1992 highlights in the major fields covered by the IEEE are as follows:

In personal computers, the subnotebook variety, which weigh less than a kilogram, spurred several developments in peripherals, notably a credit-card-sized hard disk drive. But most observers agree that pen-based computers may take longer than at first expected to become useful products.

Meanwhile, some of the key software companies have been weakened by a lacklustre global economy. The industry has also seen an extraordinary shift from minicomputers and mainframes to PCs and workstations, as well as an expansion of outsourcing software groups. The developers of operating systems competed fiercely, with no clear winner among Windows, OS/2, and all the Unix siblings.

The market in large computers has been disrupted not only by technological progress, but also by the recent recession coupled with the move towards so-called open systems based on industry-standard operating systems and a greater interest in parallel processing. The result: downsizing. Mainframes are giving way to networks of personal computers served by a mid-range computer, while workstation clusters are substituting for supercomputers.

In telecommunications, 1992 may be remembered as the year when desktop and portable computers, telephones, facsimile machines, cable television, CD ROM, audio receivers, and other devices in the office and home could all be connected globally - both through wires and radio links - not just through prototypes and technology trials, but in commercial systems. And a dark horse is shaping up as a player in the provision of merged phone, data and multimedia services: cable television.

Data communications made strides towards high-speed data highways with the establishment of the ATM Forum (an association of more than 150 world-wide organizations involved in asynchronous transfer mode switching).

In solid state, one of the biggest technology drivers last year was a demand for new devices in notebook/palmtop computers. The need of those devices for high integration and low power has accelerated the

production of 3.3-V products by almost every manufacturer of digital semiconductors. Multimedia is one of the fastest-growing mixed-signal applications, and it went consumer this year with the introduction of low-cost, dedicated ICs.

In test and measurement, software-controlled instrumentation has taken hold, with the VXIbus becoming one of the main standards. National Instruments Corp.'s LabVIEW, designed for the Apple Macintosh, last year also came out for PC-DOS users as LabVIEW for Windows, giving users of PC- and VXI-based instruments elegant software for setting up and controlling instrument systems.

In spite of a generally stagnant global economy, there were notable advances in industrial electronics. They included improved precision in computer numerical control (CNC) for machine tools; easier, high-level programming for programmable logic controllers; faster and more efficient machine vision; X-ray laminography tailored to surface-mounted boards; and more powerful power electronics devices.

Two of last year's signal developments in power and energy were unconnected policy developments: the passage of comprehensive energy legislation by the U.S. Congress and the Earth Summit meeting on global warming held in Rio de Janeiro last July. Those events, plus other factors, point to the 1990s as a time when the emphasis will be on keeping customer loads as low as possible through efficient products.

The birth of new consumer electronic products has been sparked by technical innovations and regulatory actions. In the United States, the Federal Communications Commission outlined a broad regulatory framework for the US transition to HDTV. World-wide, broadcasters are preparing for digital audio broadcasting from terrestrial and satellite transmitters, with radio reception approaching the quality of compact audio discs.

Environmental concerns and growing congestion continued to push the transportation industry towards cleaner transit systems moving more passengers, and towards better communications and guidance. In other industry news, the United States is catching up with Europe with new laws requiring access to public places for the handicapped; the electric car market has been rejuvenated; and a magnetic levitation train will be under construction this year in the United States. A submarine with magnetohydrodynamic drive was also tested.

In medical electronics, new implantable defibrillators emerged for people at risk of possibly fatal heart rhythms; ophthalmic lasers were used to correct vision by reshaping the eye; and, at long last, biosensors, devices that marry biological materials with electronics to monitor a body's state, became commercially available.

In the specialities, multimedia confronts the need for storage ample enough to handle full-motion television images; magnetic materials and technologies may meet that need with increased storage density and signal-to-noise ratio; and engineering education is going from good to better through interdisciplinary approaches.

Meanwhile, the New Technology Directions Committee of the IEEE's Technical Activities Board (TAB) has begun to produce an annual *Portfolio of Emerging Technologies*, to help the technical societies, the standards community, and individual engineers. (Source: *IEEE Spectrum*, January 1993)

Windows will dominate software sales in 1993

According to Bill Hicks, vice president of software research at Info-Corp. in Santa Clara, California, over half of all applications software shipped for 32-bit PCs this year will be Windows-based.

Microsoft controls 50 per cent of the Windows applications market because it had software ahead of competitors.

Microsoft Word and Excel programs represent the largest selling Windows applications.

Beyond the battle for operating system supremacy on the desktop is another battle shaping up for the enterprise operating system. Previously, as companies migrated from mainframes to client server computing, they bought Unix-base hardware systems.

With the emergence of Windows NT, Hicks says, there will be a battle for what operating system will run the enterprise applications. Unix has its foot in the door, but Microsoft NT, slated for release this year, promises to challenge Unix. (Extracted from *Electronics*, 11 January 1993)

RF-ID: A new market poised for explosive growth

Though the new radio-frequency identification (RF-ID) market is in its infancy, semiconductor and system vendors are bracing for explosive growth over the next several years.

Representatives at Hughes Aircraft Co. in Los Angeles predict that the market will grow at 22 per cent per year over the next few years.

AIM, the Automation Identity Systems Manufacturers and Suppliers Association, sets the West European market for all identification systems (including barcode-based systems) at about US$ 2 billion in 1990.

Of that, RF-based systems had roughly $100 million (which includes nearly $21 million for Germany alone) in 1990.

Nevertheless, RF systems are growing faster than the average. Holger Franksen, at Siemens' Automation Group in Nuremberg, Germany, figures that West Europe's RF systems market grew to $125 million in 1992. In Germany alone, sales reached $31 million last year, he estimates.

If all applications for RF-IDs were taken up, the total market today would be worth more than $6 billion, asserts Noel Middleton, European business manager for TIRIS, at Bedford, U.K. (Extracted from *Electronics*, 8 February 1993)

New directions in DRAM technology

If the presentations at the recent International Electron Devices Meeting (IEDM) (held in December 1992 in San Francisco) are any indication, the future of 256 Mb DRAM technology and beyond will focus primarily on new capacitor cell materials and designs, and new isolation technologies.

Table 1 illustrates the evolution of DRAM technology from 1 Mb to 4 Gb, showing how the cell area is being squeezed dramatically: minimum feature size decreases from 1 µm to 0.12 µm while cell area decreases from 30 μm^2 to 0.1 μm^2. This leaves DRAM device designers only two options: increase the storage capacity of the capacitor by using materials with higher dielectric constants, or maintain the existing size of the capacitor by extending it three dimensionally (i.e., stacked or trench capacitors) or by increasing the surface area.

Perhaps one of the most interesting ways to extend capacitor storage area is to fabricate a "hemispherical-grained" electrode, which has a rough surface and correspondingly increased surface area. At IEDM, researchers from NEC reported on a new cylindrical capacitor using hemispherical grained (HSG) silicon that achieves a capacitance of 30 fF in a 0.72 μm^2 cell area. The device was fabricated with a seeding technique, where the surfaces of cylindrical electrodes were covered with HSG-Si. The cylindrical capacitors were formed with a vapour HF selective etching technique.

In another approach, reported by researchers from Micron Semiconductor (Boise, Idaho), Lam Research Corp. (Fremont, California) and the University of Texas (Austin, Texas), HSG silicon was combined with Ta_2O_5, a high-dielectric constant material, to achieve a capacitance of (20.4 $fF/\mu m^2$). Here, planar capacitor with polysilicon bottom electrodes, Ta_2O_5 dielectric materials and TiN top electrodes were fabricated on 150 mm silicon wafers covered with a 200 nm-thick SiO_2 layer, in the following sequence:

- The bottom 100 nm-thick poly-Si electrode was deposited by LPCVD at 625°C to produce smooth structures;

Table 1. DRAM trends

Density (bite)	Minimum feature (µm)	Cell area (μm^2)	Capacitor structure	Dielectric
1 M	1.00	30.0	Planar	ON, ONO
4 M	0.80	10.0	STC Trench	ON ONO
16 M	0.50	3.6	STC Trench	ON ONO
64 M	0.35	1.3	STC Rugged STC Trench	ON, Ta_2O_5 ON ONO
256 M	0.25	0.5	Rugged STC	Ta_2O_5
1 G	0.18	0.2	Planar	High ϵ
4 G	0.12	0.1	STC	High ϵ

- The samples were then PH_3-doped and treated by rapid thermal nitridation in NH_3 at 950°C for 30 seconds;

- 10 and 15 nm films were then deposited at 400 or 450°C, using $Ta(OC_2H_5)_5$ and O_2;

- The films were then annealed, followed by the deposition of the capacitor's top plate.

Work along the same lines was presented by researchers from Matsushita Electronics Corp. (Osaka, Japan), who used a high-dielectric constant film of $Ba_{1-x}Sr_xTiO_3$ (BST) to achieve a capacitance of 32 $fF/\mu m^2$. The BST film was deposited by metal-organic deposition, using a newly developed alcohol-based precursor liquid.

Another, and perhaps most novel way of increasing capacitor size, is to bury the capacitor under the silicon layer in a silicon-on-insulator (SOI) substrate. This approach was presented at IEDM by researchers from Sony Corp. The advantage here is that since the cell capacitor is completely buried under the thin silicon layer, it can possess both large area and depth, providing high capacitances. Moreover, the buried capacitor cell needs no extra layout area except that for bit-line and word-line on the silicon surface. Sony researchers predict that, using a 4 nm ONO insulator film, this approach could be used to achieve a capacitance of 25 fF for 1 Gb DRAMs, with an estimated cell size of $0.18\mu m^2$.

Two new isolation schemes for 256 Mb DRAMS were also presented at IEDM: researchers from Matsushita discussed a poly-buffer recessed LOCOS (local oxidation of silicon) process, and NEC researchers reported a new trench-isolation technology.

The main concern of most new isolation technologies is to reduce the encroachment of the so-called "bird's beak". The Matsushita research represents the latest in a long list of variations on the traditional LOCOS technique (e.g., SWAMI, poly-buffer LOCOS) and reportedly suppresses bird's beak encroachment to about $0.15\mu m$ in a $0.72\mu m^2$ cell.

The trench isolation scheme presented by NEC is designed to coexist with LOCOS, and is said to avoid the traditional problems of trench isolation. According to NEC researchers, the two major problems with trench isolation have been its complicated fabrication process and an inverse narrow channel effect. The new trench isolation, called nabla-shaped (an upside-down delta), is formed by SiO_2 fill-in of a tapered trench, followed by etchback, and is said to overcome these problems.

Silicones and acrylics markets continue to grow

The sales of adhesives and sealants to the electronics industry remain a leading high-value market for US manufacturers, with annual growth projections in the 5 per cent and range for the foreseeable future. The drop in military budgets has meant that some producers must shift emphasis to the commercial market, but it does not appear to have created an overall downturn.

At the same time the marketplace is highly competitive, with epoxies maintaining a commanding position and makers of rival polymers such as silicones and acrylics claiming new advances. Consulting firm Strategic Analysis (SA, Reading, PA) says adhesives sales to the electronics market grew more than 9 per cent to $235 million/year in 1992. In the bellwether sector of die attach adhesives, used to hold integrated circuits and other types of chips in packages, 1992 sales reached $40 million, and SA predicts 5-6 per cent annual growth during the next 10 years, representing about 40 per cent of the world market for electronics adhesives. Some attribute the high growth rate to manufacturers placing more functions on the dies, making them larger. This requires more adhesive to anchor the dies in the packaging. Also the number of packages being made is increasing.

With the higher workload put on the attachments, the issue of how the adhesive materials handle stress has become more important. Epoxies have been able to meet the challenge and are the preferred material, but vendors of silicone-based adhesives say that their more flexible product may make inroads. Besides being less rigid, silicones are resistant to high heat and ozone. The heat factor has become less important as manufacturers have developed lower-heat processes. Epoxy supporters say the real issue is resisting heat changes. (Extracted from *Chemical Week*, 10 March 1993)

IBM/DEC enter memory subsystem market

Change is sweeping through the "mass storage" computer memory business. IBM and DEC have decided to enter the huge market for high capacity computer memory subsystems - mostly disc drives and tape back-up - dominated by names such as Conner, Seagate, Sony and Exabyte.

They are attacking a market worth in excess of $26.4 billion a year world-wide, according to US market research group InfoCorp, and following the lead set seven years ago by Hewlett-Packard (HP).

The big US computer makers are now selling mass storage products - ranging from the traditional tape back-up and disk drives to new devices based on emerging technologies such as optics, digital audio tape and flash chips. They are selling them to all comers, especially original equipment manufacturers (OEM) - that is, rival computer makers. Some 60 per cent of HP's $4 billion-odd mass storage business is now done with non-HP OEM customers.

In just two years DEC has grown its OEM sales from scratch to over $600 million a year, while the annual OEM business of IBM's Adstar offshoot, formed in 1992 from its mass storage interests, now stands in excess of $442 million.

These are just a fraction of their internal business, but both companies plan to grow OEM sales dramatically.

Already, HP and DEC have shown that they are prepared to buy their way into mass storage technology and manufacturing. Last year, HP bought a US tape back-up firm called Colorado Memory Systems while DEC has bought a majority stake in a hard disk technology specialist called Rock Mountain Magnetics.

DEC and IBM are reviewing their European manufacturing operations with a view to closing excess capacity. Conner and Seagate may come under pressure to trim capacity if new competition hits sales.

DEC and IBM are being forced to rethink their operations as part of deep company-wide restructuring programmes, while HP took a deliberate decision to exploit its computer memory technology with the emergence of "open systems" standards in the mid-1980s.

HP is clearly leading the way among the big computer firms. It is not at all clear that IBM and DEC have taken all the steps necessary to truly liberate their mass storage businesses.

While these firms come to terms with the prospect of selling to rival OEMs, Japan's Sony is already preparing to meet what it sees as the latest trend in mass storage - selling direct to computer users.

If Sony is right, then mass storage products will become commodity consumer items, bought and sold over the telephone just like printers and personal computers. (Source: *Electronics Weekly*, 25 March 1993)

Telecom trends

Thirty-five years ago computers took up the size of a room - often they *were* the room - and could take days to process calculations on data. Move 35 years on from today and the technological leap will be vast. Three-dimensional television, human-like robots and automatic language translation on the telephone will all be in everyday use.

This, at least, is the verdict of a team of professional futurologists. We will have to wait until the next century before we can judge their accuracy.

Guessing the future has always been a popular pastime, from the early astronomers to writers of science fiction. However, for companies intimately affected by technological change it is essential to keep a watchful eye on what is on the way. Failure to anticipate a trend may result in financial collapse. Getting it right can lead to spectacular success.

Virtually all today's new developments in computer technology use telecommunications in one way or another. The possibilities range from using a network of personal computers for video conferencing to linking hand-held computers around the world by satellite.

Every technological development which uses a telephone line represents the possibility of extra revenue for BT, AT&T, DBT and their rival telecommunications utilities. It makes predicting the future a serious business. BT employs a team of 300 professional pundits to evaluate the direction of emerging technologies. It houses this Systems Research Division in a number of anonymous buildings in a former US air base in Suffolk, on England's east coast.

The research site at Martlesham Heath, near Ipswich, is probably Europe's largest telecommunications research centre.

One of the tasks of BT's futurologists is to explore what use people will make of coming inventions. Their job is to look 10 to 15 years ahead to understand what will happen in emerging technology. Part of that work includes looking even further ahead, to draw up a "technology calendar" of future innovations.

Considering the near future, they predict that by 1997 large wall-mounted televisions will start to appear and be in widespread use five years later.

Wristwatch-sized telephones will be available for specialists by the end of the decade and be a frequent sight by 2005. By 2015 the first three-dimensional televisions watchable without special glasses will go on the market. By the 2020s we will be able to watch them with prototype artificial eyes. Exploring how all this new technology will affect the way we behave and communicate is the practical side of the job. (Extracted from *The European*, 18-21 March 1993)

Hardware glut sends warning to PC market

Despite record chip demand fuelled by the world-wide boom in PC sales, there are warning signs that PC sales growth will falter. These include a glut of hardware components for PC systems and predictions that market growth will not be as high as last year.

The slowdown in PC markets could have a serious knock-on effect that could hurt all types of component suppliers plus PC manufacturers themselves.

Market research firm InfoCorp says that the high demand for PC products seen in the second half of last

year will not be seen this year. The big increase in PC sales in the second half of last year was due to major price cuts, a scenario unlikely to be repeated this year.

So far, PC sales appear to be riding on the coat-tails of last year's boom with shortages of many PC models reported by top PC manufacturers. But there are other signs of potential trouble ahead. Disk drive manufacturers say that there is an oversupply of disk drives and not enough PCs to put them in. This is resulting in job cuts and production cuts as disk drive manufacturers attempt to synchronize supply and demand.

There is also an abundance of cheap 486 microprocessors on the US grey market with no clear indication where they have come from. A possible sign that 486 systems sales, the largest PC segment, are slowing down. (Source: *Electronics Weekly*, 21 April 1993)

Company news

Hefty funding for projection X-ray

California Jamar (San Diego, California) has entered into a cooperative research and development agreement (CRADA) with the Department of Energy's Lawrence Livermore National Laboratory. This project will use Jamar's advanced laser technology in support of the development of soft X-ray projection lithography. Intel Corp. and Ultratech Stepper are also participating in the programme.

The project is Lawrence Livermore's biggest collaboration with private industry. Half of the funding will come from the US Department of Energy and half from the participating companies. Experts see this agreement as one of the first US attempts at using so-called soft X-rays for advanced lithography; some foresee this technique being used in the production of 0.05µm circuitry by the year 2000. Lithography experts believe that the dollar amount of this project labels it as a very significant agreement promoting commercialization of the US Energy Department's research. (Reprinted with permission from *Semiconductor International Magazine*, February 1993. Copyright 1993 by Cahners Publishing Co., Des Plaines, IL, USA.)

European firms fail to enter Sematech

US and European semiconductor manufacturing firms are continuing to wrangle over participation in each other's research programmes in the run up to this year's Semicon Europa show in Geneva. Informal talks between Jessi and Sematech began in 1989 to explore the ways in which they might cooperate, but the Europeans have always failed to gain access to the Department of Defence funded programme, Sematech. (Extracted from *Electronics Weekly*, 24 February 1993)

Micros battle set

Battle is joined for control of the future of the computer industry next month when leading US electronics firms reveal details of rival processor chips for next generation personal computers (PCs).

IBM, Apple and Motorola officially launch their long-awaited Power PC processor chip in March 1993.

The IBM alliance hopes to overturn Intel's dominance of the annual market for PC processors.

The first PowerPC chip, the 2.8 million transistor 50MHz 601, made by IBM using its 0.5-micron CMOS process is already being sold to system developers by Motorola. Samples of three other chips - for laptop and desktop PCs as well as servers - made by Motorola will be available later this year.

Intel is running into overheating problems with 66MHz Pentiums and so is developing a 60MHz version as well as low-power 3.3V versions. Analysts expect Intel to produce just 50,000 Pentium chips this year rather than the predicted 500,000. (Source: *Electronics Weekly*, 24 February 1993)

IBM gambles on power of the pen

IBM is to make its first foray into the commercial market for pen-based computing with the launch of its ThinkPad 710T range.

IBM is undeterred by the slow growth of the new pen-based computer market, hampered by the limited range of software applications currently available and flat demand in the personal computer (PC) market as a whole.

The new clipboard-sized portable, which weighs in at 2.6 kg, runs on the IBM 486-SLC processor, developed jointly with the Intel Corporation. It features a four-megabyte memory, which can be boosted to 12 megabytes, and hard disks on two of the three models. This new addition is supplied with either IBM's own PenDOS software or GO Corporation's Penpoint. PenDOS comes with a handwriting trainer program to teach the machine how to recognize a user's style.

The IBM electronic pen, like most others on the market, recognises and processes handwritten characters that are not joined up, but struggles with cursive script.

Another disadvantage is that even the most ham-fisted two-fingered typist can probably write more quickly using a keyboard than with a pen. Therefore pen-based computing is not a realistic alternative for the thousands of people who use their PCs for word processing.

However, IBM believes that there is growth potential in specialized applications, particularly where the volume of data input into the system is small.

Warehousing, insurance assessments, market research and nursing are all activities where the pen-shaped electronic stylus, used in the same way as a mouse to point to options on the screen, has the potential to reduce paperwork.

The technological gamble could pay off if the blossoming range of new products succeeds in making computers as commonplace out of the office as they are in it. (Source: *The European*, 18-21 March 1993)

US firms join up on new chip technique

US chip companies are showing increased interest in a new class of semiconductor device based on ferroelectric materials with IBM, Texas Instruments and Micron Semiconductor, saying they will work together on technology development.

The three companies say that they will spend more than $10 million on the development of ferroelectric thin films for 256 Mbit DRAM products.

Ferroelectric based thin films offer chip producers ways of manufacturing high density memory devices with fast read/write cycles and to overcome physical space limitations posed by current semiconductor materials used in present DRAMs. Ferroelectric materials also produce non-volatile memories and may be an essential key to producing gigabit memory devices that will require millions of capacitors.

So far, Ramtron International is the only company selling ferroelectric based memories, which it calls FRAMs. (Source: *Electronics Weekly*, 5 May 1993)

IV. APPLICATIONS

Computer backup for priceless documents

Museums and libraries do their best to preserve rare and precious works, but accidents do happen. Fires and other natural disasters can destroy rare and irreplaceable artifacts, rendering them inaccessible to future generations. But now, in the USA, California Polytechnic Institute's Multi Media Research Project has teamed up with high-tech companies to soften the blow of losing unique historical records.

The Phoenix Project aims to convert rare and historical documents into digital code for permanent storage on CD-ROMs. This provides a record that is more robust than photocopies or microfiche, and that will allow researchers much more flexibility.

Digitized paintings or photographs, for example, could be electronically retouched to show how they might have looked originally, and then sent to researchers via a computer network. (Source: *Business Week*, 25 January 1993)

Glass-ceramic doubles disk density

Seagate is to market 2.5-in. hard disks made from glass-ceramic. The new medium, developed by Corning and to be incorporated by Seagate, gives twice the data density at the same price. Corning's MemCor disks start out as glass, which when heat treated, form ceramic crystals. When the surface is polished, the crystals stick up because they are harder than the glass in which they are embedded. In order to get the head closer to the disk, the disk must be texturized to prevent sticking, since the distance is so small. MemCor allows the head to be as close as two thousandths of an inch and below. To prevent wear, a lubricant is used. Seagate will market 2.5 in. disks initially, then move to 3.5- and 1.8-in. disks. (Source: *Electronics Weekly*, 12 May 1993)

Improved chip bonding

To meet the demands of the latest generation of high speed chip placement equipment Loctite UK has brought out an improved heat curing epoxy. Loctite 3609 adhesive, which has been developed to produce a higher wet strength and to be more flexible than other chip bonders, is seen here being deposited automatically, and at high speed, onto a substrate board. The product has a higher wet strength, it can be dispensed faster, and without stringing between deposits. Improved wet strength means that the placement machines can run faster, without the risk of chips moving on the board. (Source: *Electronics Weekly*, 5 May 1993)

RF-IDs speed automatic data collection in a variety of applications

Just as the industrial revolution levered mankind's physical capacity, the information revolution is levering its intellectual facility. One example is radio-frequency identifiers (RF-IDs) that greatly speed the collection and processing of information.

RF-IDs, often called "tags", are integrated circuits that contain information. A transmitted radio signal turns on and interrogates the identification circuit which responds with the requested information, all wirelessly.

Compared with rival ID technologies such as bar code or magnetic strips, proponents claim that RF-ID systems need no direct contact nor line of sight between reader and transponder. As a result, an RF-ID system can operate in adverse conditions of temperature, humidity, mud and dirt.

Applications include animal tracking, security, manufacturing and a host of other applications ranging from granting access to ski lifts and tracking runners in marathons to collecting tolls and collecting garbage.

One of the more promising applications of RF-IDs is in automatic vehicle identification. Tags attached to the windshield of a car travelling at 55 miles per hour are interrogated and charged a toll automatically.

In animal identification, a small tag injected into the animal is updated with information on its health, location, care and feeding over its lifetime. Tags also mark and track animals in the wild.

In security applications RF-ID circuits embedded on personnel access cards control access to property.

In manufacturing, RF-IDs are attached to products on an assembly line. At each stage of assembly, information is read from and written into the tag. The same tag is used for inventory management.

The tags are popular in Germany for garbage bin identification. The collection service weighs the bin, interrogates the RF-ID to determine the owner and bills the household by weight. (Source: *Electronics*, 8 February 1993)

GEC works with Jaguar on car radars

GEC Plessey Semiconductors is working with UK car maker Jaguar on a low cost radar system, which can be used to improve the safety of private cars. The development of the collision avoidance radar equipment (CARE) is part of the European automotive electronics project Prometheus. Both companies are receiving funding for the work which includes pre-competitive development and the initial manufacture of multibeam microwave sensors. (Source: *Electronics Weekly*, 25 March 1993)

Infrared imaging reads Dead Sea Scrolls

Infrared imaging technology is being applied to reading previously illegible sections of the Dead Sea Scrolls, 2,000-year-old manuscripts that provide insights into the early history of Christianity and Judaism. Scientists at the Rochester Institute of Technology (RIT) in New York are using infrared light to view impressions made into the documents that are not visible under natural light. Infrared light is also much softer so it will not damage the documents by drying them out. According to Bruce Guptil, a scanning and imaging analyst with New Technologies, infrared light can detect organic deposits on the paper. He likened the process to revealing "invisible ink". Under the infrared light, fragments of the Scrolls that are unreadable because they have blackened with age are revealed. Even when the writing is not clear, a computer can often fill in what is missing, according to Robert Johnson, head of RIT's Center for Imaging Science. (Source: *Electronics Weekly*, 25 March 1993)

Neural networks offer deaf hope

Profoundly deaf people may benefit from one of the first practical applications of advanced computer software technology called a neural network which can "learn" from experience.

Scientists at University College London, in partnership with Guy's Hospital, London, are taking part in a European Commission funded project to design a neural network-based hearing aid. Working prototypes were shown at the Nepcon Electronics exhibition and are also under trial in the UK, France and Holland.

The system, which must be "trained" beforehand with a group of actual voice types, uses the neural algorithm to extract the fundamental frequencies from speech. According to one of the UCL researchers the deaf person may be able to detect variations in the single frequency output.

However, as this is not intelligible in itself the hearing aid is designed for use in conjunction with lip-reading. It is intended for those people suffering from the severest forms of deafness who have no ability at all to filter normal speech frequencies. The speech is first filtered in a bank of 41 band pass filters which provide up to 246 frequency inputs to the neural network.

The processing is carried out on digital signal processing chips supplied by Texas Instruments. The output is a rapidly changing sinewave frequency which varies with voice pitch and modulation. (Source: *Electronics Weekly*, 31 March 1993)

Chip-based locks

Chips may have unlocked a new market following security firm Chubb's announcement that it plans to start selling new chip-based mortice-lock systems throughout Europe.

Chubb's Eloctro system puts a chip (coded with a unique 64-digit number) onto a key, which can only unlock doors where the microprocessor-controlled locks have been programmed to accept its number.

Chubb thinks that chip-based smart-key systems will be more acceptable than the many chip-carrying smart-card systems already on the market and sees a large market for Eloctro which has already sold 7,000 locks - with an average of 25 keys apiece - over the last year or so in Holland, where it was developed.

Dutch firm Philips is believed to be supplying the chips. High-volume markets under consideration

may include ears. (Source: *Electronics Weekly*, 20 January 1993)

Virtual reality

It will soon be possible to explore surfaces and spaces a million times smaller than a postage stamp.

Virtual reality, the marriage of computer images and real-life pictures, gives users the 3-D look, sound and feel of an environment. Special headsets and goggles plunge participants into lifelike, computer-generated stereo images in real time. These new techniques will revolutionize industries such as entertainment, communications and design, and change the way things are made - everything from aeroplanes to animated cartoons.

Britain's National Advanced Robotics Research Centre, on the campus of Salford University in Manchester, is one European institution at the forefront of development. The Centre has researched VR for the past five years, seeking ways to create more intelligent robots.

Their robots are designed to perform hazardous operations in unsafe places, such as nuclear reactors, under the North Sea or in burning buildings. They carry ultrafast stereo television cameras (which can move 1,800 degrees per second) whose lasers scan the scene, segment it and send 3-D, virtual reality shots as far away as 85 kilometres to where an operator is running the robot in a safer environment.

VR can be applied anywhere complex data is being manipulated. Andy Connell, a researcher at the Centre, and his colleagues have used virtual reality to develop a system for Rolls-Royce, currently building the engines for Boeing's new 777 jet.

With VR, Rolls-Royce engineers can not only visualize an engine, but they can walk around it, pick up pipes, undo bolts, and practise two-handed maintenance - all on something that doesn't yet exist.

The system provides crucial information for engine manufacturers who must specify the amount of time their products will need for ground repairs and who risk legal action if their estimates are wrong.

Using VR, manufacturers can assure airlines that the pipe networks in their new engines, for example, will take exactly ten minutes to fix, because they have practised the repairs in virtual reality, one which is every bit as accurate as the real thing.

Industrialists are beginning to realize the importance of VR. Late last year French electronics giant Thomson obtained the rights to two dozen American patents in the new field. The patents had been the property of VPL Research Inc., a Californian company in which the French firm owned a small share.

The original virtual reality concept was pioneered by American engineers 20 years ago. The United States Air Force used the new methods to train its fliers and NASA used early programs to familiarize astronauts with outer space and other worlds. Now once again, a military spin-off will benefit wider markets. Using VR, designers can create improved accommodation for the disabled and target their particular special needs. Japanese appliance manufacturers already use the system to help customers plan their kitchen designs and NEC recently unveiled a prototype virtual reality skiing experience.

A Rutgers University engineer has developed a computer driven "data glove" that provides tactile feedback. Such gloves, in conjunction with imaging goggles, comprise "virtual reality" systems and are used to signal the computer to move virtual objects in the virtual world projected by the goggles.

The Rutgers Dexterous Hand Master carries the realism of virtual presentations one step further by providing tactile-sense feedback to the operator. This is done with a trio of pneumatically inflated metal cylinders branching to the tips of the thumb, index and middle fingers, and adjusting curtain-rod style to the configuration of the digit. The glove can, on instruction from the computer, provide resistance to being squeezed. So far a soda can, rubber ball, and spring have been synthesized; if squeezed hard enough the soda can "crushes" and shifts from rigid to crumbling resistance.

Virtual reality (VR) systems may someday replace personal computers as we know them to support a wide range of real-world applications. Instead of entering data via a keyboard or mouse or other input-output device, workers in the future will manipulate the data within a VR environment. Current problems with VR systems include inadequate computer power, sluggish tracking devices and cumbersome displays. The technology has an incredible potential for designers, who will be able to enter inside their creations and make changes as they walk through them. Some applications of the technology include building better planes, spacecraft and wind tunnels; designing user-friendly buildings for the handicapped; conducting virtual surgery; and military simulation and training. (Extracted from *Discover*, December 1992, *The European*, 18/21 March 1993, and *Design News*, 26 October 1992)

Chip heralds low-power 486 notebook PCs

Intel Corp. of Santa Clara, California, will announce the power management version of its 486 central processor unit. Dubbed the S Series, the chip

will finally bring desktop performance to notebook computers.

The new chip will be a fully static design, which means the CPU will retain its internal memory when it is powered down.

In addition, the new S Series will run off 3.3 volts, resulting in a reduction in power and heat.

The new CPU family comes with system management mode (SMM), a power management feature that allows more intelligent control of the CPU to save power.

The new chip solves the problem faced by notebook computers since their introduction. To provide desktop performance in notebook computers, system designers have had to use the same 486 microprocessor found in desktops. But a 33-MHz 486 burns 5 watts of power, and in a notebook that can drive the temperature up to 100° C, says Robert J. Lee, president and chief executive officer of Pico Power Inc. in San Jose, California. Plastic melts at 80° C.

Consequently, designers were forced to reduce clock frequency or to write the CPU state to memory and shut it off when the notebook was idle, such as between key-strokes. (Source: *Electronics*, 22 February 1993)

Pen computers learn to read writing

At the Mobile '93 conference in San Jose, California, Communication Intelligence Corp. (CIC) of Redwood Shores, California, announced the release of its Handwriter Recognition Systems for Microsoft Windows.

The software is available for US and British English, Japanese, German, French, Italian and Spanish languages. It allows users to interact with their PC's using natural handwriting rather than keyed data.

CIC claims the software consistently provides high recognition across multiple standard operating systems including Microsoft Windows for Pen Computing and CIC's own PenDOS and PenMac pen operating environments. The HRS software will soon be compatible with IBM's OS/2 and GO's PenPoint operating systems. (Source: *Electronics*, 22 February 1993)

1M-Bit SRAM delivers 25 ns access time

Available in versions with multi-bit configurations, a series of 1M-bit SRAMs attains 25 ns access times from 3.3V operating voltages. Hitachi Limited developed the devices in four versions and is shipping the products in sequence. The SRAMS will serve in cache memory applications in RISC processors, for use in workstations and similar equipment. They come in 8-, 9-, 16- and 18-bit configurations. To create optimum internal timing and input/output interface levels, the company altered the circuitry of the 5 V products by partial masking. In addition to permitting 25 ns access from 3.3 V operation, this approach lowered the power use to less than half that of previous 5 V products. In contrast to the 1mA standby current of conventional products, the SRAMs operate on a 60 µA standby current. As a result, these products are compatible with long-term use in battery-operated equipment. The company intends to begin mass-producing 20,000 of the SRAMs in early 1993. (Source: *AEU*, No.1/1993)

Word processor accommodates 22 fonts

Equipped with an excellent-performance 400 dpi-resolution printer that turns out 190 words/sec., the OASYS 30AX-W2 word processor meets the safety standards of Canada, Japan and the United States. Fujitsu Limited released it simultaneously in the UK, Canada, Singapore, Thailand, Malaysia, the Philippines and Indonesia. Targeting business applications, the model offers three typefaces as standard and is compatible with 22 print fonts. The unit also features a desktop publishing function and a 3.5-inch floppy disk drive compatible with either double-sided high-density (2HD) or double-sided, double-density (2DD) disks. Because the 30 AX-W2 comes with 2400/1200/300 bps modem cards, users can transmit electronic mail through personal computer communication networks. Fujitsu's overseas affiliates and dealers in the seven countries will provide supplies and service. (Source: *AEU*, No.1/1993)

Moving 3-D without "gimmicks or specs"

A "no-gimmicks" true three-dimensional moving picture display system has been developed by Texas Instruments (TI).

Laser-green moving solid images floated in misty space within a large transparent hemispherical dome during the ten-minute demonstration of the prototype display - known as OmniView.

OmniView combines computer-controlled laser projection with a fast-spinning reflective helical surface, wrapped helter-skelter-like around the central spindle of the dome which measures some 24 inches across its base.

The rotating helical surface sweeps out a 3-D "solid" projection screen. Images are built up by carefully timing laser pulses to hit particular points on the moving helical surface. By rotating the screen at 600 rpm, updating the image twice per rotation, the display can offer a 20 MHz refresh. The system resolution is determined by the number of image points, known as volume-pixels or voxels, that can be used - around 4,000 on this prototype.

However, the team has already built a larger 12,000-voxel three-colour system - based on a 36-inch diameter cylindrical projection tank - for a US military project.

TI is planning to develop to a seven colour 70,000-voxel non-laser projector system. (Source: *Electronics Weekly*, 24 February 1993)

Technology special - DSPs

Digital Signal Processing (DSP) is about to become a commonplace technology in everyday products in the near future. This will be driven by an increase in performance and consequent decrease in cost of processor chips, and the development of more and more software to run on the devices.

Digital signal processing is the high-speed mathematical manipulation of digitized waveforms, and encompasses algorithm development, board design, and processor chips with special instruction sets to handle the complicated functions required to transform, filter and reconstitute the data.

Once the preserve of highly complicated and expensive systems, such as radar, avionics and noise cancellation in the most expensive of sports cars, the technology has drifted downstream and is about to break into the humble PC in the guise of multimedia and even the car radio, to produce noise cancellation and sound enhancement.

Solutions to such taxing problems as recognizing speech via a telephone line and producing machines that recognize speech in one language and automatically synthesise a translation in another are proposed.

Britain has considerable expertise in digital signal processing, fuelled in no small part by the interest in universities on the subject.

There is also the factor of the transputer which has been used in arrays to perform DSP tasks such as high performance imaging and radar. Although used as a building block for massively parallel processing supercomputers, one of the largest arrays of transputers is to be found in a radar built by GEC Marconi.

GEC Plessey Semiconductors has experience in producing DSP chips for the telecommunications market and is following that up by producing ICs for the forthcoming video telephony market. It will start sampling a chipset that will implement the CCITT H.261 standard for compression and decompression. The standard, sometimes referred to as P*64 because it supports data rates in multiples of 64 kbit/s, allows video compression ratios of 1500:1 to be achieved. It can operate on data rates from 64 kbit/s to 2 Mbit/s, and is tailored to videophones and video conferencing because it makes the assumption that the subject will move very little during transmission and trades off accordingly.

This allows the video pictures to be transmitted in real time, but if a significant change of motion occurs, the coding algorithm will take action to reduce the rate of data generation. This may take the form of switching to a lower resolution encoding rate or skipping some frames, which will result in some picture deterioration.

GPS's chipset comprises a video encoder and decoder along with a multiplexer, a demultiplexer and a video filter. (Extracted from *Electronics Weekly*, 20 January 1993)

Interactive multimedia

The computer industry loves it buzzwords. Among the current favourites is "multi-media", which means combining words and numbers with images and sounds to create more comprehensive and, hopefully, more effective communication between computers and their users.

Behind the publicity hype computer makers are desperately searching for the next big market to alleviate their present financial troubles. And multimedia offers real improvements to users in a variety of ways.

Multimedia is not new technology, though setting standards for the use of its many borrowed techniques is going to be long, and difficult. However, it is a new way of applying computer technology.

To understand it one has to go back to basics. In the beginning there was the alphanumeric characters, which are simply numbers and letters. Information going into a computer was marked onto punched cards. Once inside the computer, the information became data to be stored, processed and manipulated for eventual output, via high-speed printers, as another set of information such as factory payrolls or telephone bills.

This basic way of communicating with computers via alphanumeric characters remained in place even when the first generations of visual display terminals arrived.

The next stage was the development of visual techniques to exploit computer power. Techniques were developed which we know today as the mouse and the icon, and computer-aided design (CAD).

Today, CAD is used for more than just the design of engineering parts: it has been adapted for use in construction, land management and many other areas. The mouse and icon interface is rapidly establishing itself as a standard, allowing users to bypass obscure abbreviations used as commands to the computer in alphanumeric-based interfaces.

The other parts of the jigsaw making up multimedia are the familiar technologies of sound, video, animation and telecommunications.

The mixing of all these techniques can produce some effective ideas on how to use computers.

The key to multimedia is that it increases the effectiveness of communications, not only between computers and users, but also between people. (Source: *The European*, 18-21 March 1993)

Field-programmable gate arrays

More digital designs will be built on field-programmable gate arrays than on all traditional, mask-programmed gate arrays combined. What are FPGAs and what makes them so popular?

Like traditional gate arrays, FPGAs implement thousands of logic gates in multilevel structures. An FPGA manufacturer makes a single, standard device, like a programmable logic device (PLD), that users program to carry out desired functions. Field programmability comes at a cost in logic density and performance: FPGA capacity trails mask-programmed gate array capacity by about a factor of 10; FPGA performance trails mask-programmed gate arrays by about a factor of three.

On the other hand, a user can program an FPGA design in a few seconds or minutes, rather than the weeks or months required for the production of mass-programmed parts. FPGAs need no custom mask tooling, saving thousands of dollars over mask-programmed parts. The result is a low risk design style, where the price of a logic error is small, both in money and project delay. The reduced risk makes FPGAs useful for rapid product development and prototyping. Moreover, FPGAs can be fully tested after manufacture, so users' designs do not require test program generation, automatic test pattern generation, and design for testability.

Many kinds of programmable logic products are called FPGAs. Here, a broad definition of the term is used, including not only devices with internal structure similar to gate arrays, but also devices with internal structure similar to a collection of PLDs. The term FPGA is often reserved for the former type of part; the latter are also called complex PLDs (CPLDs) or programmable multi-level devices (PMDs).

Three programming technologies are commonly used for FPGAs. Each has associated area and performance costs, and the device architectures reflect those costs. Thus, we can categorize FPGAs according to their combination of programming technology and device architecture.

In a CPLD architecture, the user creates logic and interconnections by programming EPROM (or EEPROM) transistors to form wide fan-in gates. A CPLD consists of a few function blocks, each similar to a simple two-level PLD. Each function block contains a PLD AND-array that feeds its macro cells. The AND-array consists of a number of product terms. The user programs the AND-array by turning on EPROM transistors that allow selected inputs to be included in a product term.

A macro cell includes an OR gate to complete the two-level AND-OR logic and may also include registers and an I/O pad. The macro cell may contain additional EPROM cells to control multiplexers that select a registered or nonregistered output and decide whether or not the macro cell result is output on the I/O pad at that location. Macro cell outputs are connected as additional function block inputs or as inputs to a global universal interconnect mechanism (UIM) that reaches all function blocks on the chip. The function blocks, macro cells and interconnect mechanisms vary from one product to another, giving a range of device capacities and speeds.

In an SRAM-programmed FPGA, static memory cells hold the programming. The SRAM FPGA implements logic as look-up tables made from the memory cells, with function inputs controlling the address lines. Each look-up table of 2^n memory cells implements any function of n inputs. One or more look-up tables, combined with flip-flops, form a configurable logic block (CLB)[17]. The CLBs are arranged in a two-dimensional array with interconnect segments in channels, similar to an island-style gate array architecture.

Interconnect segments connect to CLB pins in the channels and to other segments in the switch boxes through pass transistors controlled by configuration memory cells. Because SRAM cells and pass transistors are comparatively expensive in area and delay, the switch boxes are not full crossbar switches.

An SRAM FPGA program consists of a single long program word. On-chip circuitry loads the program word, reading it serially out of an external memory every time power is applied to the chip.

The program bits set the values of all configuration memory cells on the chip, thus setting the look-up table values and selecting which segments connect to each other. SRAM FPGAs are inherently reprogrammable. They can be updated in the system, providing designers with new design options and capabilities, such as logic updates that do not require hardware modification and time-shared virtual logic.

An antifuse is a two-terminal device that, when exposed to a high voltage, forms a permanent short

circuit between the nodes on either side. Individual antifuses are small, so an antifuse-based architecture can have hundreds of thousands or millions of antifuses. To simplify the architecture and programming, antifuse FPGAs usually consist of rows of configurable logic elements with interconnect channels between them, much like traditional gate arrays.

The pins on the logic blocks extend into the channel. A logic block is usually a comparatively simple gate-level network, which one programs by connecting its input pins to fixed values or to interconnect nets. There are antifuses at every wire-to-pin intersection point in the channel and at all wire-to-wire intersection points where channels intersect.

Design process

The FPGA design process is similar to other gate array design. Input can come from a schematic netlist, a hardware description language, or a logic synthesis system. The first step in design implementation is to fit the logic in the input into the FPGA structures. This step is similar to "technology mapping" in logic synthesis. It is called "logic partitioning" by some FPGA manufacturing and "logic fitting" in reference to CPLD-style FPGAs.

After partitioning, the design software assigns the logic, now described in terms of functional units on the FPGA, to particular physical locations on the device and chooses the routing paths. These last two steps are similar to traditional gate array placement and routing. They may be algorithmically simpler or more difficult, depending on the amount of routing resources available on the chip, the types of interconnect available, and the design constraints. (Source: *IEEE Design and Test Computers*, September 1992)

Advanced computer applications

No one can doubt that the computer has revolutionized our ability to manipulate information; it is equally clear that more information does not necessarily mean better planning, policies and decisions. Computer users, especially non-technical users, are often frustrated by systems that make it hard to find critical information or present it in ways that are difficult to understand. Good science is a necessary, but not a sufficient, condition for useful and usable information and decision support systems. This is the problem addressed by the International Institute for Applied Systems Analysis (IIASA) Advanced Computer Applications group. ACA develops and implements easy-to-use, but scientifically sound software tools and systems that bridge the gap between scientific research and real-world information needs. Since 1985 ACA has designed computer-based tools and developed software packages that combine models, geographical information systems, decision support and expert systems, and sophisticated graphic displays. Most of the applications are custom-made environmental information and decision support systems. Current projects include the development of systems to help clients manage air and water quality and natural resources, to analyse problems of managing hazardous chemicals and toxic wastes, and to assess the impacts of climate change. These problems are complex. Useful environmental information and decision support systems must combine a solid foundation in physical sciences with the ability to handle large amounts of complex data. Increasingly, they must also incorporate socio-economic variables, social values and perceptions, and political factors. They require a multidisciplinary approach and the integration of advanced methods with specific domain know-how. Ongoing efforts to develop generic tools for analysis and communication of information and decision support; seven years of experience in the practical, problem-oriented pursuit of applications; and a history of collaboration with people and institutions from China to California are ACA's distinguishing features.

ACA started in 1985 as a spin-off of an exploratory project at IIASA dubbed "Dialoguing with Decision Makers". The problem addressed was, and still is, how to get scientifically sound information and methods of analysis into the policy- and decision-making process, how to communicate complex information to both scientific experts and non-technical users. Modern information technology, and, in particular, interactive models for scenario analysis and computer graphics, emerged as a promising tool for this daunting task, building on IIASA's experience in modelling, decision support and policy analysis.

The concept proved valid. Since 1985 ACA has developed custom software for application to a wide range of places and problems, from the River Rhine to the Mekong River, from local air pollution to global climate change, from toxic chemicals to regional development.

The first test of the concept was a project for the Commission of the European Communities Joint Research Centre at Ispra, Italy. The task was to compile computer-based tools that could support the implementation of the so-called Post-Seveso Directive of the EC, regulating industrial risk assessment.

The result was IRiMS, the Ispra Risk Management System. IRIMS integrated several databases and simulation models with a fully menu-driven graphical user interface. Models of air, surface water and groundwater of chemical production and transportation were linked to databases on hazardous substances, industrial processes and waste streams, and major accidents. Throughout, the emphasis was on ease of use.

IRIMS quickly attracted attention. Demonstrations of the prototype led to follow-up projects in the USA, France, China and the Netherlands. These applications of IRIMS included a geographic

information system, or GIS - a tool that would become a central component of ACA's software - and the first integration by ACA of relational databases together with a GIS and an interactive simulation and optimization model.

The step-by-step improvement of the ideas tested in IRIMS would become a hallmark of ACA. In the Netherlands, what began as a modest tool to analyse risks in transportation of chlorine has evolved into a fully integrated environmental information and decision support system.

When ACA needs to supplement in-house expertise, it turns to outside collaborators. One of the first examples was in 1987, when the US Bureau of Reclamation sponsored a development of the groundwater model of IRIMS. ACA teamed up with hydrological experts at the Institute for Mechanics of the German Academy of Sciences. Together they linked a finite element model with extensive graphical editing facilities and model output animation to produce a truly interactive groundwater model.

On behalf of the US Environmental Protection Agency, ACA also worked with the University of Colorado at Boulder on surface water quality models for the assessment of environmental risk of toxic substances. Again, ACA's role was to integrate dynamic simulation models, databases, and GIS components into a homogeneous, user-friendly interface: to make a complex system easy to use and understand.

New projects steadily broadened ACA's range of experience, while newer computer technology made it possible to build increasingly complex yet efficient systems. In a case study of heavy gas dispersion for a chemical company, several models of different degrees of complexity and resolution were coupled. In 1986 work began on a more elaborate project, a collaborative effort with Chinese scientists to integrate 16 major models and databases into a tool for integrated regional development planning in the coal-rich province of Shanxi.

The focus of the system was coal: mining, the energy sector, transportation, and heavy industry were considered, but also agriculture, the environment, and natural resources, particularly water. Economic models in the system included both traditional input-output models and a new method of qualitative simulation based on cross-impact analysis or an expert system for site suitability assessment.

From the first stages, researchers, scholars, and officials from Shanxi Province and from the State Science and Technology Commission in Beijing were involved in the design of the system; end-user involvement and on-the-job training remain important parts of ACA's approach. In this international, intercultural setting, the use of computer graphics as a universal language took on a new importance.

A prototype urban environmental information system developed in 1989 for the city of Hanover, Germany, included a number of firsts for ACA. Project members integrated satellite imagery into the GIS. On the modelling side, they implemented a new groundwater model developed by the University of Hanover.

The Hanover project also allowed ACA to explore new interactive graphical user interfaces, made possible by the development of more powerful computer workstations and the transition from the original SIGGRAPH Core graphics standard, via the Graphical Kernel System, to the X11 Windows System. The new window-oriented graphics standards allowed more dynamic interaction and editing capabilities, while pseudo-3D visualization was added to the animated model output. Hypertext structures were developed and added to the model and to the database interfaces, providing the user with more help and explanation.

Each of these tools has since been incorporated in other systems. Each ACA system is customized for a specific institutional framework, but all the systems share a basic set of generic software tools. Tools that work well in one setting can be reapplied to another. One example is a multi-criteria decision support tool first used in 1985 in a system to select paths for transportation of harzardous materials at minimum risk. The core algorithm, developed by IIASA's System and Decision Sciences Program, was subsequently used in systems dealing with other sorts of problems. In 1990 an improved version was implemented jointly with Tsinghua University, Beijing, in a project involving management of air quality and energy development in cities in China.

More recently, ACA has added rule-based expert systems and artificial intelligence components to its kit of generic tools. An opportunity to develop expert system technology emerged from a project for the Mekong Secretariat in Bangkok, Thailand. The task was to build tools to assess the environmental impact of water resources development projects; rule-based expert systems were seen as a way to operate effectively with severely limited data. Checklists of potential environmental impacts compiled by the Asian Development Bank were used as a starting point. Experts from the Mekong Secretariat provided many of the rules for the system's knowledge base.

Later the same expert system methodology was used in a pilot system for the Swedish Board of Agriculture involving agricultural water use and pollution. This case study, unlike the Mekong project, has vast amounts of agro-statistical data; the expert system helped users make sense of it.

These developments of expert systems tools led to a new concept: embedded artificial intelligence. Small expert system components could now be integrated with the simulation models and the user interface. Their task is to help the user compile complete and consistent input information, and to guide the system's operation. They act as built-in expert advisers - something of great value to users.

One application has been in ACA's Climate Impact Assessment Expert System. The system combines a global GIS and expert system with very large databases of global coverage, on topics such as basic geography, population, vegetation and soils, climate, and water resources, as well as the output of several general circulation models.

The system was also linked to the IMAGE model of climate change developed by the Dutch National Institute of Public Health and Environmental Protection (RIVM). An interface using embedded artificial intelligence helps the user to set consistent assumptions and policy variables in defining scenarios of global change and development. The interface includes a hypertext-based system to explain the model. The IMAGE model itself can be run interactively and its output viewed in graphs or as topical maps in the global GIS and mapping system.

Following ACA's work on applied artificial intelligence, the Austrian Research Foundation sponsored a study in machine learning. Monte Carlo simulation was combined with expert system tools in an attempt to "learn" a simplified and general description of a complex system from many examples of the system's behaviour. To generate the learning examples, another new technology was adapted: distributed parallel processing. Like many other basic research elements of ACA, the parallel processing ideas evolved as part of IIASA's Young Scientists Summer Program. (A further article describes some of ACA's current work on environmental models and decision support systems in water, air, and risk. While the range of applications is wide, the projects have much in common: working with real users and clients world-wide; the integration of numerous sources of information and state-of-the-art tools; an interactive interface that is easy to use and allows the user to concentrate on the task at hand rather than on the technicalities of data management; sophisticated graphics that allow users to see and understand at a glance; and built-in intelligence that adds expert know-how to software.)

ACA's focus is on the interface between user and computer. Efforts to develop systems to support decisions regarding complex environmental and socio-technical systems are guided by a few principles:

Integration - systems consolidate information and tools from different institutions and disciplines.

Interaction - they encourage users to define and explore problems incrementally and give quick answers.

Intelligence - software "knows" not only about possibilities and constraints, but also about the application and its context.

Visualization - sophisticated graphic displays allow users to see spatial and temporal relationships and to develop an intuitive understanding of problems and solutions.

Customization - systems are based on the end users' views of the problem, their language, experience and needs; end users are directly involved in the design.

Current research topics include:

Hybrid information and decision support systems - in particular, the integration of databases, numerical models, spatial information systems, and expert system technology. Wide-area networking and parallel processing are two relevant emerging technologies. The main objective is efficient management of very large and complex sets of data and information.

Qualitative analysis, symbolic simulation and approximate reasoning - expert systems, their integration with numerical methods, hypertext structures, geographic information systems and forms of knowledge representation. The objective is to develop formal methods for the use of qualitative, unstructured information.

Scientific visualization, animation, interactive graphics and user interface technology - problem representation languages for multi-media system, using a combination of numerical, textual, and graphical and sound elements that are intuitively understandable. The objective is the efficient communication of scientific information to a broad range of users. (Source: *Options*, December 1992)

Lasers boost optical signals across the Caribbean

The Caribbean will be the first home for a new generation of submarine fibre-optic cables that boost signals on their way with a form of laser built into the fibre itself.

Optical signals invariably weaken as they travel through long-distance fibre-optic cables. At the moment, cables have electronic amplifiers spaced along their length. These convert the optical signals into electronic form, amplify them, and convert them back into optical form.

Part of the new Americas-1 cable, between Florida and the Caribbean island of St. Thomas will use all-optical amplifiers, which boost signals in the cable

itself without converting it to electronic form. This will allow each pair of fibres to carry 2-5 billion bits of information per second, nearly five times the capacity of present fibre cables with electronic amplifiers.

The 8,000-kilometre system, being installed by AT&T Submarine Systems, will link Florida, St. Thomas, Trinidad, Venezuela and Brazil. It will use optical amplifiers only for the 1,800-kilometre segment between Florida and St. Thomas. Conventional fibre amplifiers will be used farther south. Work will start by the end of 1993, with the system going into operation in September 1994.

Meanwhile researchers at Bell Communications Research in Red Bank, New Jersey, have taken a big step towards making a single chip which could send many different signals down the same optical fibre by using different wavelengths of light - so greatly increasing the fibre's capacity. A group led by Chung-En Zah has made a chip containing 21 lasers plus the optics necessary to combine their output into a single optical fibre.

Sending many signals through the same fibre at different wavelengths requires a different laser for each wavelength. Other groups have integrated up to 20 semiconductor lasers on a single chip, but they used separate fibres to collect light from each laser. The Bellcore group added waveguides to the chip and a device called a star coupler which combines the beams.

Producing an output in a single fibre is vital because connecting many fibres to a chip with the necessary precision is very expensive. But the star coupler is not without drawbacks. It weakens the signal by a factor of 100 (20 decibels), a loss that Zah offset by adding an optical amplifier to the fibre after it leaves the chip. This boosts signal strength by more than a factor of 100. He hopes to replace it with a semiconductor amplifier, which could be integrated on the chip.

Problems in dissipating waste heat generated by the chip and in connecting the fibres have prevented other groups operating more than one laser at a time. Zah's team has operated 15 at a time using an 18-laser array, and is now working to test the 21-laser array. (This first appeared in *New Scientist*, London, 12 December 1992, the weekly review of science and technology.)

<u>High power and low voltage new chip for portables</u>

Longer battery life and lots of processing power for notebook PCs are promised by Intel with the launch of its 486 SL microprocessor.

The chip runs at 25 MHz and is, says Intel, a 486 DX microprocessor that only needs 3.3 volts to operate, and so consumes less charge from a battery. This means that a notebook computer based around the chip can operate for a longer time.

The 486 SL is a full 32-bit chip, meaning it can crunch data more quickly. It also has a maths co-processor built directly into it and an eight-Kbyte cache memory allowing it to calculate data at a higher speed. (Extracted from *Computer Weekly*, 19 November 1992)

<u>Shock protection for portable PCs</u>

As PCs shrink in size they become more susceptible to the effects of shock that result in the loss of data from its hard disk. Once data has been lost in this way it cannot be recovered, even by the use of software.

To overcome this, disk drive maker Seagate has developed a technology called SafeRite that prevents data loss by detecting a critical shock event, and halting data transfer until operating conditions are safe again.

Standard drives have an operating shock tolerance of about 10Gs. The shock received to the system from seemingly minor events is often much higher than the unknowing user expects.

SafeRite allows drives to receive operating shocks of up to 100Gs, providing much higher resistance to the adverse effects of shock.

There are a number of features that can be incorporated into a disk drive to offset the effects of shock.

Auto-save features can help prevent the loss of data by automatically saving work at regular intervals.

Unfortunately this feature increases the opportunities for the device to be jarred during write operations, because the system is accessing the drive beyond the user's control or caution.

Write-caching and "lazy-writing" architectures increase system performance by temporarily placing data intended to be written to the drive into a reserved area of memory. Since the data is "written" to memory, the entire transfer completes faster, resulting in faster response times for the system.

As the system cache fills, older data has to be written to the drive to make room for current data to be cached. Multi-tasking applications are also cache intensive and greatly increase drive activity as background processes complete their necessary drive access.

In all of these situations, data is held in memory, and written to the drive as conditions permit. Since the drive is often active beyond the user's control, the

measures cannot easily guarantee a steady environment for system operation.

SafeRite drives dramatically increase the margin available to the user for increased data integrity in high shock environments. When the drive is subjected to severe shock, SafeRite instantly senses the unsafe condition, and halts data transfer until the event has passed. This ensures that data on the adjacent tracks will not be overwritten. (Source: *Electronics Weekly*, 18 November 1992)

The systems angle to re-engineering

The chemical industry, coming to terms with the global nature of its business and the steadily increasing demands of regulatory compliance and quality management, is implementing fundamental changes in business processes. Much of this activity, dubbed re-engineering, deals with a streamlining of data collection and reporting in the creation of high-speed, integrated global enterprises.

The term re-engineering, however, may be misleading in that it is not usually perceived as strictly an engineering issue. It is more a matter of high-level management instituting a corporate vision of the business process. That vision, however, must be supported by a highly technical infrastructure, and several major chemical companies report that management has increased its involvement in configuring computer and control systems as enablers of high-speed global enterprises. As such, the quick-payback-driven, point-solution approach to investing in computers and controls - one that has often resulted in segregated rather than integrated information systems - is giving way to an ongoing integration of databases and downsizing of computer operations. The criteria for investment is now one of implementing the changes necessary to compete globally past the year 2000.

Technologies necessary to integrate management information systems (MIS) with controls in a multisite - indeed international - network already exist. This is evidenced by two displays of world-wide chemical operations opened in 1992, intended to illustrate the systems angle to re-engineering using commercially available products. They both showcase a principal goal - the one-phone-call answer to any customer question facilitated by the responsiveness of an integrated, real-time information system accessible to order processing, manufacturing, shipping, and other crucial business divisions, as well as laboratory and testing operations. The demonstrations also incorporate client-server architecture, a network of PC workstations operating from distributed servers rather than from a central mainframe.

The concept of systems integration has advanced considerably in the past four years, as open architectures and common communications protocols fostered a greater availability of off-the-shelf software.

On the implementation level, the integration of controls and MIS is facilitated by a vigorous and longstanding movement towards open systems and common communications protocols. The ISA, for example, has committees studying standards of interoperability, from remote field data collection to the highest level of financial reporting. In general, a three-tier architecture is evolving, constituted by a middle layer, commonly referred to as the manufacturing execution layer, that serves the information needs of the MIS at its highest level with the appropriate information from the most remote digital control monitors.

Information systems integration still has some sticking points. For example, the ISA standard process is a long one. In fact, frustrated with the pace of ISA's SP 50 fieldbus standards committee, a group of vendors led by Fisher, Rosemount (EdenPrairie, MN), Siemens Corp. (Atlanta), and Yokogawa Electric (Atlanta) has announced an effort to develop their own interoperable fieldbus using preliminary SP 50 data. One of the biggest obstacles, however, does not involve technology. As with the breakdown of technology barriers, there is the need for a "visionary champion", to engineer a peace between controls engineers and financial managers as they evolve towards sharing a common database on an integrated global computer system.

In the final analysis, while increased efficiency is likely to result in an acceptable payback for most of the systems upgrades undertaken as part of re-engineering, a fundamental shift in strategy and expectation must be undertaken by those who sign off on capital investment in computers and controls. Several sources claim that since projects will likely roll out on a plant-by-plant basis, 12- to 18-month paybacks for each incremental investment will not be unheard of. What matters most, however, is the collective effect of systems renovation company-wide. In this regard, investment will be driven more by the highest-level business strategy rather than by the appeal of breakthrough technologies for limited application. (Extracted from *Chemical Week*, 25 November 1992)

Silicon chip may aid human fertilization

With an unusual marriage of computer chip technology and biology, researchers hope to improve the current success rate of *in vitro* fertilization methods.

Researchers at the University of Pennsylvania's medical centre said they developed a low-cost silicon glass chip with miniature pathways that serve as an "obstacle course" and help select the healthiest sperm for such fertilization techniques. Current methods, which employ slides or test tubes, have an overall fertilization

success rate of less than 25 per cent. (Source: *The Asian Wall Street Journal*, 23/24 April 1993)

Sensing a market for airbag-activation

As electronic components find broader niches in ever more systems in the world, the need for sensors to measure how systems operate increases. One such sensor receiving heightened attention is the acceleration sensor. Its claim to fame comes from the push by auto makers to provide multiple airbags in passenger cars. With two or more airbags, the need for low-cost, small, light-weight, reliable sensors to tell the airbag-activation system that the car is decelerating is great. Acceleration sensors have other uses, including navigation, robot control, aerospace safety systems, among others. (Source: *Electronics Weekly*, 5 May 1993)

Venture to research tungsten deposition

A Belgian university and Silicon Valley company are teaming up to research tungsten-based chemical vapour deposition technology used in making advanced circuits.

The Genus 8700 system is the result of a joint effort between the Interuniversity Microelectronics Centre (IMEC) at the University of Leuven, in Belgium and US-based Genus Inc.

The chemical vapour deposition (CVD) technology will be used for basic interfacial studies and for research on impurities in tungsten silicide. Results will be used to best utilize CVD processes and to develop new technology for use in next-generation equipment.

The Genus 8700 system is targeted at tungsten silicide production and research. Genus calls it the best choice because it can be incorporated directly into most of the world's wafer fabrication lines. (Source: *Electronics Weekly*, 21 April 1993)

Custom designed modules

Custom designed modules with up to 60 separate circuit layers in a standard surface mounting device (SMD) should drive down component counts and production costs when they are introduced by Murata.

The multilayer modules, which are already used in miniature consumer electronics designs such as camcorders and pocket telephones in Japan, will be available in the summer.

Murata is planning standard parts such as filters up to 20 poles and delay lines up to 10 ns, but the technology has the potential to combine printed thin film techniques with SMD transistors and bare-mounted chips in custom designed modules 2 mm thick and 50 mm^2 in area. Each ceramic substrate layer is less than 100 microns

A multilayer RF amplifier measuring 4.1 x 5.5 x 3.5 mm is under development for mobile telephone handsets.

Key to the 3-D surface mounting devices is the ability to print the nickel edge electrodes around the angles of the SMD. These and the multilayer thin film design reduces component counts and more importantly the number of solder joints, which increases reliability.

Applications could include redesign boards to meet the new EMC regulations. Each module can be individually isolated with copper shields on top and bottom layers. (Source: *Electronics Weekly*, 21 April 1993)

Sun Sparcs designs based on version 9 architecture

Workstation maker Sun Microsystems is working on designs of microprocessors conforming to the latest (version 9) release of the Sparc microprocessor architecture. Early silicon can be expected next year.

Version 9, announced by Sparc International at the end of 1992, defines 64-bit addresses and data word lengths. It also allows code written for existing 32-bit Sparc architectures to run unchanged on new 64-bit implementations.

Sun's 64-bit processor will be called the UltraSparc. A silicon manufacturer has not yet been announced, but industry sources suggest it may be Fujitsu, a leading manufacturer of existing Sparc microprocessors.

The UltraSparc will be heavily pipelined (four stages) to increase the number of instructions issued per clock cycle. (Source: *Electronics Weekly*, 21 April 1993)

V. SOFTWARE

Improved crosstalk analysis tool

Smart crosstalk analysis software that uses timing information derived from simulation to reduce false error predictions has been developed by Cadence, the US design tool firm.

Crosstalk analysis tools take a software description of the layout of a circuit board or multi-chip module and estimate the amount of signal pick-up between tracks. They do this by using models to calculate the fields generated by tracks, pins and other elements when a signal switches from low to high or vice-versa.

The flaw with traditional tools, says Cadence, is that they assume all signals on adjacent tracks can generate crosstalk. This can overestimate the problem by

a factor of ten, since in practice many signals will switch during a time interval when adjacent receivers are not sensitive.

As a result, engineers have to go in by hand after the tool has finished to sort out the real problems from reams of false alarms.

Cadence's tool, Design For Signal Integrity, avoids this by taking into account real signal timing information. (Source: *Electronics Weekly*, 31 March 1993)

A window on the UN system

UN-EARTH, the user-friendly, PC-based package devised by ACCIS to answer all kinds of questions on the United Nations system, is on sale. UN-EARTH, introduced to readers in the May 1992 *ACCIS Newsletter*, offers fast access to data from many sources in the UN system, its structure, and its activities across the globe.

UN-EARTH is designed for use by a wide constituency of administrators, managers, information professionals in international agencies, government departments and the private sector, research workers, journalists and students - anyone, in fact, who needs at-a-glance access to the facts on what the UN system does, and where.

The package combines selected contemporary data on the entire United Nations system. It is menu-driven; users can select appropriate elements to answer a wide range of inquiries. Information can be found on the objectives, membership, administrative offices, information services and databases of the organizations and agencies. In addition, tabulated data can be retrieved on their human resources, development projects and expenditure. This information can be selected and viewed in full-colour displays, by organization, by country, region, politico-economic grouping, or globally.

Information can also be retrieved by country, indicating a country's membership of, and missions to the United Nations system, as well as United Nations system representation, information services and document collections in that country.

The results of a search can be printed straight away, or the data can be downloaded to a text file for further processing in the preparation of reports, statistical tables, research, mailing lists, etc.

While not intended to replace access to, or consultation of the extensive publications of the United Nations and its agencies, UN-EARTH provides a gateway to those sources which may be consulted for more substantive information.

Installing and using UN-EARTH could hardly be easier. Once inside the program, the user is presented with five main menu headings. They are: UN System; Organizations; Countries/Areas; Development Activities, and Resources. Each of these heads a ladder of sub-menus offering access to different levels of information. Navigation is by cursor, page-up and page-down keys.

The manual accompanying UN-EARTH provides a straightforward and easy-to-follow guide to getting the most from the program. Within minutes of starting up the system, the user is amply equipped to extract any subset of information, from the simplest to the most complex. In the event of any confusion, a help facility is only a keystroke away.

Sample searches of many kinds are shown in the manual, which give some idea of the scope of the software as well as showing how to use UN-EARTH to its full potential. For example, a simple search is: "*What are the United Nations Special Missions and where do they operate*?" whereas a more complex inquiry might be "*How many Brazilian nationals hold regular budget Professional posts in UNESCO*?" or "*What percentage of goods and services procured by the United Nations system originated in the developing countries*?"

ACCIS has developed UN-EARTH in response to demands for quick access to factual data on the United Nations system. Benefiting from its unique inter-agency position, ACCIS has been able to draw upon many data sources, both within and outside the United Nations system.

Much of the material presented in UN-EARTH is already available from ACCIS, forming the basis of its publications, *the Register of development activities of the United Nations system*, and *the Directory of United Nations databases and information services*. To this core has been added information obtained from the Inter-Agency Procurement Services Office (IAPSO), and from various official publications in the United Nations system and Member States.

Thus, although all material extracted is already publicly available, ACCIS has devised UN-EARTH to bring the data together in one convenient, user-friendly package.

Version 1.0 of UN-EARTH comes on two diskettes, which, because the files are compressed, must be loaded onto a hard disk. The disk must have about 12 Mb free, although future versions of the program are expected to need only around 4 Mb. The program runs on PC-compatible microcomputers with 640 K of memory, of which 500 K must be available when UN-EARTH is in use.

UN-EARTH (UN Sales No. GV.E.93.0.4) is available, price $60 (a discount is available for orders within the UN system), from UN Sales Offices in Geneva and New York. A 1993 update is being discussed. (Source: *ACCIS Newsletter*, Vol. 10, No. 5, January 1993)

User-friendly PCs

The new generation of computers appears to offer the ultimate in user-friendliness: users can now give instructions to their PC in everyday language, and it is possible to dictate a letter straight on to the computer.

Applied Voice Technologies (AVT), a London-based software house, has developed a product called VoiceServer, a Microsoft Windows-based program, which allows the user to command and control other Windows applications by voice. It is a speaker-dependent voice recognition system: users have to enrol their own custom-built vocabulary.

"The system will work with any Windows application", explained Mark Redwood, managing director of AVT. "It saves the user having to use a keyboard. More importantly, he does not need to wade through a complex menu structure to carry out a relatively straightforward command. The user simply says, for example, 'bold', 'italic' or 'centre', and the system does it". VoiceServer is clearly aimed at the mass market, at a price of £240 plus VAT.

Potential applications for such systems are endless. The disabled would obviously benefit. They could be used where users need to keep their hands free, for example by scientists, technicians or dentists and surgeons. At the other end of the scale Logica (Cambridge) is the lead partner in the Sundial (speech understanding and dialogue) project, which is one of the largest European collaborative projects in speech technology, involving partners from France, Germany, Italy, Sweden and the UK.

It aims to develop the next generation of computer systems, which will be able to hold interactive telephone conversations on subjects such as train timetables, flight arrivals and departures, and to make ticket reservations. It is planned that programs will recognize a vocabulary of about 2,000 words.

Meanwhile, Apple Computer is working on a voice interface project code-named Caspar. Few details have been revealed, but a spokesman said Apple expected the technology to be used in its products before the end of the year. (Source: *The European*, 18-21 March 1993)

Firm develops computer virus defence system

An anti-virus system, employing the use of cards, has been developed in China. The new system, known as AVC-II, has certain new features. It can automatically check two different types of computer virus while carrying out other functions such as automatic elimination and filtration of computer viruses. By the use of these cards in handling cross-contamination, the infected program can still operate normally. The application of the cards does not affect the resources of either the software or hardware offered by the system. Operation of the system retains its normal speed and there are no ill-effects from use of the cards, which can be widely applied to various kinds of electronic publication and editing systems.

A Beijing high-tech company, a subsidiary of the China Huaneng Group, donated a batch of the cards to more than 20 journalistic entities here. The company was founded in 1985 and specializes in the development of electronics, biological engineering, communications projects, new materials and technological components. (Source: *Zhongguo Xinwen She*, 11 March 1993)

Data mining

Netmap is an example of "data mining" or "knowledge discovery", a software technique for uncovering information buried in databases. A database is a store of information structured in such a way as to specify relationships between certain items. For example, names of mortgage applicants will be linked to their present addresses and to the addresses of the houses they want to buy. Details of lawyers, surveyors and so on might also be linked to the applicant, or to the house.

Using this structure, conventional techniques for interrogating databases can quickly find a particular item or group of related items of information, such as all the details of a mortgage applicant from a customer reference number. But as data accumulate in a database, so patterns, trends and correlations may develop. Standard query techniques are not designed to seek out such relationships and so, for example, would be unable to find the common link between those mortgage applicants who defaulted on their payments. Netmap and other data-mining software systems are designed to look for just such implicit, previously unknown information, seeking out unspecified linkages hidden within the database.

Both the number of databases and their contents are growing fast. By 1989 there were an estimated 5 million databases world-wide. The total amount of information in the world is estimated to be doubling every 20 months, and much of this is being stored in computer databases. The human genome project, for example, will gather thousands of bytes of data for each of the three billion genetic bases.

Interest in searching databases for implicit information has been growing as the data themselves

have accumulated. One of the first notable systems was developed in the late 1970s at Stanford University in California.

Called MetaDendral, it inverts the idea of an expert system in that it sifts through existing data and attempts to deduce rules that are implicit in the data but are not known. MetaDendral examines mass spectrometry data generated by known molecules and makes rules that Dendral can apply for identifying compounds.

Since then, data-mining techniques have been applied to databases containing a wide range of information including medical, manufacturing, social, financial and scientific. For example, the Californian company IntelligenceWare has used its data-mining package, called IXL, to solve a problem for a company plagued by persistent failure in the computer disk drives it was manufacturing. IntelligenceWare subjected the database of manufacturing data to the scrutiny of IXL, which deduced the following rule: "If error code = A301 and process = MB16 then 80 per cent sure operator = 337583". Further investigation revealed that one operator, number 337583, had not been properly trained and was indeed the cause of the faulty disk drives.

Other techniques used in data mining include probabilistic theories, Bayesian statistics and neural networks. Bayesian logic is a way of working out the most likely reason for something based on a knowledge of its effect. It allows the calculation of likely causes even where there are many factors involved. Neural networks are computer systems which mimic the human brain. They consists of arrays of simple, interconnected processing units which operate in parallel. Neural networks can be "trained" to discover patterns in data: if they are given a number of examples of data patterns, they will then search for similar patterns in new data.

Although knowledge-discovery packages produce valuable results, many suffer from being "black box" techniques in that the user sees only the result and has no opportunity to interact. Interactive systems where the knowledge analyst is part of the discovery process give the best results. Few systems, however, have facilities for visualizing the data. Netmap does, and it has an interactive system which allows the users to exercise their own expertise. Because of this, and its striking performance in seeking out previously unknown information, Netmap is generating an unusual level of excitement among computer professionals who are immune to most claims of exponential technical advances and "gee-whiz" products.

The origins of Netmap lie in organisational analysis and engineering rather than knowledge discovery. In the late 1970s John Galloway, an Australian economist and engineering enthusiast, became interested in ways of identifying the informal teams that emerge within organizations and which often control and drive their operation.

Galloway developed a method that uses a circle instead of a branching tree as the basic graphical device for describing an organization's structure. The circumference of the circle is divided into a number of groups, one for each department within the organization. The individuals in each department are represented by nodes within the group. Where relationships exist between subgroups or individuals, lines are drawn across the circle to link their nodes. He called this technique for mapping networks of relationships a Netmap.

Galloway also devised a means of gathering data for his analysis quickly and from as wide a sample of the organization as possible. Again his method was simple: a questionnaire which asks concise questions about employee communications.

Netmap causes the informal groups within the organization to emerge by applying a clustering algorithm to the data. The algorithm clusters together those individuals who communicate most with each other in getting their jobs done. The chart can then display the links connecting these informal groups. In addition to the main circle, Galloway provided for "satellite" circles which can show relationships within subgroups in greater detail.

The Netmap chart, with its nodes and links borrowed from engineering design, is a simple, elegant but remarkably powerful way of representing relationships. Complex organizational structures can be expressed with clarity, and the visual presentation allows users to apply their expertise to interpretation and analysis. Furthermore, the software allows the user to take different slices of the data, and so display alternative views of the same information. (This first appeared in "*New Scientist*", London, 9 January 1993, the weekly review of science and technology.)

Baking with software is a piece of cake

Software developed in the United Kingdom is helping bakers bake the perfect cake in double quick time. The computer program, developed at the Flour Milling and Baking Research Association in Chorleywood, Hertfordshire, allow cake researchers to predict how long a new type of cake will last on the shelf before going mouldy, simply by analysing the ingredients.

The inventors are working on two other programs which, together with the mould-predicting system, will form the world's first "cake expert system".

The system recently won third prize in the Department of Trade and Industry's Manufacturing Intelligence Award. Several of the systems have already

been sold, at a cost of £950 each. One customer saved £15,000 in development time in the first year alone.

The program has five separate parts: one deals with baked solid products, such as cakes and pastries; another deals with unbaked fillings, such as creams and marshmallow; one with baked fillings, such as those for apple and meat pies; and one with so-called "high fruit" products such as Christmas puddings and wedding cakes. The final part combines data from any of the other four.

Ultimately, the project's leaders hope to wed ERH-CALC with two other programs under development at the Association. One program diagnoses faults in products, such as a sinking cake. The system is designed to analyse the fault and suggest alterations to the recipe that will overcome the problem.

The other program compares experimental recipes with established recipes for particular types of cakes or cake products. From this comparison, the researcher can predict whether the recipe will produce the type of cake envisaged. (This first appeared in *New Scientist*, London, 19/26 December 1992, the weekly review of science and technology)

European users get raw deal on software

European users are paying over the odds for software compared to their US counterparts.

Independent researchers have examined the cost of US desktop, enterprise and networking software products in four European countries. They found that base prices for many products - especially commodity PC software - varied from US list prices by as much as 200 per cent.

The five-month investigation of pricing policies, commissioned by US magazine *Information Week*, found some European users had to pay up to three times the licence fees paid by US customers.

US suppliers say they face higher business costs in Europe and must spend money to modify software for different countries. Stiff competition has also pushed down prices in the domestic US market.

Some companies, including PC software giant Borland and database supplier Ingres, offer standard prices across Europe. Others, such as Computer Associates, are examining a pan-European pricing policy. (Source: *Computing*, 10 December 1992)

Global data network

A huge but largely unnoticed global data communications network operator is about to make its first tentative step in supplying multinational firms with data networks. The SITA Group interconnects the offices and engineering bases of 450 airlines in 187 countries.

Until now, the network's facilities have been available mainly to airlines. Now the group's installation, maintenance and facilities management services subsidiary, London, England based International Telecoms Services (ITS), plans to offer its expertise to all comers. (Source: *Electronics Weekly*, 2 December 1992)

Users give thumbs up to object-oriented programs

A survey of 150 users, carried out on behalf of Cocking & Drury, the UK distributor of the Smalltalk object development environment, found most were confident that object-oriented programming was already suitable for use in live applications development work despite its relative immaturity.

More than 60 per cent were planning to invest in object technology next year, with C++ and Smalltalk emerging as the two most popular programming languages. Nearly 80 per cent said object technology had cut their development timescales, and 73 per cent said it had reduced maintenance costs.

But there was some disagreement among respondents about whether the technology simplified application design. Systems are built using customized versions of pre-defined basic objects. The design of these can be complicated.

The findings of the survey have been backed up by the experiences of object technology users.

Investment bank UBS has successfully developed object-based stock bond applications and plans to produce a similar risk management system. It was attracted to objects by the supposed cost and time savings.

Petroleum giant Elf Aquitaine is staking its future oil exploration activities on a range of in-house developed object-oriented applications based on Hewlett-Packard's Open/ODB object database. Elf expects these to reduce the failure rate of oil exploration activities, which stands at 80 per cent. (Source: *Computing*, 10 December 1992)

UNESCO collaborates with ADONIS

UNESCO's Programme for General Information (PGI) is installing ten ADONIS systems and providing user training in developing countries. ADONIS is a CD-ROM documentation system that allows easy browsing and searching of articles.

Updated weekly, ADONIS draws material from around 370 scientific journals, covering such areas as biomedicine, chemistry, biochemistry, bioengineering and biotechnology.

ADONIS has the advantage that it can be run on relatively simple configurations: PC-ATs (or compatibles) with at least 640K RAM and 40 Mb hard disk, with a CD-ROM drive.

UNESCO/PGI offers to cover the subscription fees for the first year on a trial basis to interested institutions in developing countries, while royalty fees would be paid by the user. For more information, contact: Mr. P. Harman, Area Sales Manager, ADONIS, Molenwerf 1, 1014 AG Amsterdam, The Netherlands. (Source: *INSTE Information Bulletin* (publication of UNESCO Section of Science and Technology Education), Vol. VIII, No. 2, 1992)

Monitoring the environment

Environmental authorities in UN Member States now have access to quick and effective help from the United Nations Centre for Human Settlements (Habitat), with the launch of a new approach called ViSP (Visual Settlement Planning), which can help solve environmental problems.

ViSP's vital principle is the ability to combine large quantities of various data in a very compact form, on optical discs. Satellite images, aerial photographs or video films, slides, paper maps, statistics, text, drawings, etc., can be used and freely enlarged or reduced in size, or superimposed on each other.

The components of the system are not novel in themselves, but the approach, which was originally developed by the Technical Research Centre of Finland (VTT), presents a unique package of commercially available hardware and software, using optical discs for storing data.

ViSP's costs are remarkably less than those of earlier systems with similar functions. The core configuration can be acquired for $40,000, while advanced input/output facilities would bring the cost up to $75,000.

Launched originally at the 13th Session of the Commission on Human Settlements at Harare, Zimbabwe in April/May 1991, ViSP has since been used in several developing and developed countries. The basic hardware needed for one workstation is a standard PC or compatible (portable or desktop), complemented by an optical memory drive, a graphics board, a multisync screen, a scanner and a graphics printer.

Habitat suggests ViSP for use in projects in urban management, squatter-settlement upgrading, land inventories and physical planning. The system enables tasks that once took months, even years, to be carried out in a much shorter time. A major advantage is that the planning process can be started on the basis of images, even in the absence of any base maps.

When a ViSP workstation is fully operational and all data have been entered, charts, drawings or plans of target areas can be produced in a very short time. The flexibility of this new approach makes it possible - and even easy - for decision makers, news media, NGOs, etc. to visualize planning alternatives and thus promote public participation to an unprecedented level.

For further information, contact: Chief, IAVD, UNCHS (Habitat), PO Box 30030, Nairobi, Kenya. Tel.: +254 2/230800/520600; Fax: +254 2/226473/226479. (Source: *INFOTERRA bulletin*, Vol. XIV, No. 3)

Network of networks for Latin America

The growth in the last two decades of Latin American information networks, coupled with the profound global changes, which have occurred in that time, have led to a rethinking of the concepts on which information networks have traditionally been based. The rethinking extends to the nature of the job done by information specialists.

The training of a new generation of information professionals capable of taking on the new concepts in the management and treatment of information, is now a priority in Latin America and the Caribbean.

These issues were addressed in depth in a seminar on a "Latin American Network of Networks", organized jointly by the Latin American Association of Development Financing Institutions (ALIDE), the Pan American Centre for Sanitary Engineering and Environmental Sciences (CEPIS), the Latin American and Caribbean Trade Information and Foreign Trade Support Programme (PLACIEX) and the International Development Research Centre (IDRC). The seminar was held at ALIDE headquarters in Lima, Peru in August 1990.

Bearing in mind the increasing relevance of the information and documentation sector to the development and integration of the region, the seminar drew up a set of guidelines for the "Network of Networks" project.

The project supports and assists 18 regional networks. It is designed to set up a mechanism for promoting an exchange of experience and information among network participants. It will also initiate joint activities on product marketing and information services, database access, communications, training and technical assistance. Financial support for the project comes from IDRC.

Among the project's specific objectives:

- To establish which obstacles limit the development of markets for information systems, and to find ways of overcoming them. Also, to determine the value, costs and prices of information systems in the network, with a view to the possibilities of generating income for the network of networks;

- A directory of 1,500 abbreviations and acronyms in use in the French-speaking world;

- Geo-documentary profiles of Francophone countries in the South, giving the documentation, information and electronic networking situation of some 35 countries.

The CD-ROM is distributed free to institutions that are members of the BIEF network. For others, it is available for CDN$ 100. Further information on the diskette is available from BIEF, Ottawa, Canada K1A 0M5. Fax: +1 819/953 8439. (Source: *PADIS Newsletter*, Vol. 7, No. 2)

Indian language word processor

A word processing package for Indian languages incorporating a spelling checker has been launched by C-DAC. Called Gist Word Processor, it is available in Hindi and Marathi and will soon be available in Tamil and Gujarathi. C-DAC has launched different levels of the package ranging from one level one font to all standardized fonts for all languages. C-DAC's other GIST products include a multilingual database publisher for converting English databases like bibliographies and telephone directories to Indian scripts and an electronic subtitle creator which allows creation of subtitles at home with a VCP and TV. (Source: *Business Times*, 12 December 1992)

Environment information system going world-wide

After focusing on building up an in-house energy and environment information system and using it to generate information products, INTIB's CLEANTEC DATA programme is moving into a second, internationalization phase.

The underlying premise of the CLEANTEC DATA concept is that over 90 per cent of the information required for improved environmental management by industry is extant, but little of it reaches small businesses in developing countries. The programme therefore seeks to identify and tap internal UNIDO and external sources, repackage and disseminate this information.

The CLEANTEC DATA concept has so far been behind the creation of the REED database and internal network, the launching of an in-house awareness bulletin, the publication of a guide to information sources on industry and environment and of the INECA Journal, as well as marketing of the Micro METADEX database.

Under a $1.3 million programme, a network of national coordination "hubs" is being established to disseminate and collect environmental information.

These institutions are being selected on grounds of a proven track record in handling industrial information, including such factors as experience with computerized databases and an ability to train information specialists.

As the principal aim of the network is to reach out to small and medium enterprises (SMEs), the "hubs" will be expected to identify and work together with "spokes", in the shape of bodies in close touch with industry in both metropolitan and outlying regions. In this way, it is hoped that the network will be well used and effectively promoted. The national networks will market both CLEANTEC products - including Micro-METADEX, the guide to sources, INECA Journal, and parts of the REED database - and inquiry services.

This will be done on a commercial basis, but with pricing angled to promotional considerations and the situation of SMEs in developing countries. Subscription and inquiry fees are envisaged, as well as charges for electronic and printed products. Participants are expected to obtain an income from their network activities.

Meanwhile, action has been taken to promote the CLEANTEC concept. An information pack containing an introductory brochure and a set of loos-leaf fact sheets has been produced and distributed at the UN Conference on Environment and Development in Brazil.

A fruitful new source of information has recently been gained for the programme, in the shape of the US Environmental and Energy Efficient Technology Transfer Clearinghouse. INTIB has been selected as a focal point for this system.

The Clearinghouse is an on-line computerized information service, developed by the US Environmental Protection Agency, Department of Energy, and Agency for International Aid. The service, which is supported by experienced literature searchers on a hot line, has access to over 500 databases.

It will provide information on publications, consultants, technology vendors, technology options, databases and other topics. (Extracted from *INTIB NET*, 1992)

Software and competitiveness in developing countries
(Based on a paper by UNIDO consultant Atul Wad)

Well designed software can make an important contribution to the efficiency of companies in the developing world. International competitiveness has become a central concern owing to trends towards market liberalization and privatization.

Yet the growing literature on the software industry in developing countries has paid surprisingly little attention to the potential role of software applications in enhancing the efficiency of enterprises. Despite the many examples of software applications that have made significant contributions to productivity in various sectors, no systematic study of this experience has so far been made.

Changing context

The global context for development has changed. International competition has intensified, and capital and manufacturing are being globalized.

The pace of technological innovation has accelerated, and science-based, knowledge-intensive technology is spreading.

Niche markets are being developed, and product differentiation is taking place, on an unprecedented scale.

These changes are reflected in revised concepts of efficiency and productivity, with a shift of emphasis from economies of scale to economies of scope, and towards flexibility and innovativeness.

With the shift to a new techno-economic paradigm, the traditional competitive advantage of the third world - cheap labour - may be eroded.

To maintain their competitiveness, developing countries will have to strengthen the process of technological development and capability building in their industries, in order to make them more productive.

Developing countries must evolve international business strategies. They will require more sophisticated marketing and market intelligence. Their firms will need to define "niches" and windows of opportunity, and enter into cooperative arrangements with companies in other countries, so as to deliver quality goods or services at the right time and price.

Companies in the South must improve the quality of their manufacturing processes and products. New management techniques will be needed in order to improve productivity.

These are not easy tasks. As technology becomes more complex, it becomes harder to assess the merits of different solutions without some basic resident expertise.

At the same time, a more sophisticated approach to marketing requires networks, contacts, expertise and resources that companies in the South can seldom afford.

The culture and infrastructure of support service organizations in "soft" areas such as marketing, quality control and management rarely exist in developing countries.

The role of software

While there has been much concern over the implications of the computer revolution for developing countries, debate has centred on the hardware aspects.

Several countries have made inroads into manufacturing of peripherals, but the participation of the third world in the software industry has been much smaller.

The USA continues to dominate the global industry, which is projected to expand to $340 billion by 1996. Developing countries account for barely a few percentage points of this business, although in some countries the software markets are growing rapidly.

Recent trends in the industry may open new opportunities in niche areas, whilst closing existing options.

One opportunity is presented by the shortage of trained staff. So called "body-shopping" is offered by Indian companies that sell cheap labour for software development via marketing arms in industrialized countries.

Here, a common problem is that potential clients are uncomfortable with arms-length transactions. Nevertheless, several companies from developing countries have been successful in selling software services to clients in the North.

Many developing nations suffer from low productivity, inadequate maintenance, low skill and educational levels, shortages of materials and poor supervision of staff.

Damachi and Souder argue that such problems lend themselves to computer applications. The latter benefit from declining hardware costs, can be made user-friendly, and are mostly standardized. Computer applications can:

- Eliminate or reduce repetitive tasks;

- Facilitate productivity control;
- Assist in quality control;
- Improve the quality of information storage, retrieval and analysis; and
- Support decentralized decision-taking.

However, the rate of diffusion of software applications in developing countries has generally been slow. This is partly a function of the slow adoption rate of computer technology, as such. In general, large corporations and the public sector have been the driving force in generating demand for computer technology, while small and medium enterprises have been less active.

Apart from poor infrastructure and communications systems, the barriers to the spread of computer technology include: lack of understanding of the potential benefits; perceived high costs; lack of finance; security worries; shortage of trained personnel; and antiquated management structures that do not lend themselves to computerized methods.

In addition, potential users face a shortage of local companies capable of delivering software applications effectively. Many are simply vendors.

In countries where hardware has been oversold and under-utilized, there may be a general mistrust of the technology.

Government policies that favour exports of software services, rather than fostering domestic demand, may also contribute to slow diffusion.

Despite all these difficulties, software applications can make a great contribution to productivity improvements in developing economies.

Examples of successful applications cited by one author include: a Brazilian municipal management model that projects cash-flow requirements; an accounting system for businesses operating in the hyper-inflationary conditions of Argentina; an Anglo-Indian system for monitoring foreign exchange transactions; and the adaptation in Tunisia of standard software packages for Arabic speaking countries.

Balanced development

A balanced approach to the development of software industries in the South would take into account basic needs and agriculture, the government sector, productivity improvement in industry and services, and software exports.

At the basic needs level, software can play a useful part in improving the quality of social services, health care, education and training.

In developing countries, the State tends to play a crucial role in the economy as a whole. This is because of its purchasing power, and frequently large State industrial sectors. In addition, the inefficiency of government bureaucracies is often cited as the main obstacled to industrial growth. Software can help to reduce administrative delays.

A balanced approach to software needs to be based on the generation of a demand for software services, and enhancement of the supply of inputs, such as trained personnel.

Despite export concerns, it should be remembered that an export capability cannot sustain itself without a strong domestic base. If an "enclave" situation emerges, the software industry may price itself out of the home market.

Thus in India, where software engineers are very highly paid by local standards, small business are unable to afford software services.

Since the path pursued by the software industry in the North is itself being questioned, imitative strategies will not work.

In future, software will be called upon to resolve problems that are not amenable to algorithmic solutions, involve judgemental decisions, require highly context specific knowledge, do not have ready-made solutions, or must be addressed in the absence of adequate data.

New possibilities are opening up. For instance, there is increasing interest in process control and monitoring software, based on expert systems, to address environmental concerns.

Meanwhile, "knowledge-based engineering", which provides a means of storing "product or process attributes, rules and requirements" and using them to generate designs, tooling or process plans, is providing more powerful and flexible design tools than conventional CAD.

For the developing world, where design times tend to be lengthy, this software could assist in reducing time to market, leveraging existing engineering knowledge and improving the capacity for concurrent engineering.

Thanks to the advances in hardware technology, it is not unlikely that knowledge-based engineering

systems will soon be able to reside in smaller workstations or even PCs.

Capabilities

Three broad categories of technological capability can be identified as important for the software industry:

- Technology sourcing;
- Technology adaptation;
- Technology delivery to end users.

Technology sourcing is more of an art than a science, but certain general principles have proved useful. Among these are: a horizontal perspective, in that applications in one area may be useful in another, a global perspective; an on-going effort for which a given person or persons should be responsible; personal contacts; and careful assessment of the software needs of domestic industry.

According to a senior executive of a large Indian software company, sourcing is labour- and time-intensive.

He said that fairs and exhibitions around the world were an important source of information.

He told the author that the demand for software existed on the home market, but the needs had to be understood, and this was best done through surveys, trade journals, manufacturers' associations and feedback from sales forces.

The executive found that large customers generally knew what they needed, but smaller firms were less clear and had to be persuaded.

He stressed the importance of keeping abreast of technical literature.

Clear procurement policies and mechanisms, proper costings and realistic prices were also important, he added.

Finally, the interviewee stressed the importance of negotiating technology acquisition with a full knowledge of the legal, accounting and proprietary issues.

Technology acquisition ought to be followed by an efficient process of assimilation. However, firms in developing countries often spend long periods adapting and absorbing new software technology.

The same issue arises on the delivery side. Adapting software to the specific needs of the customer, training users, follow-up and troubleshooting are essential - but customers are often left stranded with software packages they cannot use.

Software in Jamaica

A recent Jamaican study by Gillian Marcelle is one of the few thorough analyses of a software industry in a developing country.

According to Marcelle, sources of software tended to be: hardware manufacturers (operating systems); specialist software houses; specialized applications suppliers, or large distribution firms, mainly in the USA.

Sourcing costs ranged between 0.3 per cent and 24 per cent of the revenues of the firms studied.

The average level of spending on technology acquisition was high compared to other sectors in Jamaica, indicating the relative importance of this function to the computer industry.

Marcelle found that, while the Jamaican industry had become very adept at identifying and adapting overseas technology, and keeping in touch with the state-of-the-art, the ability to create new or fundamentally altered products was weak.

To contribute substantially to the competitiveness of local manufacturing companies, this capability would, however, be needed. (Source: *INTIB NET*, 1992)

An unlikely couple

At first sight, Cics and Z seem an odd couple. Cics is IBM's on-line transaction processing warhorse, a classic of pragmatic commercial software development. Oxford University's Z is a formal specification language based on a mathematical notation that employs set theory and logic to build abstract models.

Yet the application of Z to Cics won a 1992 Queen's Technological Achievement Award for IBM's UK Hursley Laboratory and the Computing Laboratory at Oxford University. Z was used to help restructure core elements of Cics in developing its ESA version 3.1 and for the retrospective specification of standard Cics interfaces.

In the next phase of their collaboration, IBM and Professor Tony Hoare's Programming Research Group at Oxford are focusing on a project called Clean/Z. This will explore how the quality of software developments can be enhanced by combining Z with Cleanroom and literate programming methods.

The Z notation was inspired by French mathematician Jean-Raymond Abrial while he was working

at the PRG in the early 1980s. About the same time Harlan Mills, at IBM's US Federal System Division, began developing the Cleanroom software engineering process.

This aims to reduce software defects and to provide accurate measures of reliability, such as mean-time to failure. The Cleanroom process divorces testing from design and implementation phases. Checks are made during development to ensure the software correctly implements its design. Statistically-based, functional testing is conducted after the whole product has been assembled.

Literate programming was developed by Donald Knuth of Stanford University, California, for his Tex language and Web documentation system. It provides an elegant means of structuring programs to make them easier to read and write.

A literate program consists of a sequence of named fragments introduced in the order which best helps the reader's understanding of the narrative flow. Like numbered chapters in a book, the fragments can be produced in the sequence most suited to the writer's thought processes.

Although these methods evolved independently, Jim Woodcock, the PRG's external studies director, has been surprised and gratified by the degree to which Z matches Cleanroom and literate programming requirements. This is confirmed by Glyn Normington, a member of IBM's Cics/ESA development team with extensive Z experience.

Z can also assist with the definition of abstract data types. Cleanroom specifications say what effect any sequence of operations, known as a "stimulus history", has on a given abstract data type.

The Cleanroom life cycle progresses from the highest level specification into code through a series of "refinement" steps. A review is carried out at each step to check the correctness of program fragments. Z facilitates this by enabling specifications to be constructed from named fragments called "schemas". The schema's name can be used in a program instead of the full mathematical text, as would be done with a macro.

Z has also been of great value in creating definitive interface specifications. These include the first precise statements of the behaviour guaranteed for the Cics application programming interface, which consists of commands that can be embedded in C, Cobol and other programming languages to access Cics services.

Z's help in clarifying the API and Cics communications interface has also assisted in building the recently-announced RS/6000 Unix version of Cics. That showed the old warhorse could be moved successfully onto fresh pastures.

The collaboration has also helped in the development of tools to support Z, such as software to display and print its complex notation. For Clean/Z, additional tools are being used. These include a parser and type checker, code collector and IBM's BookMaster for text formatting. In the longer term, tools for automatic correctness proving are being investigated.

Aids such as these are vital if Z is to be taken up more generally. Another boost would be the establishment of an internationally agreed Z standard. This is being spurred on by IBM, Oxford, British Aerospace, BP and others in the ZIP project, funded by the Science and Engineering Research Council and Department of Industry.

Z's appeal could also be enhanced by the way it meets the reuse and prototyping objectives popularized by object-oriented methods.

Benefits such as this and the quality management potential of Clean/Z indicate that Z might indeed attract a wider audience. (Extracted from *Computing*, 26 November 1992)

Euro project prepares for MPP

A consortium of European companies and research institutes is working on the development of a set of tools to make supercomputer software suitable for massively parallel processing (MPP) machines.

The ESPRIT-funded Prepare project is developing an environment in which High Performance Fortran programs can be developed or restructured in a machine-independent way.

The project has three basic strands. The first is a parallelization module based on the High Performance Fortran language, a de facto standard for MPP applications.

The second is an interacting module that helps the programmer to specify data distribution. It reports to what extent the system is able to parallelize the program automatically, and on obstacles it may encounter.

The third strand is to integrate the first two with efficient compilers optimized for parallel execution.

The interacting module has access to the internal representation of the compiler as well as to the parallelization module. (Source: *Electronics Weekly*, 2 December 1992)

Software cuts time to develop fuzzy logic

National Semiconductor has slashed the development time taken to produce fuzzy-logic programs for embedded controllers. NeuFuzz 4 is a software product that harnesses the self-learning capabilities of neural networks to cut development time from weeks to a matter of hours.

Fuzzy logic allows input parameters to be described in non-specific terms like "warm" and "cool" instead of "hot" and "cold". These descriptions are known as membership functions.

The problem is that the task of developing the rules that decide the boundaries of membership functions can be particularly onerous for complex systems.

The popular method is to use heuristic, i.e. trial-and-error techniques, which can take several weeks. Even when using software tools developed for the purpose, heuristic algorithms can take weeks to develop.

The NeuFuzz software allows initial conditions to be set up whereupon the program can be left to execute and the neural network algorithms learn the required results. NeuFuzz programs can calculate an output from two or four parameters, each of which can have seven membership functions. (Source: *Electronics Weekly*, 21 April 1993)

Compression software cuts down memory

To cut down on the vast amounts of memory used to generate colour images, a small Silicon Valley start-up has released an image handling, compression software. Storm Technology's PicturePress is a suite of image handling tools for Macintosh operations. The software is capable of compression ratios ranging from 2-to-1 up to 2-to-100. PicturePress is the first application to generate 24-bit PICT JPEG previews for EPS and EPS PJEG files using QuickTime. PicturePress files are also able to be transferred between Macintoshes and MS-DOS based machines because the software supports JPEG, TIFF, and EPS files formats. (Source: *Electronics Weekly*, 5 May 1993)

VI. COUNTRY REPORTS

China

Telecoms firms take China by storm

European firms have been having a mini boom in China. Ericsson, Alcatel and GPT have won telecommunications orders totalling over $500 million. Alcatel will build two joint venture factories in Chengdu and Hubei regions to supply over two million lines of digital switching equipment and optical line systems. Ericsson, already the main cellular network supplier in China, has won a further order to double the capacity of the network in Guangdong province to over 500,000 subscribers. GPT has announced a first contract to supply digital cordless telephone CT2 equipment to China. Alcatel and Ericsson are building on their long-standing strength in China. Alcatel has supplied 40 per cent of China's digital switching equipment. (Source: *Electronics Weekly*, 24 February 1993)

China to buy $2 billion of chip equipment

Chinese officials have said they plan to buy as much as $2 billion worth of US equipment to produce computer chips over the next two or three years, according to newspaper reports.

High-level officials first raised the possibility of such large purchases during a meeting with US executives in Beijing in May.

"The Chinese decision appears to signal Beijing's intention to become a power in the highly competitive global computer industry over the next decade", the newspaper added.

The equipment it is reportedly seeking is for basic component manufacture.

Until many restrictions were relaxed last year, the sale of such equipment to China had been banned by the multinational group that vets the export of advanced technologies to communist States. (Extracted from *Electronics Weekly*, 10 February 1993)

Laboratory makes superconductor

Researchers at the Shanghai Metallurgical Laboratory have fabricated a bulk-type superconductor with a 100,000 A/s cm current density at 77° K. The researchers made the yttrium-based superconductor material using a quench and melt growth fabrication method. (Source: *Technology Update*, 19 October 1992)

European Community

Open systems project shows early results

Europe's open systems initiative for microprocessors should begin yielding results ahead of schedule, according to the manager of the EC-funded Open Microprocessor systems Initiative (OMI), Jean Pierre Demange.

Demange said that several of the 20 projects, begun in 1992 on the pre-competitive R&D programme ESPRIT, are expected to be commercially implemented

by 1995. The average project is expected to take three years before implementation.

The core of the European strategy is to strengthen its capability in 32-bit Risc processors and to develop on-chip macrocells.

Fifty organizations and companies are engaged in developing hardware, software and operating systems under the OMI umbrella. Licensing of the Inmos transputer and ARM microprocessor is seen as widening the commercial base of European micros. (Source: *Electronics Weekly*, 17 February 1993)

EC opens chip project door to non-Europeans

Europe may open microprocessor research projects to companies from outside the European Community.

Jean Pierre Demange, head of the European Commission's Open Microprocessor systems Initiative (OMI), has said that companies that showed a commitment to Europe by undertaking R&D and manufacturing within the Community could participate in future OMI projects, and he anticipated that the programme would extend beyond 1995.

Stressing the urgency of the OMI programme, he said that 98 per cent of the market for standard microprocessors was taken by two US companies - Motorola and Intel. He said that Europe stood a far better chance when it came to 32-bit embedded Risc processors. European makers took a 36 per cent share of this market.

OMI uses an open processor architecture, rather than a closed or proprietary one. This means that software can be transported from one processor to another. For strategic reasons Europe's OMI encompasses the US Sparc and Mips processors, as well as Europe's transputer and ARM processors.

OMI uses an architecture that is based upon the use of a library of macrocells. Different circuit functions are brought together on a single silicon substrate to produce a customized processor for volume applications.

The programming software will be capable of being transported from one processor to another. Demange said that an ESPRIT IV stage would be commercially exploited in a wide range of products.

He went on to stress the urgency of action by comparing the $17 billion to be spent by the US for its technology programmes under the present administration with the EC's £350 million for ESPRIT III. (Source: *Electronics Weekly*, 17 March 1993)

Germany

Optimistic communications market

Although economic growth in Germany will slow to a snail's pace in 1993 - 0.5 per cent is the most optimistic forecast for the year - the country's market for communications equipment will again increase by 7 per cent to 8 per cent, the industry says.

As it is for most other European countries, the Germany communication market's biggest sector is that for digital public exchange systems; it will remain so for quite some time as, by early 1992, only one fifth of the country's 33 million telephone subscriber lines were tied to a digital switch.

Although digital exchange systems are the industry's mainstay, making the headlines these days are two other sectors: data transmission systems such as metropolitan area networks and digital mobile communication even though these sectors have not provided significant growth. (Extracted from *Electronics*, 11 January 1993)

Korea

Electronics industry to grow

Korea's electronics industry should enjoy a moderate growth in production and sales in 1993, says a report by the Electronics Industries Association of Korea (EIAK). EIAK expects production, exports and domestic sales to increase 9.1 per cent, 10 per cent and 6.5 per cent to US$ 37 billion, US$ 23.3 billion and US$ 9.6 billion, respectively. This projection is based on the assumption that the domestic and major overseas markets such as the US will recover and the industry's globalization effort and continuous investment in new product development will bear fruit.

By industry sector, industrial electronics is expected to do well due to rising demand for telecommunications equipment and computer peripherals. Consumer electronics will do less well because of evermounting protectionism in its major outlets such as the US and Europe and greater price competitiveness.

Amid the rosy prospects, the only concern for the industry is the mounting pressure from the US and European Community for Korea to reduce subsidies, and the introduction of anti-dumping rules. (Source: *Electronics*, 11 January 1993)

Russian Federation

Microsoft moves to Moscow

Hundreds of new jobs will be created in Russia's computer industry following a decision by Microsoft to manufacture its products there.

At a recent press conference the firm announced that it is to base its operation at the factory of Kazan Software Publisher (KSP), 650 kilometres south-east of Moscow, once the largest mass producer of pirated software in the former Soviet Union.

Although details about pricing and orders have yet to be finalized, a formal announcement is expected this spring, with production due to start later this year. Employment will be boosted not only in the country's up-and-coming software sector, which employs assembly workers, technical staff and translators, but also in the rapidly modernizing hardware sector, with which Microsoft is also in close cooperation.

Localized production offers many benefits, especially in reducing the dollar drain on the company. At the moment, Microsoft supplies all of its Eastern European markets from its factory in Ireland, a manufacturing location chosen by several other leading software companies.

The firm expects to spend around $3 million (ECU 2.4 million) each year for the next five years in the former Soviet Union, including the Baltic States where growth has been quickest. Further investments will be funded from roubles derived from sales. Production at Kazan will cover many of Microsoft's growing inventory of "localized" software, including best-selling versions of Word and Windows programs. (Extracted from *The European*, 18-21 March 1993)

United Kingdom

UK adopts EC health directive on display screen equipment

The UK Health and Safety Commission has become the first to incorporate the provision of European Community Directive No. 90/270/EEC into national law. The regulations set out minimum safety and health requirements for work with display screen equipment, including software, furniture and lighting systems.

Under the new rules there is a compulsory obligation on employers of workstation users - ranging from word-processing stenographers to computer-aided designers - to analyse all workstations for compliance, to assess health risks and to provide eye tests for users on request. They will also have to plan display screen work so that there are breaks or changes of activity and to provide full training and information for users.

Technical requirements in the regulations are minimal, specifying only that keyboards must be separate from screens, and that screens must be adjustable for tilt and swivel and have readily accessible contrast and brightness controls.

The only mitigation is that non-compliant equipment already installed and in use on 31 December 1992 need not be changed until 31 December 1996. (Source: *Electronics*, 14 December 1992)

Chip makers ready to up production

Semiconductor makers in the UK are expecting to turn up production as the market continues to move out of recession.

A survey by the Semiconductor Manufacturers Association (SMA) reveals that 67 per cent of those surveyed expect production to increase. The same number are forecasting the total market will increase while 78 per cent are anticipating an increase in export sales.

A massive 88 per cent report total bookings and export bookings have increased and 78 per cent report the same situation on billings.

While the climb away from the pits of the recession is welcomed there is a note of caution. Only 22 per cent are expecting an increase in average selling prices. Increased business will not produce a jobs boom as only 22 per cent expect to increase their workforce over the next 12 months.

Increased research and development spending is anticipated by 38 per cent. The rest expect R&D spending to remain static.

The figures are the first of what will be regular quarterly surveys of the semiconductor industry in the UK. The SMA is an association within the Electronic Components Industry Federation. (Source: *Electronics Weekly*, 17 February 1993)

United States of America

DARPA to spend on multichip programme

The US defence research agency DARPA is funding a development programme to reduce the cost and time necessary to produce new multichip module designs.

The goal of the Application Specific Electronic Module (ASEM) programme is "to ensure that MCM technology becomes as accessible to systems designers as ASIC technology is today". The programme will run for two and a half years and aims to reduce module development time by a factor of four. Currently MCM prototyping can take 16 weeks or more, but one of the

participating companies reckons it will be able to reduce the time taken from receiving a design to delivering a tested prototype within four weeks. The project will define a family of standard MCM carriers with associated sockets and fixturing. It will also standardize a die library format and substrate sizes with preprocessed power, ground and decoupling layers. Like gate arrays, these substrates can be customized quickly using two signal routing layers. Design kits will be produced for use with major EDA software tools.

The standardization initiatives will similarly help reduce the non-recurring engineering charges from about $100,000 for a moderately sized module to about $25,000. (Source: *Electronics Weekly*, 10 February 1993)

VII. STANDARDIZATION AND LEGISLATION

Standardization

Europe's GSM standard gains acceptance

Europe's GSM (Global System for Mobile Communications) standard for cellular mobile communications is finding ever greater acceptance. Drawn up only during the past few years, this digital standard will be or already has been adopted by more than 50 countries around the world.

Dominating the scene, however, will still be the US standard, the Advanced Mobile Phone System (AMPS) standard. Of the 100 million cellular mobile telephone subscribers world-wide that Siemens predicts for the year 2000, 48 million will be in the AMPS and 31 million in the GSM camp. Japan's Nippon Telegraph & Telephone (NTT) standard will account for 13 million.

For most West European countries, the boom years will come when GSM is off and running.

Taking a look at West Europe as a whole, Infratest predicts some 12.9 million telephone subscribers by 1995, which compares with 3.37 million in 1991. Again, GSM will account for the majority of West European subscribers. (Source: *Electronics*, 11 January 1993)

IBM to standardize on chip technique

By the year 2000 IBM is to standardize on the "mini-environment" technology for use in the production of its chips.

Mini-environment technology is a method of transporting cassettes containing the wafers in pods from one cleanroom environment to the next processing stage.

This system of transportation isolates wafers from the factory environment, without incurring cleanroom costs throughout the facility.

The establishment of a world standard for the mini-environment technology is being organized by a special task force.

This task force is made up of researchers from the European and US research programmes JESSI and Semitech. (Source: *Electronics Weekly*, 20 January 1993)

JEDEC plans 2.5 V power specifications

The Joint Electronic Development Engineering Council (JEDEC) plans to complete a specification for chips operating from 2.5 V power supply within the next year.

Although 3.3 V ICs have just begun to break into the market, work has started on the development of the new standard that will further reduce the power requirements of portable equipment such as notebook computers.

Key members pushing the development include Digital Equipment, Hewlett-Packard, Apple, Intel, AMD and NEC.

According to JEDEC, there are two main reasons for lowering the voltage. The primary reason is that as ICs continue to shrink in size, the amount of power used must also be lowered to enable the ICs to perform at optimum levels.

It will be several years before manufacturers have the capability to manufacture ICs below 0.35 microns. Currently the smallest ICs being mass produced range from 0.6 to 0.8 microns.

The second big reason for the push towards a lower power supply is to save battery life in portable devices and notebook PCs.

While the development of the 2.5 V standard has been backed by several industry players, it is also meeting some resistance. Hitachi of America said that it may be a little premature to develop a new voltage standard because it wants to keep only two generations of DRAMs using different voltages, and if there were more than a couple of choices, it would force Hitachi to support additional types of DRAMs. (Source: *Electronics Weekly*, 10 February 1993)

PEP sets up field bus standard user group

PEP Modular Computers is setting up a British Profibus User Group, the inaugural meeting of which

will be held at the Control & Instrumentation Show in Birmingham in May.

Profibus is a German serial field bus standard for use in the factory automation and process industries. The British group will have the name PNOUK.

A field bus is a shielded twisted-pair cable running between nodes in an industrial environment. It uses serial communications to link robots and motors to a plant's supervisory computer system.

The Instrument Society of America, via its SP50 committee, has been trying to develop a world-wide field bus standard for some years. In terms of the seven-layer Open Systems Interconnection model, standards need to be defined for layers 1, 2 and 7, with a special user-interface eighth layer also required.

To date the SP50 has agreed a standard only for level 1. Alternative de facto solutions to the other layers come from Germany with Profibus and France with FIP, both of which have the support of about 100 companies.

A spokesman for PEP said that the group would accept an SP50 standard if one was agreed by the end of the year. In the meantime it would offer an upgrade to the new standard to existing users of FIP or Profibus. (Source: *Electronics Weekly*, 10 February 1993)

CAD group releases framework standards

The CAD Framework Initiative, supported by 50 international electronic design automation (EDA) vendors and users, has released the first version of its framework integration standards.

The new version 1.0 includes developer toolkits, a certification process and a testing lab to ensure compliance.

The release marks a definite turning point in the EDA business as rival tool vendors agree to team up on integration efforts, leaving more time for other value-added development efforts. Participants include IBM, Cadence, Hewlett-Packard, Mentor Graphics and Sun.

Release 1.0 claims to provide users with the ability to connect design tools by manipulating and exchanging some basic netlist data with limited support for tool encapsulation and communications.

The first release, costing $350 to members and $500 to non-members, includes four major specification areas: design representation programming interface, inter-tool communication programming interface, tool encapsulation specification and computing environment services.

Version 2.0, expected for the year-end, will include integration of front-end such as synthesis, capture, logic and timing simulation and wave-form generation.

Release 3.0, scheduled for the end of 1994, will encompass the complete integration of front end tools with specific physical design implementations and manufacturing methodologies. (Source: *Electronics Weekly*, 24 February 1993)

Standards issues for RF-ID

Standardization is becoming more of an issue as the radio-frequency identification market takes off. Both technical standards and standardization of code formats are subjects of discussion.

Technically, the debate revolves around amplitude versus frequency modulation.

The method of measurement of radio-frequency power used by RF-ID systems, at least at the low-frequency end of the spectrum around 130 kHz, gives a pulsed system some advantage. In the UK, for example, standard specifications set average field strength measurements in millivolts or microamperes per metre.

But coding of data is another matter. It is essential that transponders made by one manufacturer can be read by another's system depending on the application. The agricultural sector is furthest ahead in the area, with at least agreement that there should be a standard for livestock tagging being reached at a recent meeting of the International Standard Organization at Orlando, Florida.

The International Air Transport Association (IATA) has already tentatively agreed that RF-ID should be the baggage tagging technology of choice.

These industries, together with others that need to keep track of thousands of items, will provide the mass market for simple transponder devices. These devices have capacity for a single 64-bit unique code number that is transmitted back to a receiver when interrogated with an RF signal.

Other applications such as access-control security, manufacturing tracking or the decrementing of a stored value demand more flexibility. Extra data to be transmitted imposes a need for data rates that frequencies of a few hundred hertz cannot sustain. So the next move will be to microwave frequencies. Here the world starts forming into blocs. For a pan-European standard, the European Telecommunications Standards Institute (ETSI) is setting out to identify a common frequency at around 5.8 GHz. (Source: *Electronics*, 8 February 1993)

Prolog language set to raise ISO standard

The 20-year-old artificial intelligence (AI) language Prolog has been standardized, after 15 years of commercial availability.

Prolog is mainly used by applications such as expert systems - a recent successful application was for a pig-breeding knowledge base - but it can also be used for commercial IT applications.

The draft standard, which unifies the different dialects of Prolog that have evolved and defines a common subset of routines, is based largely on Edinburgh Prolog, already adopted by many Prolog users, though each has its own variations.

The draft standard was published by the National Physical Laboratory, but it will be at least two years before it becomes a full international standard.

Lack of an ISO standard for Prolog has hampered its take-up in the US, where Lisp is usually preferred for AI applications. Although issues such as error handling, for which most Prolog companies have adopted their own methods, still have to be thrashed out, Prolog suffers very little from the political infighting that bedevils many other areas of computer industry standardization.

Areas for Prolog to standardize include interfaces to SQL, object-orientation and constraints operations where users can reduce the amount of searching a Prolog system needs to do. (Source: *Computer Weekly*, 22 April 1993)

USA to adopt UN EDIFACT

As the USA was voting for a new President in late 1992, the American National Standards Institute (ANSI) was deciding whether to continue developing domestic standards for Electronic Data Interchange (EDI) or to move to the international standard UN/EDIFACT.

The result of a ballot was a large majority in favour of UN/EDIFACT. The ANSI committee responsible for EDI standards, ANSI X12, will now stop developing their national messages after X12 version 4, expected in 1997. After that, they will devote their efforts to the international standards being developed within the United Nations framework.

Since the first UN/EDIFACT standard was agreed upon in 1987, it has played a key role in the work of standardizing the electronic equivalents of purchase orders, invoices, payments, transport and customs documents. Over 50 UN Standard Messages have already been agreed upon and work is progressing in some 70 more, covering all aspects of administrative, commercial and transport transactions.

The European Commission, through its Tedis programme, has been providing the secretariat for the Western European EDIFACT Board, and support for message development groups since 1988. While Europe was quick to realize the importance of international standards in EDI, the USA has, until now, preferred to work with domestic messages. The decision is seen as a clear signal to businesses world-wide that confusion over different standards is no longer a reason to hold back from implementing EDI. (Source: *XIII Magazine: News Review* (published by the European Commission), Issue No. 5/92)

WTSC concludes

Over 450 telecommunications standards were approved at the ITU's World Telecommunication Standardization Conference, which concluded its work on 12 March 1993. The Conference, which met in Helsinki, Finland, with representation from 68 countries and eight international organizations, was intended to further streamline ITU's Telecommunication Standardization Sector, so as to increase its competitiveness in the global standardization arena. It sprang from a decision taken at the last meeting of the legislative body governing standardization at ITU, in Melbourne, Australia, in 1988. The legislative body was then known as the Plenary Assembly.

The World Telecommunication Standardization Conference (WTSC) decided to set up a Telecommunication Standardization Advisory Group whose role will be to review priorities and strategies for activities of the Telecommunication Standardization Sector, to review progress in the implementation of its work programme and to recommend measures to foster cooperation and coordination with other standards bodies, and with other organizations that have an interest in telecommunications standardization.

The conference saw the official launch of ITUDOC - the organization's electronic document exchange service, which includes not only administrative and general information documents, but also the full texts of ITU telecommunications standards approved since 1988. It also announced the availability of all ITU telecommunication standards on CD-ROM. (Source: *ITU Press Release* ITU/93-4, 12 March 1993)

PC makers agree new bus standard

A group of leading personal computer makers has agreed an enhancement to the bus structure of standard IBM-compatible computers that will allow servers with up to four times the I/O bandwidth of existing machines to be built. The Extended Industry Standard Architecture (EISA) bus consortium, which includes companies like Compaq, Intel, Olivetti, DEC and Zenith Data Systems, was originally set up to standardize and improve the Industry Standard Architecture (ISA)

around which IBM-compatible computers were built. The new specification, called EISA with Enhanced Master Burst (EMB) addendum, offers two new transfer rate modes. The first doubles the 32-bit burst transfer rate from 33 to 66 Mbyte/s, and the second widens the data path to 64-bit thereby achieving a peak transfer rate of 133 Mbyte/s. (Source: *Electronics Weekly*, 12 May 1993)

Legislation

Russian firm claims basic DRAM patents

A Russian company says it has a fundamental patent on all DRAMs at the 256k generation and denser and seeks a Western partner to help extract royalty payments worth $1 billion a year.

According to Vladimir Solomonenko of Nortec, the Russian chip design house based in Zelenograd near Moscow, the patent relates to the connection between the bit line and the amplifier. Solomonenko says that, as memory size gets bigger, the less chance there is of using any other method of connection. He reckons every DRAM manufacturer uses the method today.

Solomonenko says that the patent dates from 30 September 1976 which has been accepted as the priority date in the USA, Germany and the UK. He says Siemens' application for the same patent was rejected by the German patent office in 1977 because of Nortec's prior patent the previous year.

Nortec led the Russian DRAM Project of the 1970s which designed the first Russian DRAM. (Source: *Electronics Weekly*, 2 December 1992)

Taiwan steps up enforcement of intellectual property licensing agreement

Taiwan is stepping up enforcement of the Taiwan-US Memorandum on intellectual property rights, in which Taiwan agreed to inspect goods destined for the US for copyright violations before issuing the export licence. The agreement, signed in June 1992, marked the first time that any country agreed to export inspection.

Beginning January 1993, Taiwan's Bureau of International Trade, the agency responsible for issuing export permits, will begin inspecting the software coded on integrated circuits.

Since September 1992, the agency has been inspecting software on all computer items departing for the US, including software on diskettes, and printed circuit boards, cartridges, computers, printers and video game sets. The routine procedure is to randomly inspect one to five pieces out of every 100 items for any possible violation of US-registered copyrights.

The Bureau reports that it has not found any violation of the copyright of the 95 software items, including operating systems and BIOS, registered with the Taiwan Government by the owner of proxy of the copyright. (Source: *Electronics*, 14 December 1992)

VIII. RECENT PUBLICATIONS

Diffusion of advanced telecommunications in developing countries

Few changes are having a greater impact on the ability of firms and countries to compete in global markets than the revolution in telecommunications. The new capabilities of information processing and transmission are profoundly transforming requirements for human skills, for capital equipment and for corporate strategies in countless manufacturing and service industries. This transformation affects both developed and developing countries.

A study published by the Organisation for Economic Cooperation and Development (OECD) examines in detail the economic factors underlying the speedy adoption of advanced telecommunications in many newly industrializing economies and shows how they can catch up with - and even leapfrog - certain OECD countries. The study cites macroeconomic evidence and provides a model of diffusion linking technological change, investment and productivity growth.

Entitled *The diffusion of advanced telecommunications in developing countries*, the study, written by Christiano Antonelli and produced by the organization's Development Centre, costs F79. ISBN 92-64-13578-2. For further details, contact the Development Centre, OECD, 94 rue Chardon Lagache, 75016 Paris. Tel.: +33 1/4524 8219; Fax: +33 1/4524 7943.

ASTM standards international - new publication for the International Standards Community

ASTM, one of the world's largest, voluntary, full-consensus standards development organizations, is publishing an international newsletter. ASTM Standards International will provide the global standards community with the latest scientific and technical information on the standards development activities of ASTM's 131 technical committees. The newsletter, which is free of charge and will be published

periodically, will benefit those in industry, government and academia by serving as a medium for the exchange of information and ideas. The first issue will be available in English and Spanish. Future editions may be printed in other languages.

Topics of interest will include ASTM's cooperative efforts with other international standards development organizations; international issues of environmental concern (such as radon testing, biodegradability and recycling); current ASTM standards development activities; information on the newest ASTM publications; and announcements of ASTM meetings and Standards Technology Training Courses.

The first issue coincides with a non-technical seminar to be held on 8 June 1993 in Mexico City. The seminar will focus on the ASTM standardization system as it relates to international trade. It will encourage international participation in ASTM's technical committee work and increase awareness of ASTM standards, related publications, and their international availability. For more information on the seminar, contact Drew Azzara, ASTM, 1916 Race Street, Philadelphia, PA 19103, USA. Tel.: +215/299-5579; Fax: +215/299-2630. (Source: *News Release*, 24 February 1993)

ILOLEX CD-ROM

A new CD-ROM contains the trilingual (English/French/Spanish) database of the International Labour Organisation (ILO) on international labour standards, together with its search and retrieval software.

Each language version of the CD-ROM, which is called ILOLEX, contains:

- ILO Conventions;
- ILO Recommendations;
- Triannual Reports of the Committee on Freedom of Association from 1985;
- Comments of the Committee of Experts on the Application of Conventions and Recommendations from 1987;
- Annual Report of the Conference Committee on the Application of Standards from 1987;
- Reports of Committees and Commissions established under articles 24 and 26 of the ILO Constitution to investigate representations and complaints;
- Ratification lists by Convention and by country; and
- The ILO Constitution.

The ILOLEX CD-ROM is expected to be of interest to academic and other institutional libraries interested in labour law, as well as the "ILO constituency".

Priced at $850 ($695 for the ILO constituency), the ILOLEX CD-ROM (ISBN 0-7923-1884-6) is available from the publishers at either of the following addresses: Kluwer Academic Publishers Group, Order Dept., P.O. Box 322, 3300 AH Dordrecht, The Netherlands (Tel.: +31 78/52 4400; Fax: +31 78/52 4400) or Kluwer Academic Publishers Group, Order Dept. P.O. Box 358, Accord Station, Hingham, MA 02018-0358, USA (Tel.: +1 617/871 6600; Fax: +1 617/871 6528).

Trade marks on CD-ROM

ROMARIN is a new CD-ROM, just launched by the World Intellectual Property Organization (WIPO). It contains information on all trademarks registered under the Madrid Agreement Concerning the International Registration of Marks in the International Register maintained by WIPO's International Bureau, and which are currently in force.

The ROMARIN CD-ROMs (ROMARIN stands for "Read-Only-memory of Madrid Actualized Registry Information") have been available since June 1992; they were developed jointly with Jouve Systèmes d'Information in Paris, France.

The CD-ROMs contain such information (on each mark) as: the serial number of its registration, the mark itself, the name and address of the owner, and data on exclusions or limitations.

If a mark contains or consists of an image, the image is stored on the CD-ROM in facsimile or bit-map mode.

The total number of international registrations presently valid in WIPO's International Register is around 280,000, approximately one third of which have images. The oldest valid mark was first registered in 1893.

Most of the data are indexed, and can be searched using a wide range of parameters, including the serial number of the registration, the name of the owner, or the details of the mark. Search software has been specially designed.

At present, two CD-ROMs (one containing the complete data from the register, the other containing the images) are distributed. The bibliographic data are provided monthly, the image data once a year.

ROMARIN runs on 80386 or 80486-type PCs with at least four megabytes of RAM, an 80Mb hard disk and a floppy drive. Two CD-ROM drives are

preferable. A yearly subscription to ROMARIN costs Sw F2,000, but a free trial of sample data, as well as further details, are available from Mr Paul Claus, Director Advisor, WIPO, 34 chemin des Colombettes, 1211 Geneva 20, Switzerland. Tel.: +41 22/730 9144; Fax: +41 22/734 1446. (Source: *ACCIS Newsletter*, 10(6), March 1993)

New technology directions: IEEE portfolio of emerging technologies

Electrotechnology faces seven grand challenges, and if it surmounts all seven, many people (1) will be reachable at any time, anywhere, through world-wide personal communication networks and wirefree and fibreless communications, and (2) will have instant access to all information, through databases, high-speed links, and flat-panel displays and interfaces. A person may be (3) present at any time, anywhere, through virtual presence and reality. In the flesh, though, people will (4) enjoy abundant, clean, safe, and affordable energy. (5) travel faster and more safely over intelligent highways, (6) work in paperless offices, and (7) never carry cash, using instead an electronic purse or wallet.

That, more or less, is the conclusion of the New Technology Directions Committee (NTDC), a standing committee of the IEEE Technical Activities Board (TAB). NTDC is also part of an effort to keep the international standards community abreast of the most significant of the latest technical papers.

The technologies crucial to meeting the seven challenges are in many cases highlighted in an NTDC report, a "living document" that has grown in draft form almost every month. Called a *Portfolio of Emerging Technologies*, it is to be published in the Committee's first annual bound volume this year.

NTDC has also begun creating videotapes on emerging technologies; last year saw the first - a video tutorial on microwave optoelectronics by Alwyn Seeds, co-produced by NTDC and the IEEE Educational Activities Department. Also in the cards is a distinguished lecturer programme.

The emerging technologies described in the *Portfolio* range from power electronics through diamond deposition to standards.

To receive a copy of the current *Portfolio of Emerging Technologies*, contact Jayne Cerone by sending an e-mail message to info.new.technology@ieee.org.

For more on IEEE publications, contact the IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08855-1331; Tel.: 908-981-1393. (Source: *IEEE Spectrum*, January 1993)

DESIGN, TROPICALIZATION AND MANUFACTURING OF TELCOMMUNICATIONS EQUIPMENT IN LATIN AMERICA

by Dr. Arturo Serrano Santoyo*

I. INTRODUCTION

Latin American countries are going through substantial changes in their economies, as well as in their telecommunications scenarios. Local equipment manufacturing is being greatly affected by new forces in the market and by privatization and liberalization processes currently undergoing implementation.

The establishment of a programme to promote technological cooperation in the region's telecommunications industry would contribute towards creating and stimulating an integration process, with strategies and lines of action regarding local equipment manufacturing. The purpose of this paper is to identify those elements that support such integration process in the light of the region's particular socio-economic conditions.

Argentina, Brazil and Mexico have the strongest manufacturing base for telecommunications equipment in Latin America. Other countries, such as Chile, Colombia, Costa Rica and Venezuela show very dynamic telecommunications scenarios with great potential towards contributing to local systems manufacturing or assembly.

Another important aspect related to equipment manufacturing is the availability of human resources with knowledge and experience in high technology disciplines. A country with more skilled human resources would be able to attract companies to install manufacturing facilities. The participation of R&D institutions in cooperation programmes with local industry is an important factor to increase productivity and efficiency. In order to provide sound and cohesive results, a regional cooperation programme in telecommunications equipment manufacturing will have to include the aspect of human resources.

II. THE TELECOMMUNICATIONS SCENARIO IN LATIN AMERICA

Recent modernization and regional integration projects are signs of the importance that authorities, operating companies and service providers are giving to telecommunications. Latin America has entered into a dynamic process of privatization and liberalization in which most countries in the region are opening their doors to local private and foreign funds. An avalanche of equipment vendors has established bases and partnerships with local representatives in order to take advantage of the market opportunities created by the new regulatory and socio-economic conditions.

Under this scenario, local telecommunications equipment manufacturing has undergone significant changes; in some cases it has created opportunities for expansion, but in others it has been detrimental. Competitiveness, lack of human resorces and financial factors have been fundamental to ensure the survival of local manufacturing in Latin America. In most cases only multinational companies on their own or in alliances with financially strong local industrial groups, have been able to create or strengthen manufacturing platforms for domestic and export purposes. There are also cases where indigenous companies have taken advantage of current conditions to expand their base and compete in international markets.

In order to establish a frame of reference to discuss issues related to telecommunications equipment manufacturing in Latin America, a summary of the most significant data on telecommunications infrastructure will be presented. This information has been compiled from different sources, the ITU (International Telecommunications Union) being the most important.

First of all, it is important to consider the Latin American region as a whole in its global context. Even though there is a more noticeable presence of new mobile satellite and terrestrial data and digital voice services for corporate and rural applications, the basic telephone infrastructure is the most significant figure to date in defining the status of telecommunications for a particular region. With that in mind, Table II.1 shows the world distribution of telephones by continent. Although the figures show that the Americas have one third of all the telephones of the world, Latin America owns only 6 per cent of the total, as can be seen in Table II.2.

Some important figures are observed from Table II.2: Argentina, Brazil, Colombia, Mexico and Venezuela own 70 per cent of the telephones in the area [1], the poorest countries of the Caribbean area have the lowest telephone density, contrasting with other Carribbean islands with better standards of living. Correlation of socio-economic

*Telecommunications Consultant, Calle 10 y Obregon Local 18 Altos, Ensenada, Baja California, Mexico.

parameters and telephone density is a fact. Furthermore, no country has achieved a higher standard of living without an adequate telecommunications infrastructure [2].

While major technological advances have been made and implemented in industrialized countries during the last two decades, most Latin American telecommunications infrastructures were not able to provide the services required by the economies of their respective countries. The obsolescence of most of the equipment associated to difficult financial situations impeded the achievement of adequate levels of competitiveness. Substantial investment was required to face the challenge of expansion and modernization of the telecommunications infrastructure so as to offer efficient digital services. This condition forced state-owned companies to asses the functions of government in telecommunications. Two main factors were taken into account: the need for financial resources and the realization of the government's inability to operate a dynamic and high technology oriented organization.

In this way, the availability of investment resources and technological changes have transformed the Latin American telecommunications sector from its former governmental monopolistic structure into profitable national telephone operating companies. However, there is still a lot to do in order to modernize the networks and acquire a higher degree of quality to overcome the lag of the past years. In particular, there is a great need to overcome the disparity between urban and under-privileged areas observed in most Latin American countries.

The private telecommunications companies in Latin America have been able to take advantage of the dramatic changes in the sector by providing value added and specialized services such as private satellite networks, cellular networks, electronic mail, videotext and other data processing services. The telecommunications services companies have witnessed substantial growth in the new privatized and liberalized environment and have for most of the time required the use of high technology equipment manufactured abroad to satisfy the pressing demands of competitiveness and quality service. This situation has considerably affected the independent local telecommunications manufacturing companies, which during the former monopolistic and closed market scenario enjoyed a privileged status as exclusive providers of public and private entities.

Table II.3 presents the status of privatization and liberalization of major Latin American telecommunications industries, including aspects of competition in mobile and basic services.

According to CEPAL (Comisión Económica para América Latina y el Caribe) [3], the Latin American average telephone density of 10 telephones/100 inhabitants has to increase to 20/100 by the year 2000 and reach a data processing capacity equivalent to the current figure for industrialized countries. In order to achieve that goal, each country will have to invest an equivalent to 1.5 per cent of their GNP. It would also be necessary to channel between 5 and 10 per cent of gross capital revenue to

Table II.1: The World's Telephones

Continents	Lines (millions)	Population (millions)	Density (lines per 100 inhabitants
America	184,088	739.2	24.91
Europe	186,102	505.1	36.84
Ex-USSR	32,844	295.3	11.12
Asia	108,223	3,047.3	3.55
Oceania	10,103	27.2	37.14
Africa	8,945	810.8	1.10
World	530,305	5,424.9	9.77

Source: Siemens, ITU and Telepress (publications cited)

Table II.2: Latin America's Telephone Network

Country	Total Lines (thousands)	Tel. Density (lines per 100 inhabitans)	Per Capita Income (US$)	Population (thousands)
Brazil	10,020	6.56	2,640	152,705
Mexico	6,670	7.81	3,211	85,490
Argentina	3,880	11.17	2,740	33,050
Colombia	2,750	8.74	1,176	31,440
Venezuela	1,787	8.23	3,538	19,250
Chile	1,112	8.13	2,040	13,670
Puerto Rico	1,033	27.34	6,355	3,750
Uruguay	623	19.96	2,936	3,120
Peru	601	2.64	2,175	22,730
Ecuador	520	4.54	1,267	10,780
Dominican Rep.	385	4.75	773	7,270
Costa Rica	384	12.43	1,701	3,089
Cuba	366	3.41	2,804	10,710
Panama	245	8.92	2,334	2,420
Guatemala	223	2.08	838	9,200
Bolivia	221	2.36	666	7,400
Trinidad & Tobago	182	14.15	4,191	1,230
Bahamas	1,143	57.01	6,654	250
El Salvador	125	2.38	781	5,250
Martinique	122	35.88	3,083	340
Guadeloupe	118	34.70	5,446	340
Paraguay	112	2.61	1,275	4,280
Jamaica	97	4.00	1,149	2,420

Country	Total Lines (thousands)	Tel. Density (lines per 100 inhabitants)	Per Capita Income (US$)	Population (thousands)
Honduras	88	1.72	869	5,110
Barbados	83	31.92	5,658	260
Netherlands Antilles	63	25.11	5,446	200
US Virgin Islands	62	55.00	9,279	111
Nicaragua	52	1.34	976	3,870
Haiti	45	0.69	374	490
Bermuda	41	65.66	16,071	63
Surinam	37	8.61	3,115	430
French Guyana	32	30.76	1,256	104
Guyana	25	3.04	351	822
Belize	23	8.90	1,327	195
St. Lucia	15	11.80	1,231	150
Cayman Islands	12	46.12	11,429	26
St. Vincent/Grenadine	10	9.10	980	110
Dominica (France)	9	10.84	1,184	83
Monserrat	7	53.84	3,230	13
Antigua & Barbuda	6	7.20	1,453	80
Aruba	5	7.20	3,880	60
Grenada	4	4.10	965	98
UK Virgin Islands	4	30.80	6,667	12
St. Kitts & Nevis	3	6.50	1,413	7
Anguila	2	29.00	1,143	7
Turks & Caicos Islands	1	6.70	3,750	8
LATIN AMERICA	32,448	7.31		443,338

Source: Siemens, UIT and Telepress (publications cited)

investment in new information technologies. In summary, the necessary investment is in the order of 2 to 3 per cent of the regional GNP.

This would imply doubling or increasing fourfold the resources invested over the last decade equivalent to 0.5 per cent of the regional GNP.

This same goal of reaching a 20/100 telephone density in Latin America was proposed in a document entitled the **Acapulco Declaration**, which was issued in Acapulco, Mexico, during the Americas TELECOM meeting in June 1992. The basic elements of this declaration are as follows:

ACAPULCO DECLARATION

1. Accelerate the expansion of telecommunications networks to duplicate at least the number of telephone lines in each Latin American and Caribbean country in order to reach a regional density of 20/100 inhabitants at the beginning of the 21st century.

2. Provide telephone access to rural communities and all under privileged urban areas through special programmes that take advantage of the opportunities new telecommunications technologies offer.

3. Promote regional integration through the interconnection of all countries of the Americas through modern telecommunications systems, such as fibre optics, satellite and digital networks.

4. Strengthen audio and image broadcasting systems, incorporating new techologies as well as expanding the area of cover so as to take advantage of radio and TV for the dissemination of information and for cultural and educational diffusion.

5. Stimulate the generation of human resources and improve institutional structures to ensure a sustainable development of telecommunications infrastructure in order to guarantee efficient operation and quality service.

6. Modernize the regulatory, legal and economic structure to create an environment of fair competition to induce public and private investment for the development of telecommunications.

7. Achieve an accelerated rate of expansion and modernization of telecommunications on the basis of financial self-sufficiency through tariff schemes that gradually adjust to cost and incorporate new financial strategies appropriate for the region.

Table II.3: Telecommunications Liberation

Country	Partial or Full Privatization	Mobile Communications Competitions	Basic Services Competition
Argentina	C	C	P
Brazil		P	
Chile	C	C	C
Mexico	C	C	P
Venezuela	C	C	P

C — Complete

P — Planned

Source: *Privatization International*, various issues; Davidson, W.H. Hubert, R, and St. Croix, E. *Telecommunications Policy and Performance*, University of Sourthern California, January 1993; Company documents.

III. LOCAL MANUFACTURING OF TELECOMMUNICATIONS EQUIPMENT IN LATIN AMERICA

Privatization and liberatization throughout the the Americas has stimulated the marketplace and proved to be the key to encouraging huge investments for the improvement of telecommunications services from the world's major lending banks. This in turn has affected the

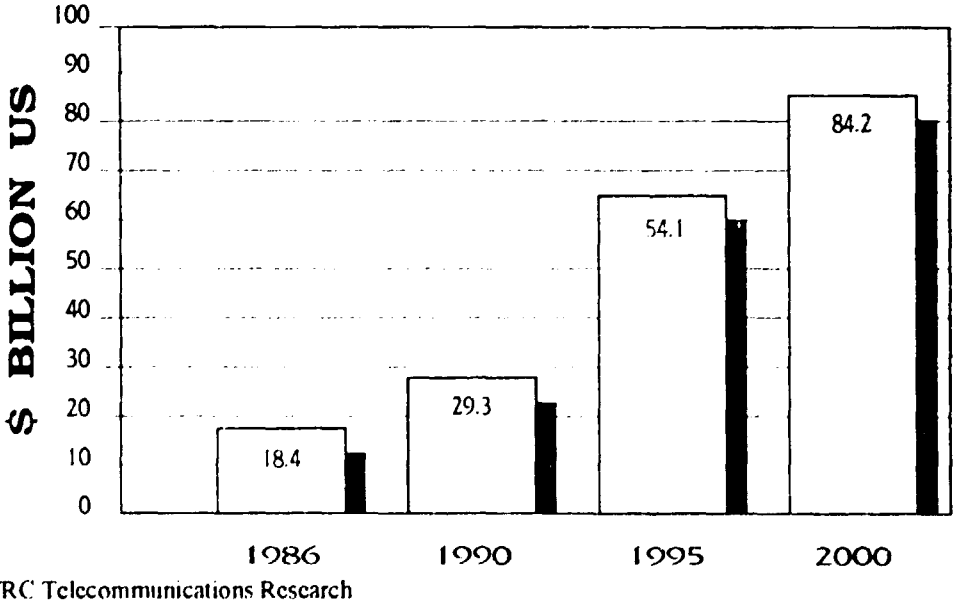
process of local manufacturing of new information technologies in the area. Market dynamics have established a situation in which local manufactures find conditions to compete difficult or even to exist. The urgent need for restructuring, and in some cases create complete networks from scratch, has required the deployment of telecommunications equipment that in most of the cases local manufacturing firms could not develop to the specifications and in the time frame defined by the telecommunications operators. Only the multinational telecommunications companies with bases in Latin America have been able to produce equipment necessary for the modernization of the networks through the participation of their foreign manufacturing base or by establishing an integration or assembly scheme. There are some cases where local manufacturing and software development have been fundamental in securing important contracts for both indigenous and multinational companies.

In order to establish terms of reference to discuss local manufacturing of telecommunications equipment in Latin America, some figures relating to the market condition are important. Table III.1 shows a projection for the year 2000 of total telecommunications equipment for the Latin American region. Latin America, including the Caribbean countries, plans to install 85 million telephone lines for an estimated population of 514 million. This will require investments of around US$ 90 billion to obtain a telephone density of 20/100 inhabitants in the region. The level of investment reflects the market opportunities. The challenge to access a rapidly accelerating market, along with the new regulatory conditions, has forced local and multinational telecommunications firms to revise their roles as systems and services providers, as their manufacturing plans, where aspects of human resources availability and R&D are key elements in their short- and long-term growth strategies, have been drastically affected.

their equipment in the countries, while in other cases they have ownership stakes in specialized service centres as well as in the national common carriers. Table III.2 shows a matrix of the growing influence in Latin America of multinational telecommunications operators. It is becoming increasingly evident that the manufacturing plans are not defined on the basis of national priorities, but more on market forces or strategies developed at the head offices abroad. It is important to mention that in some cases manufacturing facilities have been established when multinational companies offer local manufacturing or assembly of telecommunications systems or components as a marketing strategy to obtain important contracts and to create a regional base for export.

Some multinational telecommunications industries have also established join ventures with strong local financing groups or with local specialized companies that have experience in the manufacturing or service area. The status of manufacturing of telecommunications equipment in Latin America varies from country to country and according to the local market and liberalization policies. However, three main categories of telecommunications companies can be identified (see Figure III.1) in the main manufacturing countries of Latin America, i.e. Argentina, Brazil and Mexico. Chile, Costa Rica and Venezuela also have very dynamic telecommunications markets, but their industrial base in telecommunications is not as significant as in the former. In fact, Chile was the first country in Latin America to privatize telecommunications in 1987. Since then, and as a consequence of an aggressive investment, Chile has strengthened its telecommunications infrastructure by installing fibre optic and satellite links for national and international long distance services as well as a cellular telephone service. Local telecommunications participation has been focused in the area of services and software development.

Table III.1: Total Telecommunications Expenditure (equipment) — Central and South America and the Caribbean



Source: TRC Telecommunications Research

Local manufacturing in Latin America is also affected by the growing presence of the biggest telecommunications operators in the world, which in some cases only distribute

Telecommunications in Venezuela were privatized at the end of 1991 and between 1992 and 1993, CANTV will install half of all the telephone lines it placed during the

Table III.2: Presence of Telecommunications Operators in Latin America

Latin America																
Chile	⊙	●	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	⊙	⊙	⊙
Venezuela	○	●	⊙	⊙	⊙	⊙	⊙	○	⊙	⊙	⊙	⊙	○	⊙	⊙	⊙
Mexico	⊙	●	⊙	⊙	⊙	○	⊙	⊙	●	⊙	⊙	⊙	⊙	○	⊙	⊙
Argentina	⊙	●	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	○	⊙	⊙	⊙
Puerto Rico	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	⊙	⊙	⊙
Belize	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	○	⊙	⊙	⊙	⊙	⊙	⊙
Uruguay	⊙	●	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙

⊙= No ownership role ● =Ownership stake in specialized service center ○ =Ownership stake in common carrier

AT&T | Bell South | Ameritech | Nynex | Bell Atlantic | SW Bell | US West | GTE | Bell Canada | BT | CWW | STET | Telefonica | France Telecom | Singapore Telecom | CTC Australia

Source: Pyramid Research, Inc.

past 50 years. With an impressive investment in 1993 they plan to achieve the goal of 18 lines for every 100 inhabitants by the year 2000, duplicating the present telephone density. There is a potential of increasing local participation in the services area and to look for some opportunities in software development.

Costa Rica has the highest telephone density in Latin America (13/100 inhabitants), with a significant telecommunications infrastructure in which also the services and software development areas constitute important niches for local participation.

Considering that Argentina, Brazil and Mexico are the most active of Latin American countries in telecommunications manufacturing, a basic description of current activities and trends following the structure of Figure III. 1 will provide a picture and reference for a proposed programme of regional cooperation in the area.

III.1 *TELECOMMUNICATIONS MANUFACTURING IN ARGENTINA*

A turning point in Argentina's telecommmunications development occurred in 1991 when the government sold its state-owned telephone company through public auction and two companies were created to service the Argentine market: one for the northern region, TELECOM ARGENTINA formed by:

Stet (Italy)
France Telecom (France)
Grupo Pérez-Companc (Argentina)
J.P. Morgan (USA)

and one for the southern region, TELEFONICA DE ARGENTINA formed by:

Telefónica (Spain)
Inversora Catalinas (Argentina)
Citicorp (USA)

The purchase agreement granted exclusive license to each company to provide basic telephone services to its respective areas. The exclusivity feature will last for seven years ending at the end of 1997, with possibilities of extension for three more years. Telefonica de Argentina and Telecom Argentina are supervised by the independent government agency CNT (Comisión Nacional de Telecomunicaciones) to ensure compliance with the operating license and to approve equipment and technical standards.

Due to the fact that each of the operating companies has undertaken a major investment programme to increase the number of lines, update the equipment and increase the operating efficiency of the service, a significant amount of telecommunications systems (hardware, software and external plant infrastructure) were necessary to achieve the modernization goals set for the first years of operation.

The demand for new telecommunications equipment has been so overwhelming that in some cases old infrastructures have been completely dismantled and replaced by new digital systems.

Local industry has been able to respond with external plant requirements (air conditioning, power supply, cabinets and controls) and in services related to the installation of new telephone lines, both public and private. Telecommunications equipment relating to switching, processing and transmission has been supplied by the following sources, in order of importance:

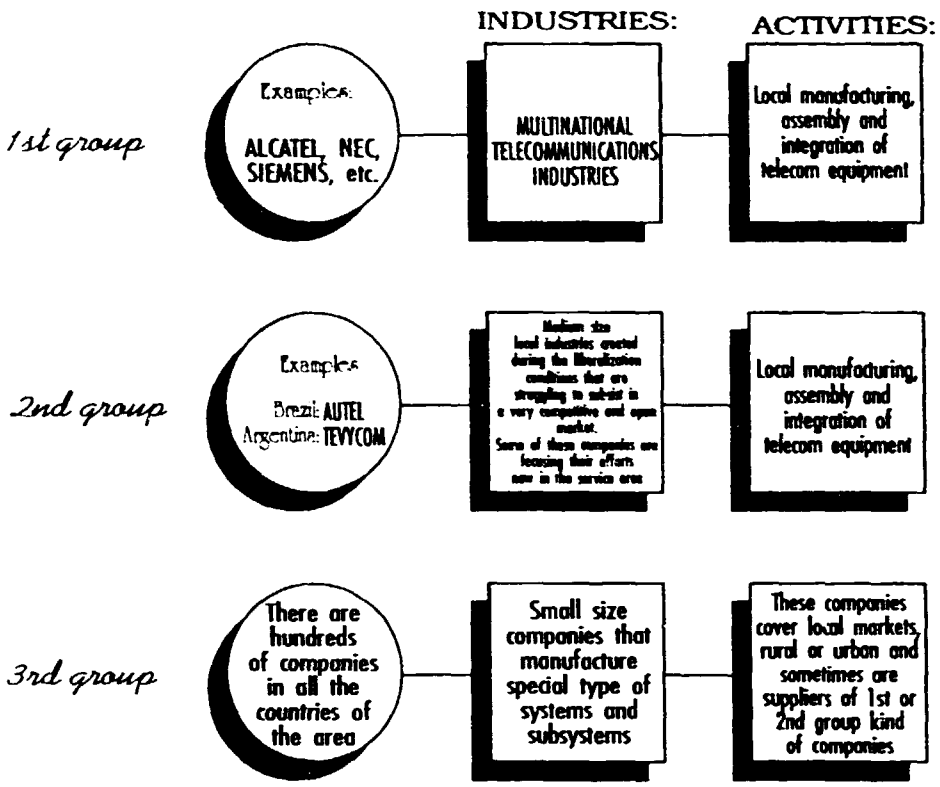


Figure III.1

- Foreign sources of multinational character of company affiliates or business associates of the two telecommunications operators. (Example: ALCATEL, Telettra Española).

- Local manufacturing of multinational companies working independently or under joint ventures with Argentinian financial groups. (Example: SIEMENS, PECOM-NEC)

- Medium-sized local manufacturing firms to cover specialized switching and transmission needs with low or medium capacity systems for urban or rural applications (Example: Tevycom-Fapeco).

As a strategy to cover local and regional markets some big multinational companies, such as NEC and ALCATEL, have established joint ventures with local partners, thereby creating groups such as PECOM (Pérez-Company); NEC and Techin-ALCATEL. In the case of PECOM-NEC they have established one of the most modern telecommunications manufacturing plants in the world in the province of Buenos Aires.

Even in the area of services, the two telephone operators have a strong position through the presence of companies that serve the public and private sector, like STARTEL, a telecommunications service oriented venture property of Telecom and Telefónica.

The modernization trend has forced the import of a great amount of telecommunications systems that affect the local development and manufacture of equipment. The medium-sized local telecommunications firms and local multinational manufacturers that before 1991 constituted major providers of equipment, have had to restructure their manufacturing base and re-think their roles in the new privatization and liberalization scenario. Some former manufacturers have closed production lines (modems and multiplexers) to become distributors of foreign systems, others have simply become service providers.

Medium-sized manufacturing companies have become "endangered species" and new schemes of government support to stimulate technology development are necessary in order to provide minimum subsistance to mantain and create a revitalized national industrial base.

On the other hand, joint ventures of local financial groups with multinational telecommunications companies have been firmly established with aggresive strategies to cover local demand and participate in the export of high technology systems manufactured and/or assembled at their plants.

Important establishments such as MERCOSUR and the launching and operation of the domestic satellite NAHUEL I can be important stimulii for local manufacturing if proper policies and audacious initiatives are established.

More cohesive university-industry programmes have to be established to take advantage of the excellent level of Argentine engineering and science before the technological gap becomes a greater obstacle for local participation.

A sample of representative telecommunications manufacturing industries consists of those companies associated to CADIE (Cámara Argentina de Industrias Electrónicas). The following is a list of such companies in alphabetic order:

Arbelaiz, S.A.:

Small manufacturer of radiocommunication supplements.

Ariema, S.A.I.C.Y.F.:

Small manufacturer of equipment and accessories for TV reception.

Cambe:

Small manufacturer of passive electronic componenets.

Carvajal, S.A.I.C.:

Small manufacturer of antennae and accessories.

DIESEL NEUQUEN, S.A.:

Medium-sized manufacturer of power supply systems for communications equipment.

Eastel, S.A.I.C.:

Small- to medium-sized manufacturer of telephone equipment and radio communications.

IATA/ALCATEL:

Medium to high capacity manufacturer of public and private telephone switching radio communications and fibre optic systems, which has recently widened its base through acquisition of ALCATEL and other product lines. Through the joint venture with Techint it has become one of Argentina's most important communications companies.

Italtel:

Medium to high capacity manufacturer of public and private switching multiplexer and radio communications systems.

Kombi Electronica, S.A. - Trasa:

Medium-sized manufacturer of rural telephonic and radio communications systems.

LACI:

Small manufacturer of printed circuits.

MACH Electronics:

Small manufacturer of radio communications systems.

MAURO Comunicaciones:

Small- to medium-sized manufacturer of radio communications systems and accessories.

PECOM-NEC:

Argentine-Japanese manufacturer of public and private switching systems and transmission equipment. PECOM-NEC recently expanded its industrial base and became an important manufacturer in the local and export markets.

SIEMENS:

German manufacturer of public and private switching systems and assembler of other telecommunications systems for the local and international markets. Siemens is one of the most important manufacturers of telecommunications equipment in Argentina

TECSEL

Small manufacturer of systems and components for private and public telephony.

TEVYCOM/FAPECO, S.A.:

Medium-sized manufacturer of switching equipment and concentrators, multiplexers, radio communications and data transmission systems.

III.2 TELECOMMUNICATIONS MANUFACTURING IN BRAZIL

Brazil has a telephone network of 10.5 million lines with a population of 150 million, corresponding to a telephone density of 7/100 inhabitants. With this figures, Brazil is eighth in telephone density in Latin America and number forty in the world. Although the privatization and liberalization processes have not ben as open as in Argentina, Chile and Mexico, the telecommunications scenario in Brazil is very dynamic. Cellular trunking and value added data services are becoming popular and important alternatives to conventional services.

The Ministry of Communications (MINICOM) is the highest communications authority in the country, with the TELEBRAS system as the national carrier structured out of 27 regional telephone companies and EMBRATEL as the international carrier.

The recent liberalization process that expanded the base of multinational companies and opened the door for new ones along with the new industrial policy issued in April 1993, will play an important role in the regulation and structuring of the telecommunications manufacturing scenario of Brazil.

The restrictions related to new information technology imports defined in the Informatics Law (Ley de Informática) have been modified to make the incorporation of foreign sophisticated components in locally manufactured systems [4] more flexible. The modifications also include some tax incentives for high technology locally manufactured more flexible products.

Brazilian telecommunications authorities and telephone companies have always been aware of the importance of local equipment manufacturing, issuing standards for op-

eration and tropicalization and advising domestic companies to comply with international regulations in order to create an export base. For example, from the total investment of TELEBRAS for 1993 of US$3 billion, $180.4 million will be used for the installation of TROPICOR switches. This switch is currently manufactured by ALCATEL do Brasil and originally developed at the TELEBRAS research branch CNPqD (National Research and Development Center) in Campinas.

ened the manufacturing infrastructure and was an important element to relate user needs to industry and research and development. It is in Brazil where we have the best examples in Latin America of R&D prototypes turned into products throughout, with the participation of local manufacturing firms with universities and research centres. Engineering schools produce highly qualified engineers with the capacity to absorb and adapt new telecommunications technologies (hardware and software) to the Brazilian environment.

Table III.3.1: Telecommunications market (millions of US$)

	1988	1989	1990	1991	1992(e)	1993(e)	1994(e)
Public switching	77	131	220	236	265	296	344
Transmission	159	217	444	455	173	204	192
Cable	138	244	212	341	91	446	503
Private switching	33	33	40	44	55	64	69
Voice Terminals	34	54	94	150	205	281	507
Radio communications	1	43	31	319	356	175	373
Data terminals	6	44	44	50	61	62	74
TOTAL	448	766	1,085	1,594	1,706	1,526	2,062

(e) = Estimated Source: CANIECE

In spite of the restrictions of the former informatics law, local telecommunications firms have been very competitive and export oriented. Although they captured and dominated the local market, some of them had the impulse to look for foreign clients. Medium-sized companies have been experiencing pressure from the increasing participation of advanced international telecommunications firms in the Brazilian market.

In some cases, the medium-sized companies have been able to establish alliances with international partners, in others, they reoriented their manufacturing base with new products and have sometimes been able to sell part or most of its stock to local multinational companies. There are also cases of former manufacturers that have become equipment distributors and systems integrators.

There is no doubt that Brazil has the strongest telecommunications manufacturing base of Latin America. The former informatics law on the one hand limited the advancement and production of new and sophisticated telecommunications systems; on the other, it strength-

In the area of telecommunications manufacturing, the biggest and most important companies are NEC do Brasil, Equitel y Matec (member of the Ericsson Group). These companies dominate the local market of switching and transmission and have important export participation in the Latin American market. For example, NEC do Brazil has plans to achieve a 16 per cent export volume out of all total shipments in the next five years.

There is an important group of medium-sized local companies that develop high technology telecommunications equipment for local manufacturers and have recently advanced themselves to strong positions in the export markets. Out of the total affiliates to ABINEE (Brazilian Association of Electrical and Electronics Industry), the following manufacturing companies play an important role in the telecommunications manufacturing scenario of Brazil.

Table III.3.2: Telecommunications Imports (millions of US$)

	1985	1986	1987	1988	1991(e)	1992(e)
Telephone systems	5.2	12.9	9.7	28.3	46.9	60.9
Transmission systems (radio and television)	37.8	70.5	22.2	44.3	73.4	95.4
Data transmission equipment	1.5	1.0	3.6	5.7	9.5	12.3
TOTAL	44.4	84.4	35.5	78.3	129.8	168.6

(e) = estimated Source: CANIECE

ALFATEST:

Develops automatic testing equipment for the Ericsson group and has plans to export systems to Middle Eastern countries. They project around 50 per cent of export from total sales.

AUTEL:

Manufacturer of analog and digital radios, multiplexers and other radio communications systems. Autel has recently expanded its export base from Latin America to Thailand. They obtained around 15 per cent of exports out of total sales during the last three years.

CELTEC:

Software developer of cellular products that has established important business relations with the US manufacturer Plexsys.

LEVCOTRON:

This company has developed its own technology in the area of micro PABX for local and export purposes.

LINEAR:

Manufacturer of microwave telecommunications systems for UHF, TV and satellite applications.

TELEMULTI:

Developer of transmission systems with participation of Telebras CPqQ.

ZETAX:

Digital switching manufacturer with technology developed at CPqQ.

Table III.4.1: The Current Status of Telecommunications Manufacturing

Country	Condition of liberalization	Presence of major multinational telecommunications companies	Condition of medium-sized national telecommunication manufacturing
Argentina	Complemented	Important presence of major alliances with local industrial groups	Endangered, with policies to stimulate production and increase competitiveness are necessary
Brazil	In evaluation	Presence growing in importance, open to technology imports	Facing challenge of open market with export possibilities to Latin America and other industrialized countries
Mexico	Almost completed	Important presence with major export plans when NAFTA is in operation	Practically disappeared, incubators and other schemes in pprocess of being established

III.3 *TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN MEXICO*

Mexico's telephone company TELMEX was privatized in 1990 and cellular operations provided by private companies were permitted. The concession given to TELMEX to operate as a privatized monopoly will end during the summer of 1996, this fact along with the eventual North American Free Trade Agreement, will revolutionize the telecommunications scene in Mexico.

Today, after three years of market liberalization in telecommunications equipment imports, the medium-sized national telecommunications manufactures have practically disappeared, with only the multinational companies and a myriad of small-sized manufacturers that provide support to local industries remaining.

Before the liberalization process, the model of import substitution supported the participation of a group of medium-sized national telecommunications manufacturers that took advantage of a closed market and unfortunately did not achieve a competitive level to subsist after the opening up of the market. These medium-sized companies showed a slow productivity growth, where industrial production grew fundamentally because facilities and equipment also grew, but efficiency stagnated and R&D investments were not properly allocated.

It is obvious that after liberalization, the balance of trade has been highly deficitary, with telecommunications manufacturing concentrating on assembly or "maquiladora" operations and to the big multinational companies, such as Ericsson, Alcatel, NEC, Northern Telecom and others. Unable to compete with foreign manufacturers, the medium-sized national telecommunications industries became importers or equipment distributors, systems integrators or service providers.

The telecommunications scenario is in general very dynamic, in spite of a condition of a privatized monopoly in basic telephone services. The presence of cellular and other value added companies provide alternatives for the pressing demand for services. The launching of the Morelos Satellite System in 1985 brought important alternatives for corporate communications. To date, the satellites are almost 100 per cent full and the second generation of Mexican satellites to operate from the first semester of 1994 will provide substantial capacity for data, voice and image transmission to cover demand, along with the modernization projects of TELMEX. TELECOMM, the decentralized wing of the Ministry of Communications and Transport (SCT), is in charge of satellite operations in the country, having transferred the microwave national network for TELMEX operation. The need to improve Mexico's average telephone density of around 7/100 inhabitants and the increasing demand for services at corporate and social interest areas (rural, under priviledged, suburban) are the most important factors to induce investment in telecommunications for the next couple of years. Government policies and support to create or stimulate national telecommunications manufacturing in a highly competitive and open scenario are necessary to improve the current balance of trade in telecommunications in the medium- or long-term.

Important developments in several states of the country regarding industrial incubators and technology parks, as well as in the generation of new R&D schemes and university-industry programmes, will be fundamental to creating a new breed of dynamic micro-industries to export or produce for the major multinational telecommunications manufacturers. At present, the Mexican Institute of Communications (IMC) is in the process to establishing a new concept to stimulate national participation in telecommunications manufacturing, as well as in software development for telecommunications.

To date, according to CANIECE (Cámara Nacional de la Industria Electrónica y de Comunicaciones Eléctricas), the following companies are the major telecommunications manufacturers in Mexico:

ALCATEL INDETEL:

Manufacturers of public and private switching, telephone systems and transmission equipment.

MITEL DE MEXICO:

Manufacturers of private switching and telephone systems.

MOTOROLA:

Manufacturers of radio communications systems and accessories.

NEC DE MEXICO:

Manufacturers of switching and transmission systems.

NORTHERN TELECOM:

Manufacturers of private switching and telephone systems.

ROLM TELECOMUNICACIONES:

Manufacturers of private switching and telephone systems.

TELEINDUSTRIA ERICSSON

Public and private switching and telephone systems, as well as software development for switching applications.

Apart from these major manufacturers there are, according to CANIECE, 362 small-sized companies in the area of electronic components, communications and telecommunications systems. In these group we can find small manufacturers, service providers, systems integrators and "maquiladora" assemblers.

In order to summarize the condition of the telecommunications industry in Mexico, tables III.3.1 and III.3.2 show the value of the telecommunications market in Mexico, as

well as the telecommunications imports from 1985 to 1992. These two tables show the effect of the liberalization policies set in motion by the Mexican Government at the beginning of this decade. These policies, as mentioned before, affected the telecommunications manufacturing process in the country.

III.4.4 SUMMARY OF THE STATUS OF TELECOMMUNICATIONS EQUIPMENT MANUFACTURING IN ARGENTINA, BRAZIL AND MEXICO

As mentioned before, the telecommunications markets of these three countries are very promising and dynamic, showing different conditions of privatization and liberalization. Due to the fact that the most important telecommunications companies are of a multinational nature, R&D activities are mostly concentrated in the main laboratories of such companies, although software development and modifications and adaptations to local needs are undertaken locally. In order to subsist, medium-sized national telecommunications manufacturers face a challenging and difficult situation if proper schemes for governmental support or new and creative niches are found to increase their efficiency and productivity.

Table III.4.1 summarizes the current status of telecommunications manufacturing in the three major industrialized countries in Latin America.

IV. PROPOSED SCHEME TO STIMULATE LOCAL MANUFACTURING OF TELECOMMUNICATION EQUIPMENT IN LATIN AMERICA

In spite of Latin America's dynamic telecommunications scenario and the presence of multinational companies in the region, the manufacturing infrastructure is insufficient. It is necessary to create programmes to strengthen current manufacturing activities, taking into account the following basic elements:

- Research and development, human resources and manufacturing strategies
- Certification and test procedures, compliance with international (open) standards
- Regional cooperation, establishment of programmes to strengthen telecommunications manufacturing

Regarding research and development, an analysis of those public and private telecommunications research centres, laboratories and universities focusing in telecommunications should be carried out. This will provide strategies and lines of action to:

- Create new entities of R&D
- Strengthen those R&D entities with current programmes in telecommunications
- Define plans and recommend actions to establish links between industries and research centres working in the field of telecommunications.

The fact that there is an insufficient industrial base in Latin America is related to the lack of experience in certification and test procedures. It is important to encourage participation of Latin American industries, research centres, governmental agencies and individuals in international standards committees.

Some of the countries in the area have programmes and agencies homologous to high technology equipment, but their regulations and normativity are fixed according to foreign patterns and are not normally adapted to the fast international technological pace the industry requires.

The rapid and explosive growth in the use of telecommunications technology in Latin America — particularly after the liberalization processes — has created the need for managing the electromagnetic spectrum more aappropriately and efficiently. It would be important to develop comprehesive and well structured spectrum management policies to cope with the dramatic use of wireless telecommunications systems. The lack of proper spectrum management facilities limits the use of new communications technologies that have the potential to be applied in corporate and social environments.

Regional cooperation could play an important role in strengthening telecommunications manufacturing in Latin America. Recommendations to stimulate regional cooperation in the area are the following:

To create a database or directory of Latin American manufacturers of telecommunications equipment for distribution among the manufactures themselves, as well as other private and public agencies, telecommunications carriers and service providers so as to create the possibilities for mutual exchange.

To explore the possibilities through industry associations, universities and industries to strengthen or create programmes for human resources generation to support regional manufacturing in Latin America.

Look for special niches that can be considered for participation by the Latin American industry.

Identify the strengths of the manufacturing industries to take advantage of their capabilities in the region.

Issue a series of recommendations to support medium- or small-scale manufacturing companies so they can coexist and subsist in a very demanding and competitive area.

Stimulate and create new schemes of support for micro- and small-sized high technology companies according to their own regulatory and industrial environment.

These recommendations have to be analyzed and discussed in order to define a plan of action of regional range with priorities to allocate the financial resources required to implement the strategies delineated in such plan.

V. CONCLUSION

The liberalization trend of telecommunications services in Latin American countries has created a deficitary balance of trade, due to a considerable increase in imports and decrease in local development and production of telecommunications equipment.

The lack of competitive and aggresive local telecommunications manufacturing infrastructures, whether national or multinationl, has the danger of transforming a complete region of technology users or technology absorbers. Over the medium- or long-term, the Latin American countries cannot afford to stop developing telecommunications technology by offering only the economic incentive of cheap labour to create assembly or maquiladora type operations.

Latin America cannot only base its development platform on the export of raw products.

There is a great need to establish creative human resource programmes focused on new information technologies. Although Latin American engineers and scientists have an excellent capacity and great potential for technology production, comprehensive and practical school-industry programmes are also necessary to take advantages of market opportunities.

There is also a need to identify niches with possibilities to obtain a high degree of competitiveness and allocate adequate financial resources to well planned projects.

Initiatives such as NAFTA and MERCOSUR give important opportunities to Latin American manufacturers to position themselves as exporters of telecommunications equipment. If adequate policies and programmes are not established, the benefits of open markets will be for a few countries only, and in the long-term the dependency created for high technology products will be detrimental to encouraging a sustainable development of telecommunications manufacturing in the area.

Software development has been seen as an area of great potential for participation in telecommunications manufacturing. Countries such as India and Israel have created programmes to stimulate this fundamental aspect of the new information technology disciplines.

New schemes of operation apart from maquiladora and incubators are necessary to establish and stimulate small- and medium-sized national telecommunications companies. Although maquiladora operations in Brazil and Mexico are fundamental elements for the export of manufactured or assembled technology products, cheap labour cannot be or continue to be the only attraction for the establishment of manufacturing facilities.

Incubator or technology parks have to be restructured and adapted to regional conditions, with market oriented programmes and adequate and timely financial support in high technology areas such as telecommunications.

The technology gap is overwhelming and is growing rapidly. However, crises and opportunities always appear together. Telecommunications technology plays an important role in improving the quality of life of humankind. To participate in cooperative regional programmes in the processes of "know-how" and "know-why" related to telecommunications design and manufacturing will contribute to Latin American integration by preparing the area to face the challenge of creating a fair and more stable society.

ACKNOWLEDGEMENTS

It is difficult to name all the institutions, government agencies, technical editors, publishers and individuals that contributed so much by giving their opinions, suggestions and remarks to the development of this monograph and I deeply appreciate the time and interest of the following people and enterprises in particular who guided me and provided important information. Further opinions will enrich its content and scope and will hopefully provide a basis for creative dialogue to stimulate or strengthen manufacturing entities of telecommunications equipment in Latin America.

ARGENTINA:

CADIE, Cámara Argentina de Industrias Electrónicas.

Ing. Ulises J.P. Cejas, Gerente

TEVYCOM/FAPECO, S.A.

Ing. Mir Angel del Moral, Gerente División Comunicaciones

SIEMENS, S.A.

Ing. Ricardo Bernhardt, Gerente, Publicidad y Relaciones Publicas

PECOM-NEC

Ing. Octavio D. Nadal Viñals, Gerencia de Operaciones, Depto. de Exportaciones

SURREY

Ing. Sohrab Yasdani, Gerente de Ventas

Revista Entelequia:

Politicas de Telecomunicaciones, Informatica, Economia y Empresas

Revista Telecomunicaciones y Negocios:

Telefonia, Teleinformática Sistemas, Servicios y Comunicacion Satelital

BRAZIL:

ABINEE: Associacao Brasileira de Industria Electricae Electronica

Eng. Fabian Yaksic, Gerente de Politica e Tecnologia Industrial

Eng. Celso Ricardo Nisterenko, Analista

Elebra Comunicacao de Dados Ltda.

Dr. Leopoldo da Silva Pereira, Diretor

Autel Telecommunicacoes

Eng. Daniel Verbicário Santos, Diretor Comercial

MATEC

Eng. Artur Morales Borges, Gerente, Division Redes

Equitel, Telecomunicacoes

Eng. Hector A. Corvalán, Vendas Internacionaes

NEC do Brasil

Eng. Fabio Gril C S. Rangel, Gerente Marketing Internacional

ALCATEL

Eng. Richard Daniel Goetz, Diretor de Marketing

Eng. Waldemar Panades Filho, Gerente Marketing de Produto

Eng. Victor Guillermo Tiferes, Eng. Electronico Sr.

Revista Nacional de Telecomunicacoes e Telematica

Telepress Latinoamerica

Jornal de Telecomunicacoes

Informática Hoje

MEXICO:

CANIECE, Camara Nacional de la Industria Electrónica y de Comunicaciones Eléctricas

Lic. José Javier de la Rosa R., Estudios Económicos

IMC, Instituto Mexicano de Comunicaciones

Dr. Enrique Melrose A., Director de Investigación

Lic.Enrique Quibrera M., Director de Cooperación Internacional

Northern Telecom

Dr. Bernardo Retchkeman, Director de Ventas

Teleindustria ERICSSON

Ing. Jorge Arredondo, Director de Comunicación y Estrategia Corporativa

TELSAT

Ing. Fernando Luengas H., Gerente

CICESE, Centro de Investigación Científica y Educación Superior de Ensenada

M en C. David Covarrubias, Investigador/Telecomunicaciones

Latin Finance, Privatization in Latin America

Business Week, the Mexican Worker

Revista AHCIET

Periódico El Financiero

REFERENCES

[1]"New Prospects for Telecommunications in Latin America" TelePress Latinoamerica, Año 3-No.13 Marzo-Abril/93

[2]"Privatization in Latin America", A Latin Finance Supplement, May 1993 issue

[3]"Información y Telecomunicaciones: Vector de la Transformación productiva con Equidad", CEPAL, Febrero 1993.

[4]Jornal de Telecomunicacoe No. 56 y 57 mai/Abril 1993, Sao Paulo, Brasil

Parallel Computers and Their Industrial Applications

Boleslaw K. Szymanski
Department of Computer Science and Scientific Computation Research Center
Rensselaer Polytechnic Institute
Troy, NY 12180, USA

1. Challenges for Parallel Computers

Parallel computing has become a critical technology for manufacturing processes. It is also quickly gaining importance in sciences, medicine and the drug industry. Large-scale computer modeling impacts decision making in banking and finance, military and government. The Industrial Revolution of the 18th century has freed humans from the enslavement of manual labour and has transformed craft and handywork into the industries of today. Likewise, the Computer Revolution we are now witnessing has been freeing the labour force from routine mental tasks, which were and are often still done by assistants, clerks and low-level managers. Parallel computers form an important component of this revolution. They empower decision makers, such as high-level managers and chief scientists, with the ability to gather, access and synthesize information, as well as simulate real-life processes to measure the impact of social, economic and design decisions. The quality of the simulations and synthesized information is strongly dependent on the applied computational power. Today, even the largest uniprocessor computers are too slow for the most challenging problems of this kind.

In the United States of America, the quest for higher-speed machines is fueled by computationally intensive problems with profound economic and social impacts, referred to as Grand Challenges[3]. It is difficult to list all Grand Challenge problems because so many areas of science and engineering are potential sources of such problems. The short list typically includes:

- high-resolution weather forecasting crucial to agriculture, disaster prevention, etc.;
- pollution studies that include cross-pollutant interactions, important in environmental protection;
- global modeling of atmosphere-ocean-biosphere interactions to measure the long-term impact of human activities on the stability of the global ecosystem;
- human genome sequencing that will assist in recognizing, preventing and fighting genetic diseases;
- the design of new and more efficient drugs to cure cancer, AIDS and other diseases;
- high-temperature superconductor design that can revolutionize computer design, electrical devices, etc.;
- the aerodynamic design of aerospace vehicles (airflow modeling) and improvements in automotive engine design (ignition and combustion modeling) that can lead to more efficient use of depletable fossil fuels in transportation;
- the design of quantum switching devices important in building more powerful computers.

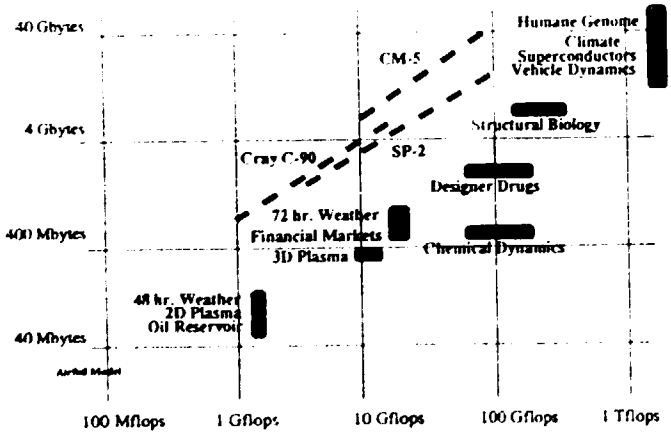


Figure 1: Computational Speed and Memory Required for Grand Challenge Models versus Current Parallel Machines

It is estimated that to achieve acceptable response time for these problems, in the order of several hours, will require a machine with performance of teraflops = 10^{12} floating point operations per second. Today's parallel computers approach a tenth of a teraflops, i.e., about 100

9 gigaflops (1 gigaflops = 10^9 flops). However, such speed is achieved only on certain very large, highly localized, finely tuned, often idealized applications. The demand for computational speed and memory for some applications from the above short list of Grand Challenges are shown in Figure 1. The position of some current parallel machines discussed in this article is also marked in Figure 1.

In this article, first the need for parallel computers is justified on technological grounds. Then, recent developments in parallel computer architectures are discussed, followed by a brief review of their software and limitations. Finally, the industrial applications are summarized and discussed.

2. Need for Parallel Computers

In recent years, it has become increasingly difficult to improve the performance of a uniprocessor based on the time-honored von Neumann model. By laws of physics, the speed of signal transmission in a computer cannot exceed the speed of light in the transmission media, about 3×10^7 m/sec for silicon. Consequently, it takes 10^{-9} of a second for a signal to propagate in a silicon chip of an inch in diameter. However, one signal propagation can support at most one floating point operation. Hence, a sequential computer built with a chip of such a size can provide at most 10^9 flops = 1 gigaflops, i.e., one-thousandth of the needed teraflops. The immediate conclusion is that the only feasible path to a teraflops computer leads through massively parallel machines (MPPs).

An interest in parallel computing systems is not new and can be traced back as far as the 1920s. However, as late as the early 1970s, major criticism of parallel processing was based on Grosch's law, which states that the computing power of a single processor increases in proportion to the square of its cost. Recent careful analysis of Grosch's law showed that it is valid only within one technology. Economy of scale for mass-produced memory and RISC (Reduced Instruction Set) processors makes them a few orders of magnitude less expensive than custom designed chips for mainframes and traditional vector supercomputers. The improving computer chip technology enables the placement of ever-faster processors with ever-increasing amounts of memory on a single wafer. Hence, introduction of RISC technology made Grosch's law obsolete. Massively parallel computers built from a large number of RISC processors provide a superior performance-to-price ratio compared to computers based on the powerful, custom-designed CISC (Complex Instruction Set) processors.

The traditional vector supercomputers are built of a limited number of powerful processors connected to large shared memory. In addition, they explore array operation parallelism through vector co-processors. As discussed below, because of the shared memory, the number of processors in such a parallel system cannot easily be increased and is limited to about 16. In contrast, massively parallel computers have processors with local memories. The processors are connected directly to each other by a network. The cost of such a parallel computer is roughly proportional to the requested number of processors. Therefore the size of the computer installation is more limited by costs than technical considerations. The massively parallel computers have three advantages over traditional vector supercomputers:

1. An accelerated rate of advance of peak processing power. In the last decade, microprocessor performance has increased four times every three years, following the rate of integrated circuit logic density improvement. By contrast, the clock rates of vector machines have improved much more slowly, doubling every seven years [2]. These trends are expected to continue for at least the 1990s.

2. An improvement in the performance-to-cost ratio. In 1993, this ratio was between two to eight times higher for MPPs than for the vector supercomputers.

3. Scalability of the machine. The smallest configurations of MPPs are usually low priced to entice initial purchase (in 1993, the least expensive MPPs cost below $100,000). The initial configuration of the MPP can be upgraded incrementally as the needs and available funds arise.

The clear conclusion is that only massively parallel computers can deliver the much needed teraflops level of performance.

3. Architectures of Parallel Machines

In Flynn's well-known classification of parallel computational models [5], the von Neumann model is characterized by a single stream of instructions controlling a single stream of data (SISD). To achieve parallelism, multiple data streams can be introduced, thus creating a SIMD model. A further extension adds multiple instruction streams, which leads to multiple instruction multiple data streams (MIMD) architectures. The last category splits into two classes on the basis of a memory access mechanism. One class, the shared-memory architecture, is characterized by the existence of a single global memory. Each processor has equal access to this memory. The other class, the distributed-memory architectures, have processors with local memories. Each processor has direct access to its own memory and indirect access to the memory of other processors. The indirect access is typically supported through a message-passing mechanism that enables processors to communicate with each other.

On SIMD machines, all processors execute the same statement, but each operates on a different piece of data (data parallelism). The major task of a programmer is to identify data that can be distributed among the processors. However, programming itself is relatively simple because each processor executes the same sequential program. If, for a particular program step, a processor does not have any data assigned to it or the executed step does not apply to its data, the processor remains idle. For this reason, SIMD machines are efficient only in such applications that have enough operations applicable to a large number of data pieces.

An example of a massively parallel SIMD system is the MP-2 computer produced by MasPar. The MP-2 is built around an array of processors with a single circuit board containing 1024 processors. Each processor has 64 Mbytes of local memory. A processor can communicate with its eight nearest neighbours interconnected in a two-dimensional grid. Another means of communication is supported by the hypercube interconnected network and a global router that can deliver messages from any processor to any other processor. The Array Control Unit (ACU) controls the operations and communication of all the processors in the array. The front-end of the machine is a standard UNIX workstation with standard and high speed input/output subsystems. The front-end handles traditional serial processing. The MP-2 includes up to a 16,364 array processor and delivers up to 6.3 gigaflops with 32-bit precision arithmetic. MP-2 runs an operating system that is a derivative of the UNIX system and has optimizing compilers for MPL (a variant of the data parallel C language) and Fortran.

Programming for MIMD machines is more complex than programming for sequential or SIMD machines. For MIMD shared-memory architectures, the most difficult programmer's task is to map the program onto processors. Synchronization and data exchange can be efficiently implemented through blocks of shared memory. Programming of such machines is less difficult than for distributed-memory machines, thanks to the global address space that makes any data uniformly accessible from any processor. The challenge is in the hardware support for shared memory. As the number of processors increases, so does the traffic in the network connecting processors with the memory. If the memory requests from the different processors are directed to the same memory bank, memory access is done sequentially, slowing down the processors. Consequently, it is believed that shared-memory machines cannot support massive parallelism. The currently available architecture in this class is the Cray C-90 series, which represents a traditional vector supercomputer with limited interprocessor parallelism [8]. Its largest configuration consists of 16 processors, each with a performance of 1 gigaflops and shared memory of 8 gigabytes. Each processor can have two vector pipes and two functional units active in a cycle, thus producing four vector results per clock unit. This parallelism of operations within each processor can be multiplied by 16 available processors resulting in the peak performance of 16 gigaflops. The Cray C-90 runs under the UNICOX operating system and has vectorizing compilers for Fortran and C.

Programming for distributed-memory machines inherits all the problems of the shared-memory programs and is further complicated by the the need for data distribution. Each processor has the direct access to the local memory only. Non-local data must be negotiated with the owner processes using communication. The synchronization imposed by the wait for a communicated data can significantly slow the performance of a computer. Subsection 4.1 discusses the Fortran extensions that allow the programmer to define data distributions. Another effort to ease the programmer's burden is to support non-local data access through hardware, as done by the Kendall Square Corporation in the so-called all-cache KSR-1 machine. Although the memory of KSR-1 is distributed, the address space of the program is global. If the accessed data is not in local memory, the operating system suspends the process and brings the data to the processor. The efficiency of such a solution is being evaluated by the KSR-1 users [8].

The MIMD architecture, also capable of SIMD execution mode, is exemplified by the CM-5 computers produced by Thinking Machines Corporation [8]. The CM-5 machine consists of processing nodes (the configuration can vary from 32 to 16,384 processors), a number of control processors, a data network, a control network and a diagnostic network. Each processing node is a RISC processor with 32 Mbytes of memory and a 128 megaflops vector processing unit. Input and output are provided via a high-bandwidth interface. The data network is interconnected into a fat-tree and provides high-performance, point-to-point data communication between the processors. Unlike an ordinary binary tree, the channel capacities of a fat-tree increase as the tree is traversed from leaves to root. The control and diagnostic networks are implemented as binary trees; the first one provides cooperative operations such as broadcast and synchronization, whereas the second one supports testing system integrity as well as detection and isolation of errors. The data parallelism in CM-5 can be implemented in either SIMD mode, multiple SIMD mode or synchronized MIMD mode. The reported performance of the 1024 processing node configuration was about 50 gigaflops. Theoretically, a full configuration of 16,384 processing nodes could reach teraflops range but, with current pricing, such a machine would be prohibitively expensive.

The biggest promise of wide commercial use, in the opinion of the author, is the recently announced (end of the year, 1993) scalable SP-2 computer produced by IBM Corporation. It is an MIMD computer based on the RISC System/6000 processors. The system consists of three major components: the number of the RISC System/6000 processors, the high-performance switch, and the control processor. Each processor can perform at 250 megaflops. The high-performance switch is a multi-stage network with optical links. The switch is capable of a 40 Mbyte/sec processor-to-processor data transfer with a latency of about 3 microseconds. The software approximately doubles this latency. The predecessor of this machine, the SP-1, is about half as fast as the SP-2. Both systems run under AIX operating system and support PVM message-passing protocols. The Cornell Theory Center at Ithaca recently announced the replacement of its SP-1 machine with the 512-processor SP-2 computer with a peak performance of more than 100 gigaflops in 1994. The Theory Center plans to use the new system to introduce commercial users to scalable computing for such applications as modeling sedimentary basins to predicting where oil is present, interactive access to large data sets, aerospace engineering, dissolution of natural gas, turbulent combustion and orthopaedic biomechanics.

The size of the high performance computing market worldwide is about $2 billion (excluding sales of the IBM add-on vector hardware). The large share of this market is held by Cray Research, which accounts for roughly 40 per

cent of sales. On the other hand, many MPP vendors have sales below $100 million. Clearly, the MPP industry is still in the early stages of development and it is very likely that some existing companies will disappear, while new ones will emerge. However, in the opinion of the author, the direction of development towards the MPP system will intensify.

4. Programming Models and Languages

While the use of parallel computers has been increasing, their popularity has been hampered by the level of effort required to develop and implement the needed software. Parallel software must often be tuned to a target architecture to execute efficiently. Thus, it often requires costly redesign when ported to new machines. Different categories of parallel architectures have led to a proliferation of dialects of standard computer languages. Varying parallel programming statements for different language dialects limit parallel software portability.

Parallel computation can be viewed as an interwoven description of operations that are applied to data values, and of data movement and synchronization that dictate the form of data accesses and computation order. The traditional programming languages, such as Fortran, C, or C++, provide for description of data movements and synchronization through ad hoc architecture-dependent extensions. Examples are various synchronization constructs such as busy-wait, locks or barriers used in programs for shared-memory machines, send and receive with different semantics employed by programs for message-passing architectures, and dimension projection and data broadcast popular in programs for SIMD computers.

To counter this trend to proliferation of language constructs and variants, there has recently been a strong push towards standardization of programming models and languages. Examples are the High Performance Fortran (HPF) language, the Parallel Virtual Machine (PVM) communication primitives library, and the Message Passing Interface MPI standard. There is also a trend towards an object-oriented paradigm represented by several experimental languages based on C++. Many operating systems for parallel machines are derivatives of UNIX; therefore, next to Fortran the most popular language available on parallel machines is C with extensions. However, since its introduction in the 1950s, Fortran has been the language of choice for scientific and engineering applications that have driven sales of parallel machines so far. Fortran compilers are available on virtually all computers ranging from personal computers to workstations to parallel computers. The newest version of Fortran that was designed as a standard for parallel processing is discussed below.

4.1. High Performance Fortran

Fortran has evolved over the period of its existence by incorporating such features as array operators, dynamic storage allocation and enhanced support for modular programming. To exploit the full capabilities of modern parallel architectures, the programmer must be able to define additional features of the programs, such as [7]:

1. Data mapping among processors.

2. Placement of data within a single processor

3. Specification of control parallelism.

4. Specification of parallel sections of code.

The Fortran extensions that enable the user to provide this kind of information in the source program are called High Performance Fortran (HPF). They were developed by a group of users between 1991 and 1993 [7]. HPF is intended as a platform for portable parallel programming. It is widely assumed that major vendors of parallel computers and third-party compiler and system software developers for parallel processing will adopt HPF.

HPF includes features for mapping data to parallel processors, specifying data parallel operations and interfacing HPF programs to/from libraries and other languages. HPF uses compiler directives if the extension cannot change the program semantics and explicit language extensions otherwise. The parallelism in an HPF program can be expressed by array operators, FORALL and DO INDEPENDENT loops and EXTRINSIC and library procedures. Since communication in a program is an overhead that lowers the parallel execution efficiency, HPF puts much of the burden of defining communication on the compiler. The user supplies very high-level data mapping strategies and the compiler generates the needed communication.

4.2. Message Passing Interface

MPI is intended to be a standard message-passing interface for applications running on MIMD distributed-memory computers and workstation networks. The design of MPI has been a collective effort involving researchers in the United States of America and Europe from many organizations and institutions. MPI supports point-to-point and collective communication routines. It provides constructs for defining process groups, communication contexts and application topologies. Since MPI was introduced in November 1993, it is difficult to measure its impact on portability of programs written with its use. It is hoped by its authors [10] that it will be useful in building libraries of mathematical software for MIMD machines. MPI's design allows heterogeneous implementations and definitions of virtual communication channels. The design was also influenced by the need for ensuring that it could be implemented efficiently in a multi-threaded environment.

5. Limitation of Parallel Processing

System performance defines the computational problem sizes that can be handled within acceptable time and cost limitation. Performance is impacted by the four factors that may be of varying importance in different applica-

tions. The first is the raw computational speed (processor and memory clock time, number of arithmetic operations per second). The second is the memory of the machine (loading/unloading the data to/from the disk increases the program execution time). The third factor is the rate of input/output operations, i.e., the rate at which data can be loaded into and produced by the machine. The fourth factor is the synchronization and communication delay. It is relevant only for parallel computers. The synchronization delay arises when a processor idles because it waits for other processors to finish the corresponding stage of computation. The communication delay results from a processor's wait to receive the requested data. In both cases part of the computational power of the machine is lost.

A parallel machine with p processors, each with speed of m megaflops, can theoretically achieve the peak performance of $p*m$. However, rarely can the algorithm be divided equally among processors. There are usually parts of it that can be done one step at a time. The so-called Amdahl law defines the limit on the speedup of a parallel execution due to the residual sequentiality of the program [1]. Speedup for a p-processor system over a uniprocessor system is defined as

$$S_p = \frac{T_1}{T_p}$$

where T_1 is the execution time for the best serial algorithm on a single processor and T_p is the execution time for the parallel algorithm using p processors. Let α be the so-called Amdahl's fraction, i.e., the ratio of the execution time spent in sequential parts of the algorithm to the total execution time on a single processor. Then

$$(1) \qquad S_p = \frac{1}{\alpha + (1-\alpha)/p} < \frac{1}{\alpha}$$

Amdahl's formula (1) suggests that no matter how many processors are available to participate in the computation, the speedup is limited by $1/\alpha$. For example, if 5 per cent of an algorithm cannot be parallelized, the maximum speedup will not exceed 20, no matter how many processors are used.

In most engineering and scientific algorithms, the fraction a is not a constant but a decreasing function of the problem size n. Algorithms for which $\alpha(n)$ asymptotically reaches 0 while n increases are called *effective parallel algorithms*. Such algorithms, if applied to large enough problems, are capable of achieving speedup nearly equal to the number of used processors. To substantiate this point, let $S < p$ denote the desired speedup, arbitrarily close to p. Since the achieved speedup S_p is given by formula (1), then

$$(2) \qquad S_p = \frac{1}{\alpha(n) + (1 - \alpha(n))/p} \geq S$$

Hence, it follows that

$$\alpha(n) \leq \frac{p - S}{S(p-1)}$$

For an effective parallel algorithm $\alpha(n)$ is asymptotically decreasing to 0. Hence, it is always possible to select such a large problem size n_0 that for problems larger than n_0, $\alpha(n)$ satisfies inequality (2). Therefore any problem with size $n > n_0$ will achieve speedup greater or equal to S.

In a message-passing system, a significant fraction of the total execution time is often spent on communication between processors. To examine the effect of communication overhead on the speedup in such systems, let c denote the fraction of the total execution time spent on communication that is not overlapped with computation. If t is the sequential execution time and α is Amdahl's fraction then, with p processors, the total execution time (which includes the time spent on communication) is

$$(3) \qquad \frac{\alpha t}{1 - c} + \frac{(1-\alpha)t}{p(1-c)}$$

Thus, the speedup in this case is

$$\frac{1-c}{\alpha + \frac{1-\alpha}{p}} = \frac{p(1-c)}{(1 + \alpha(p-1))}$$

Since $p \geq 1$, the speedup is limited by

$$S_p \leq p(1-c)$$

As in the case of Amdahl's fraction, the communication fraction of the execution time c is often a function of the problem size, say $c(n)$. A parallel algorithm is *communication effective* if $c(n)$ asymptotically reaches 0 with the growth of n. The conclusion is that for large applications using effective parallel algorithms the speedup can be very close to the number of the used processors despite the communication and synchronization delays.

Large applications running on a single processor can exceed the memory and cache limit of the machine. The resulting excessive paging or cache miss ratio lead to the poor performance of such an application. On a parallel machine, each processor runs only a fragment of the application. Hence, the cache and memory of the processor might be sufficient to achieve low paging and cache miss ratio. As a result, the application can achieve superlinear speedup on a parallel computer, meaning that the sum of execution times on all parallel processors is smaller than the total execution time on a single processor, i.e.,

$$S_p = \frac{T_p}{T_1} > p$$

Such speedups have been reported for large irregular computations [9].

6. Industrial Applications

Industrial applications of parallel computations are limited mainly by the relatively high cost of solving compu-

tationally intensive problems. The use of a parallel computer must be justified by the economical significance of the results. As the performance-to-price ratio and reliability of new generations of parallel computers increase, the range of applications will follow. A large part of the cost of parallel processing results from the high cost of program development. The new standardization efforts described in the previous section have a potential of fostering software portability and reuse, thus further contributing to the decline of the cost of parallel computing. The next few years will most likely witness wide-spread commercialization of parallel computers. Today, the range of applications is already impressive and there is a clear trend towards an increased involvement of industry in parallel processing, as evidenced by Table 1 [2].

In 1992, the worldwide installed parallel computer base (of US vendors only) was nearly equal between academia and government (129 in total) and industry (122). In academic centres, the usage of parallel computers by industrial users nearly doubled between 1991 and 1992 (last two years for which data is available).

Table 1. The Percentage of Parallel Computer Installations for Different User Categories

Year	Government	Academia	Industry
early 1980s	70	5	25
late 1980s	60	15	25
1993	40	20	40

The cooperation between academic centres and industry is strong in the United States of America. For example, the Scientific Computing Research Center at Rensselaer Polytechnic Institute brings together 35 faculty, 50 graduate students and many researchers from 16 organizations, including such industrial leaders as Alcoa Technical Center, Dassault Systems, General Electric Company, General Motors Corporation, Grumman Aircraft, and IBM Corporation. The spectrum of investigated problems covers computational fluid dynamics, engineering structural analysis, human joints dynamics, and epidemiological modeling.

Some of the largest customers of parallel computers are commercial aerospace companies. They have been using computational fluid dynamics to analyze airflows for spacecraft and aeroplanes. An interesting application of this method was made by Boeing to predict airflow in aircraft cabins using a Cray parallel computer. The design of an aeroplane's environmental control system involves the specification of air supply and return and analysis of airflow speed and distribution. The computer simulation eliminates the majority of candidates and the full-size aeroplane cabin mockups are used only in the final selection. The expense and time required for testing the large number of candidate airflow systems has thus been largely reduced. Computational fluid dynamics is also useful in the analysis of airflow for cars. For example, Nissan Motor Company reported that it saves on wind tunnel tests by using the model of an unsteady, three-dimensional viscous incompressible flow program on the Cray C90 computer achieving the performance of 7 gigaflops.

Oil reservoir modeling uses cross-well seismic data to build and run the model. Even with current parallel supercomputers, large models use a computational unit of several-hundred feet, which may contain few separate wells. However, there are important fluid events at the scale of a foot, such as the mixing of elementary fluids. Companies such as Mobil Corporation and Amoco Oil Company use parallel computers to exploit existing, as well as searching for new reservoirs. Shell Oil Company reported that it built parallel versions of several petroleum reservoir simulators, but those have not been put into use because of the difficulty in providing requisite network and job support. In contrast, selected geophysical application programs have been used successfully in corporate settings. In [4], British Petroleum Exploration Inc. reported the accurate modeling of a complex reservoir to predict potential gas and oil production, the rate of production and the impact of operating decisions on recovery and economics. When operating under constrained computer resources, the model of a reservoir must be simplified and projections conservative. More reliable projections obtained with the use of the parallel computer increased predicted recovery and reduced the time and cost of the study. The economic benefits far outweighed the cost of using the parallel computer.

Challenged by the international market demand and increasingly complex production requirements, a growing number of heavy industries worldwide are exploring parallel processing usage to optimize manufacturing processes. A division of the German industrial conglomerate Mannesmann used the Cray parallel computer to optimize pipe and tube milling [11]. Structural and civil engineering problems are solved at Mitsui Construction Company in Japan. Ford Motor Company purchased the Cray Y-MP C90 system for structural analysis, crash simulation and other problems related to automotive design and engineering. A smaller system, the Cray Y-MP 4E, was also installed in the PSA Peugeot-Citroen in Velizy, France, for similar applications.

Computational chemistry uses parallel computers to study problems such as the prediction of relative stability of different molecules, the identification of transition states, and reaction intermediates based on the model of heat formation. A commercial application also includes an analysis of the effect of a molecular structure on the flexibility of polymers [6].

Designing, installing and operating a power transmission network and ensuring its stability and reliability are complex challenges. Each network is a dynamic system subjected to oscillations, which can lead to costly equipment failures, network separation and eventually blackouts. Events such as lightning bolts, ice storms and tornadoes disturb and threaten to disrupt power network operation. The growing demand for electrical power and the complexity of interconnected, expanded networks require prudent operational planning and the ability to predict a

power system's behaviour under various conditions. Hydro-Quebec in Canada uses the Cray computer for testing and predicting the network's operation under the various contingencies to decide the proper improvements for the network structure.

Weather forecasting uses grids of the size of two-hundred miles by three-hundred miles, too large to register local rains, storms, etc. To reliably model storms, the Center for Analysis and Prediction of Storms at Oklahoma University developed the ARSP (Advanced Regional Prediction System). ARSP has been ported to the massively parallel computer CM-5 with 1024 processors [12]. A high speedup of 907 times over a single processor was achieved with the overall performance of about 50 megaflops. Still, for the problem size corresponding to a regional weather prediction, the simulation runs about one-fifth as fast as the weather changes (so after one hour of simulation, the prediction could be made for four hours in advance). It is estimated that a teraflops machine would be able to produce a four-hour forecast in about 2.5 minutes.

There is a growing trend among Wall Street securities firms to utilize the advanced computer simulations to track and model global financial markets. Among them, Prudential Securities is a pioneer of parallel computing, currently using the Intel 32-node hypercube computer IPSC/360. Dow-Jones News Retrieval acquired two Connection Machines from Thinking Machines Corporation to improve the performance of their commercial document retrieval systems.

Parallel computing and related technologies of computer networks, database management systems and graphics are changing the scale and scope of data that companies and governments can manage and analyze. This process involves not only computer expertise but also finance, marketing and management. Parallel computing helps organizations produce information in three major domains: 1. changes in production, with greater emphasis on managing the data as a strategic resource. 2. improved control over relationships with customers and clients. 3. development of new kinds of information.

In recognition of this trend, ORACLE has been making its database system available to a growing number of parallel machines. The impact of parallel computers on this kind of application should rapidly grow.

NOTES

[1] Amdahl, G.M., "Validity of the Single Processor Approach to Achieving Large-Scale Computing Capabilities," Proc. 30 AFIPS Conference, AFIPS Press, pp. 483-485, 1967.

[2] Branscomb, L. (Chair), From Desktop to Teraflop: Exploiting the U.S. Lead in High Performance Computing, NSF Blue Ribbon Panel on High Performance Computing, Washington, DC, August, 1993.

[3] Committee on Physical, Mathematical and Engineering Sciences, Grand Challenges: High Performance Computing and Communications, NSF/CISE Report, Washington, DC, 1991.

[4] Cullahm, W.E., Deskin, R.H., Handyside, D.D., Karaoguz, O.K., and Li, K.-M., "Improved Financial and Operational Forecasting with Large-Scale Reservoir Models," Cray Channels, vol. 14, no. 3, pp. 26-31, 1992.

[5] Flynn, M., "Some Computer Organizations and Their Effectiveness," IEEE Transactions on Computers, vol. C-21, pp. 948-960, 1972.

[6] Graffunder, S.K., "Barrier-Breaking Performance for Industrial Problems on the Cray C916," Proc. Supercomputing'93, Portland, OR, November 1993, IEEE Computer Science Press, Los Alamitos, CA, pp. 516-519.

[7] High Performance Fortran Forum, High Performance Fortran Language Specification, version 1.0, Center for Research on Parallel Computation, Rice University, Houston, TX, Revised May 1993, to appear in Scientific Programming, vol. 2, no. 1, 1994.

[8] Hwang, K., Advanced Computer Architectures, McGraw Hill, New York, 1993.

[9] Lewis, T.G., and El-Rawini H., Introduction to Parallel Computing, Prentice Hall, Englewood Cliffs, NJ, 1992.

[10] The MPI Forum, "MPI: A Message Passing Interface," Proc. Supercomputing'93, Portland, OR, November 1993., IEEE Computer Science Press, Los Alamitos, CA, pp. 878-883.

[11] Pehle, H.J., and Thieven, P., "Advances in Metal Forming Simulation at Mannesmann," Cray Channels, vol. 14, no. 1, pp. 6-9, 1992.

[12] Sabot, G., Wholey, J.B., and Oppenheimer, P., "Parallel Execution of a Fortran 77 Weather Prediction Model," Proc. Supercomputing '93, Portland, OR, November 1993, IEEE Computer Science Press, Los Alamitos, CA, pp. 538-545.