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# **MICROELECTRONICS MONITOR**

**VOLUME 1, NUMBER 4, 1994**



**UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION**  
Vienna, 1994

## MICROELECTRONICS MONITOR

Vol.1, No.4, 1994

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*IT Standardization and  
the Disparate User*

*By Georges Ferné*

*(Reprinted from the OECD  
Observer, No.189, August/  
September 1994)*

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Scientific editor: Konrad Fialkowski  
Compiled and edited: Diane Rhind  
Editorial Board: K. Venkateshman;  
V. Podshibaykin; P. Mehin; A. Spina;  
R. Bullington; E. Gahan; C. Gürtük.

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Industrial Development Organization  
(UNIDO)  
Vienna International Centre  
P.O. Box 300  
A-1400 Vienna  
Austria

Tel.: (43-1) 21131-0  
Fax: (43-1) 220-7366

### TO OUR READERS

It has now been a year since the United Nations Industrial Development Organization (UNIDO) put into effect its plans for organizational restructuring in an effort to revitalize the Organization, according to its new mandate set forth in the Yaounde Declaration of November 1993. In spite of UNIDO's shrinking financial resources, the Organization was nonetheless able to make considerable achievements in human resource development, development and transfer of technology, and industrial rehabilitation and modernization. In early November 1994, the policy making body of UNIDO, the Industrial Development Board, convened and reaffirmed the Organization's central coordinating role in the United Nations System to promote and accelerate industrial development and technology transfer and emphasised its important role in complementing these efforts through the supply of industrial information, policy and institutional advice and technical expertise, and by acting as an honest broker on crucial industrial development issues, as well as a catalyst for international industrial cooperation.

However, the Board called for a further strengthening of UNIDO's programmes on small- and medium-scale industries, industrial investment promotion, the environment, energy and sustainable industrial development, and the further participation of women in industrial development. Two important decisions were adopted giving UNIDO a clear-cut mandate to assist the private sector, including privatization and restructuring programmes, and an active involvement in the preparation and follow-up of the World Summit for Social Development.

In the area of the development of applications of computer technology, UNIDO rendered preparatory assistance in the the first phase of establishing the Regional Application Software, Training and Marketing Center (RASTER), to be located at the Higher Institute of Applied Sciences and Technology in Damascus, Syria. To meet a tremendous demand for specific software, development of applications, up-to-date hardware, telecommunication facilities, consultancy, training and information in the region, RASTER would serve Syria and neighbouring countries with information technology and computer facilities on banking, public administration, public and private industries, education, medical care and insurance, and business. The Center will initially focus on application software development and training. After a period of two years, it could be established as a fully-fledged regional centre, becoming self-sustaining within five years from its initiation.

Another activity is a proposal to improve management performance through the application of computers and training for small- and medium-sized enterprises in Africa. As new technologies spread around the world, as trade barriers come down and financial markets become deregulated and consumer tastes converge across borders, business opportunities have been granted to thousands of small- and medium-sized companies in developed countries. However, although the basic business principles are also very much applicable to SMEs in the third world, there is very little indication that the power and usefulness of computers as new business tools have been discovered by managers of these enterprises. For the countries of Africa facing numerous competing demands for often scarce financial resources, it is vital that investments reach an acceptable level of financial productivity. It has thus been considered imperative to improve computer usage in industry in order to make better use of monetary investments and of the potential benefits in computer applications to improve performance and productivity. The intention of the proposal is that UNIDO assists the African Regional Centre for Technology (ARCT) in the form of technical assistance on strengthening business skills among SME managers through awareness training and the implementation of computer tools for business control, the development of software packages for SMEs, with particular emphasis on business management and control, and the promotion of a more active recognition among vendors of the importance of business management software for SME users through improved seller-buyer interface with information available on vendor products/services and user needs.

As 1994 draws to a close, with its motley collection of joys and woes, we would like to wish all readers of the *Monitor* the best of the Season's greetings and a happy 1995.

Konrad Fialkowski  
Scientific Editor

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## I. NEWS AND EVENTS

### **UNIDO's Informatics and Telecommunications Industry Programme**

Developing countries still lag behind in the field of informatics technology, particularly with regard to industrial applications. Key capabilities are skills, experience and the ability of the local industry to match international standards, development of software and design of applications-specific integrated circuits.

The UNIDO programme emphasizes increased awareness, strengthened national capabilities, regional co-operation, micro-processor application centres, promotion of technology transfer and strengthening or promotion of test facilities. UNIDO provides guidelines for the purchase and utilization of hardware and software, strengthens developing countries' capabilities through micro-processor application centres or core groups, and helps set up software houses and activities for the design of integrated circuits. Studies on software focus on its relevance to developing countries, the approach to software development, and guidelines for software production. The whole programme is guided by the advice of the Consultative Group on Informatics Technology for Development (COGIT). Developments and diffusion of informatics and telecommunications technologies are continuously monitored and reported in a quarterly current awareness newsletter, the *Microelectronics Monitor*.

Special emphasis is given to computer applications in medium and small-scale industry. This task is being performed in cooperation with other United Nations agencies and at the same time fulfils the recommendations of ECOSOC resolution E/RES/1991/71, which includes UNIDO as one of the leading agencies in the field of informatics.

Although the economic impact of telecommunications is generally recognized, the poor status of telecommunications in most developing countries constitutes one of the major constraints to economic development. Industrial investors increasingly direct their resources to countries with acceptable telecommunications facilities. Technological advances and investment considerations have led to major policy changes with a diminishing role of the state in both the provision of services and manufacture of telecommunications equipment. The private sector is emerging as the lead player in telecommunications.

The UNIDO programme on telecommunications emphasizes the promotion of local manufacturing of telecommunications equipment. While some developing countries are already engaged in manufacturing of telecommunications equipment, the far greater majority relies almost exclusively on imports even for simple items which could be locally produced. The UNIDO programme builds awareness on manufacturing opportunities through technological disaggregation of telecommunications systems, identification of potential projects, assistance in undertaking feasibility studies and promotion of technological co-operation especially on a TCDC basis. To complement the manufacturing activities, UNIDO encourages regional cooperation in the establishment of type approval facilities, standardization, quality assurance, and inter-country R&D programmes. Exchange of information through publication of directories of manufacturers and development of data-

bases for the benefit of regional institutions is also supported. UNIDO also provides guidance to software firms in developing countries wishing to enter into the telecommunications software industry.

### **CD-ROM products of the World Intellectual Property Organization (WIPO)**

The World Intellectual Property Organization, based in Geneva, administers a number of treaties, including the Madrid Agreement Concerning the International Registration of Marks, the Patent Cooperation Treaty (PCT) and the Strasbourg Agreement Concerning the International Patent Classification. It also publishes a number of patent-related CD-ROM databases.

ROMAPIN contains all the data related to each international mark registered in the International Trademark Register. These disks have appeared on a monthly basis since May 1992. As well as serial numbers, dates, names of trade mark owners and other information, the disks also contain the texts of the Nice and Vienna Classifications in French and English.

The second edition of the IPC:CLASS CD-ROM (described in *World Patent Information*, 14, 4, pp. 227-230) will appear in 1994, in a Windows version.

The *Journal of Patent Associated Literature* (JOPAL) provides bibliographic details of articles covering new manufacturing methods and processes, materials and products, and costs Sw F 250. Using the same user interface and search software as ROMARIN, this disk is searchable by IPC (International Patent Classification) symbol, author, title, PCT number or journal details.

IP-LEX contains the texts of, and information regarding, international treaties and national laws regarding intellectual property. These will be available in English, French and (where available) Spanish. The disks will include glossaries and search software. The annual subscription is Sw F 1,200.

Other series include several under the generic name, ESPACE: -WORLD, -FIRST, -ACCESS and -OAPI. Further series are planned. (Extracted from *World Patent Information*, 16(2), June 1994)

### **Paperless trading set for take-off in Europe**

According to a new study, European businesses are increasingly rejecting paper and turning to electronic systems for ordering and invoicing. Paperless trading—electronic data interchange (EDI)—generated 322 million ECU (US\$ 355 million) for the providers of electronic commercial networks in 1993. The figure is an increase of 53 per cent on the total for 1992. The figures come from *Value added services in Europe 1994*, the latest report from London-based analyst CIT Research. CIT expects the EDI market to experience a ninefold increase in revenues over the next decade to reach over 2.8 billion ECU by 2003.

The United Kingdom was the leading EDI market in Europe for 1993 with revenues of 109 million ECU, more than France and Germany put together.

The American-based company, GE Information Services, is currently the leading provider of paperless trading services in the EDI arena with a 19 per cent share of the European market. GE Information Services consolidated its position in January this year with the takeover of International Network Services (INS), the

United Kingdom-based EDI supplier. (Source: *ITU Newsletter* 4/94)

### **Buenos Aires Conference on Global Telecommunication Development for the 21st century**

The First World Telecommunication Development Conference (WTDC-94) held by the International Telecommunication Union (ITU) since the establishment of its Telecommunication Development Sector, took place in Buenos Aires, Argentina, from 21 to 29 March 1994. Delegations from 133 member countries of the ITU, headed by ministers or senior officials, and representatives of 31 organizations and agencies, as well as many private sector representatives, participated in the Conference. The purposes of the Conference were: (a) to review the progress made in telecommunication development since publication in December 1984 of the Report of the Independent Commission for World-Wide Telecommunications Development "The missing link"; (b) to set the goals and objectives up to the year 2000 and to define and establish a common vision and strategies for achieving balanced telecommunication development by and beyond the end of the century; and (c) to approve an Action Plan which translates the goals and objectives agreed upon into a concrete work programme to be implemented over the next four years, identifying those priorities specific to the ITU and those areas of cooperation with its development partners.

The Conference was addressed by many ministers responsible for telecommunications and other senior representatives of governments and international and regional organizations, who stressed the importance of translating the indisputable potential of telecommunications into concrete action to improve the lives of all peoples of the world, especially those in developing countries. They also stressed the serious imbalance in world telecommunication development, which constrains the development of the global economy and should be a common concern of the whole international community. (Extracted from *ITU Newsletter*, 5/94)

### **Between dynasties (Investment in the Information superhighway)**

At present, the only network that is remotely comparable to the imagined information superhighway is the INTERNET. The INTERNET, though it is rapidly diversifying, is primarily a mechanism for world-wide information transfer. The information superhighway, on the other hand, will be increasingly comprised of interactive multimedia. Instead of information transfer, the kind of interactions conducted over this medium will be value-added transactions.

If the superhighway is to become a reality, three worlds—the computing, education and telecommunication industries—must converge to provide content, form, and distribution. Content is any information that can be digitized and then read, watched or listened to. In this category fall books, movies, music and television or printed news. Form is the computer hardware and software: the kind of intelligent form digital information must take to be easily comprehended, manipulated and value-enhanced. Distribution refers to the methods by which digital content in intelligent form is communicated around the country, including cable television, switched phone lines and on-line networks.

The controllers of, or investors in, any company that dominates one of these three digital worlds are going to become immensely powerful. Companies like Apple and Microsoft dominate the world of capturing information and enhancing data in an intelligent way, while the Baby Bells and cable TV companies dominate the world of distribution. It is in the world of distribution that business deals that take the form of investments, mergers or buy-outs involving the Baby Bells and cable companies are becoming the models for the dominant conglomerates that will create distribution networks for the information superhighway. (Extracted from *Inform*, 8(5), May 1994)

### **Computer crime**

The creation of the facility to move within virtual worlds has caused the distinction between reality and artifice to become blurred. Seemingly, also, that between right and wrong has become less clear to some people. What about computer crime?

In March, a US Federal Grand Jury indicted David LaMacchia, a student at the Massachusetts Institute of Technology (MIT), on a charge of distributing over \$1 million worth of software over the INTERNET. It was alleged he had created a bulletin board on two MIT computers which acted as a clearing-house for pirated versions of commercial software. The charge does not state who placed the software there, but accuses LaMacchia of providing the means by which software could be copied. Since 1992, it has been a felony to make and distribute ten or more copies of copyright-protected software (with a value of more than \$2,500). The Software Publishers' Association claims that last year in the United States, \$1,570 million worth was pirated. The existence of the INTERNET makes such activities easier.

At its peak, the bulletin board was processing 180 requests for downloading software in a 16-hour period. Network users accessing the bulletin board were advised to use aliases, if necessary routing their requests through Finland, where a service exists which allows users to conceal their identity.

This raises issues of whether computer criminals should be treated any differently from violent offenders. At present, most white-collar criminals are viewed more sympathetically than other varieties, but this attitude may change. (Extracted from *Informatics*, May 1994)

### **The promotion of Informatics in Africa and the role of the ARCT**

The development of software, both systems and application types, in any country or region is closely dependent on the level of indigenous computer systems engineering. In most African countries this level is at its minimum with hardly any policies for software manufacturing. A few countries have, however, made some progress, notably Ethiopia, Kenya, Mauritius, Nigeria, Uganda and Zimbabwe, but efforts are mainly concentrated on applications industry-specific software for certain tasks, such as accounting, computer-aided instruction, banking and finance management. No recorded software development efforts have been made in the area of systems-type software (operating systems, database management, utilities, telecommunications monitors, etc.)

In the majority of countries, the source of both application and systems software has been through vendors of



European and American companies. South African software is currently being marketed in Ethiopia, Kenya, Lesotho, Malawi, Namibia, Uganda, Zambia and Zimbabwe.

The situation is quite different in North Africa as indigenous software manufacturing has been quite developed in Algeria, Egypt, Morocco and Tunisia. Most of these are in Arabic and are geared to serve local industries and government departments. Application software from this region is exported mainly to the Middle East.

The development and manufacturing of software in Africa has not been successful due to the small market. It is only recently that private companies, government departments and NGOs started using computers in their day-to-day operations. Even then, there are countries where the import of computers is handicapped by excessive taxes, not to mention the absence of local computer manufacturing. The absence of coordinated and committed investment in R&D in Africa is in part responsible for what has happened in the past. Government policies on science and technology (S&T) are not consistent, while S&T mandates are given to weak ministry departments whose S&T policies are relocated year after year and are often relegated.

Cultural and linguistic barriers also contribute to the lack of investment in software manufacturing in the region. Ethiopia, for instance, has developed a number of applications software packages in Amharic, but cannot sell them in neighbouring countries.

In other developing regions, most initiatives were started by their governments. For example, in Brazil, the Government promoted the development of an indigenous computer industry since the early 1970s. By 1989 there were 150 computer-related hardware manufacturers and 1,200 software and computer servicing firms with a total employment of 21,000. Multinationals such as IBM and UNISYS still dominate the market for larger computers, but they have been largely driven out of the mini and personal computer markets. The success of this development was mainly due to government policy—the new information industry law was put into force in 1984. Similar developments have taken place in China, India, Hong Kong, Korea, Malaysia, Mexico, Singapore, Taiwan, Thailand, etc.

For Africa, the above-mentioned problems have no easy remedies. However, the African Regional Centre for Technology (ARCT), which is based in Dakar (Senegal), is attempting to support programmes that will help to resolve the issues in the long run. A computer culture has to be created in Africa. This may be slow, but it has to be done. The African Regional Centre for Technology has tried to resolve the problems through capacity-building of the centre itself and then strengthening selected national institutions and private enterprises in its member States through training and technical support. Emphasis is also being placed on establishing a programme of similar training and technical support for small- and medium-scale industries that will focus mainly on software development for simple applications and for export.

For the software manufacturing industry to be developed in Africa, the following problems need to be urgently addressed:

(a) Standardization: There is a need to provide guidance for software quality assurance. The International Organization for Standardization (ISO) has done some

work in this area, but there is still a lot to be done, especially in Africa.

(b) Lack of consistent national informatics policies: The biggest handicap of software development in Africa is the absence of policies to direct the investors in software development. The problems of software importation, pirating and dumping need to be addressed.

(c) Infrastructural development: The absence of computer system engineering, and tailor-made programs to develop any, keep frustrating any concerted efforts to develop the infrastructure and capacity for investment in software development.

(d) The small market issues: A group of countries may wish to share software development in given fields such as medicine, engineering, management control, finance, etc.

(e) Training and human resource development: Software programs should start at universities, which is rarely the case in most countries. The ARCT is currently compiling a database of African scientists and technologists working in companies and universities in Europe, the United States and Canada.

The biggest group of players to direct efforts are the policy makers, then the freelance software workers, including employees of small computer shops, and returnees from overseas universities and companies. (Extracted from a paper presented by Michael Nageri at the COGIT meeting in Vienna, 22-24 November 1993)

### ***Opto-electronics: a perfect marriage?***

The marriage of optics and electronics has been highly successful because they are complementary, they compete with each other—hence the incentive to innovate—and they are sustained by buoyant demand (audiovisual sector, data processing, telecommunications).

The opto-electronics industry has already reached a turnover of almost \$40 billion in 1993, shared among Japan (70 per cent), the United States (20 per cent) and Europe (9 per cent).

Proceeding as in a game of Go, opto-electronics first conquered the outlying sectors of information techniques: transmission of information through optical fibres, screen visualization equipment, information storage on optical disks and, of course, the coding of data through light impulses from LEDs and lasers.

Now that progress has been made in manufacturing techniques and compact laser equipment has been developed, opto-electronics can tackle the heart of the system, the micro-electronic circuits. The development of opto-electronic chips is still in its infancy but it is clearing the road for mass production and the introduction of hybrid computers (electronics/optics) that are eminently suitable for parallel processing. By the year 2000, opto-electronics are expected to revolutionize many aspects of trade and industry as well as the life of consumers (much as electronics has).

For the time being the merger of optics (or photonics) and electronics is proving successful. The new technological system is fostering decentralized, user-friendly and communicating information systems. The emphasis is therefore shifting from equipment to interconnections and from large-scale systems to network structures—in other words, to the fields where opto-electronics excel. The presence

of this sector is therefore being felt in many different areas:

- Telecommunications—the diffusion of optic-fibre networks is essential for improving output and thereby allowing broad-band services to develop as well as image transmission and processing;
- Data processing—improved printing (laser printers) and higher storage capacity (compact disks) can be achieved with higher-frequency light: an all-optical computer is no longer just a dream;
- Production plant—the development of optic-fibre sensors and inspection systems is revolutionizing automated quality control;
- Defence industries—despite budget constraints, opto-electronic instruments (infrared detectors, laser guidance systems, overhead holographic displays, optical circuitry flight controls) are becoming more widespread;
- Transport—opto-electronic components are starting to modify driving conditions in cars: and further improvements are likely with navigation aids, systems which detect obstacles and display the state of the vehicle;
- Medical sector—combined laser and fibre equipment are already improving diagnostic techniques: they have led to the development of photodynamic therapies and high-precision surgery.

(Source: *The OECD Observer* No. 185, December 1993/January 1994)

### **Information Indigestion!**

We are told that this is the age of information, where the amount of available information doubles every five years. This gives rise to new concepts and vocabularies. Today, the English language contains approximately 500,000 usable words, five times more than at the time of Shakespeare.

George Schultz, a former US secretary of state, suggested that information is the international currency upon which fortunes will rise and fall. And, as more and more information is brought to our attention, we spend more and more time trying to process it for our own benefit. As a result most, if not all, of us will suffer occasionally or even frequently from information overload. A recent survey of nearly 1,000 chief executives showed that three out of four thought their company suffered from information overload to some degree at least.

This article looks at some of the reasons why information comes in the door faster than we can cope with it. It also warns that there is no "best way" to tackle this problem and, indeed, you may not wish to be cured! What proportion of relevant information would you lose if you closed your door to the incoming flow of information generated by your superiors, friends, subordinates and the media? Would the loss of that information not outweigh the gain from a reduced information overload?

Tony O'Reilly said that "the first thing that strikes me about information systems is that we are getting too much information ... Much of this data is only partly digested and much of it is irrelevant to what I believe to be the fundamental objective of business information which is simplification."

Systems developers, and often management, concentrate on building up large amounts of data. The assumption made is that the managers can then select the information they need at a particular time.

Ironically, the computer can be the greatest possible obstacle to management information because it is used to produce huge quantities of the stuff. Either the limitations of analytical skills lead decision makers to collect information that cannot be used or else, confronted with situations they cannot make sense of, they collect as much information as they can, expecting that some of it will turn out to be enlightening. Thus, there may be a great deal of information, but little is relevant. While it is easy to blame system developers, even personnel who do not receive computer printouts or formal reports can still suffer from information overload.

What is needed are systems which can translate raw data into information—meaningful data presented in a way that enhances their relevance to a particular problem. In the last 30 years, DP departments have been very good at mass-producing raw data but they have failed to support managers, i.e. produce usable knowledge, drawing on individual experience and separating the significant from the irrelevant. Top managers have now lost interest in this approach to information systems.

For most organizations, information has become a signal and a symbol: gathering information provides a ritualistic assurance that appropriate attitudes about decision-making exist in the organization, and managers' status is enhanced by the variety of their information sources and the obvious nature of their information-gathering. They are regarded as more powerful, and as better decision makers, than people with less obvious access to information, regardless of the nature of this information. Similarly, organizations need to be seen to be efficient in their information processing. These are now social norms.

Organizers, therefore, often develop cultures which cause more information to be gathered than may be necessary. And certainly, they do not utilize information in accordance with the classical economic view, which holds that the value of information depends on its relevance to the decision to be made and on its reliability and accuracy. Investing in information is worthwhile if its marginal expected return in improving decision-making exceeds its marginal costs.

This economic view assumes that the collection of information is strongly linked to decision-making and that information plays little or no other role. However, many researchers have shown that much irrelevant information is gathered and processed within organizations and that most individuals and organizations collect more information than they could measurably expect to use in making decisions.

Most of us use information more to interpret and understand what is going on around us than merely to address current decisions.

Management researchers describe top executives as spending their careers trying to build a mental model of their organization and its environment so as to support their high-level task of elaborating an organizational strategy and their vision of the future. This is justified by the nature of the tasks which face senior executives.

Where decisions are equivocal, there are no objective guidelines for the collection of information and decisions are often made on the basis of subjective judgements and opinions sometimes disregarding information which had been collected.

However, a number of organizations have been known to experience an information glut as a shortage of information and this type of overload can further contribute to the breakdown of the overall information processing capabilities of such an organization. This confusion between the unavailability and the unretrievability of information is a product of our senses and can be observed at organizational level as the erratic information behaviour which accounts for the information overload we have all experienced.

This problem is aggravated by the strong incentives given to the information gatherers to be more and more efficient and therefore to gather increasing amounts of information. Typically, these information gatherers are separated from the information users and they transfer the costs of obtaining the information to those users. The normal supply and demand equation is defeated by such an "organizational information market", since the information providers have no incentive to adjust their output to suit the real needs of the information users.

These information users, because they are also decision makers, are led to accept this overload in order to increase the safety of their position in case they make a wrong decision.

Finally, information should not be regarded as an "innocent" commodity. There is evidence to show that the information in an organization is very often the weapon used by managers in their internal fight to have their representation of reality recognized. It is used to persuade and force people to do something. Many conflicts of interest are tackled with the generation of numerous flows of doubtful information which one would be unwise to regard as anything but propaganda.

Information serves more purposes than we commonly identify and the pattern of our search for information must be treated with care. Looking at information as a mere commodity which one has to keep in stock with typical re-ordering levels is dangerous. Individuals and, above all, managers must continue to search their environment for the information which will improve their understanding at the risk of suffering from information overload. (Extracted from *Technology Ireland*, February 1994)

### **The coalescence of technology**

Technologies, like bodies of matter in space, are irresistibly drawn to each other. They go on to cooperate, even to merge. That explains why so many innovations emerge at the junction of different disciplines, mechatronics, biooptics, chemitronics, opto-electronics, composite materials, neural engineering and other techniques all began in this way. The study of the fusion of these technologies helps to unravel the internal workings of present-day technical change and to predict further developments more clearly. Governments are now paying more attention to this creative cross-breeding, to try to produce a suitable business environment to hatch fertile technological hybrids.

The technological choices that businesses make are based foremost on considerations of cost and probable demand. But there are also "organic" aspects involved. An

understanding of innovation and the complex way in which it works requires study by technological analysts and historians. The mechanics of technological growth can be clearly grasped with reference to engineering and product design. Concentration on the technical substratum of innovation and its operational rules allows both a new perspective and the avoidance of pitfalls. This "projection" into the world of technology also has the advantage of setting the study of technological clustering in new terms and identifying its internal mechanisms. It also serves to shape and guide government action in the activities concerned.

The relationship between science and technology has grown from strength to strength. In many sectors, scientific knowledge has been tapped to validate technological advances, and to design and improve new products and systems to meet market requirements. This process has resulted in the emergence of new applied sciences known as "scientific engineering" or "technosciences" (materials engineering, nanotechnologies, micromachinery, and so on). Scientific innovations are also being more quickly taken up by technology (fuzzy logic, auto-organization, fractal imagery).

In this context optimization and innovation take on specific forms in the production system. It leads both to product change ("dematerialization") and to organizational change (redistribution of tasks with the introduction of decentralized data processing, known as "re-engineering", and "partial automation"). The competitive success of Germany and Japan, both of which base their strategies on priority to industry, highlights the importance of such changes and of the technological potential of industry and of production itself. This is also reflected in the recent efforts of many large enterprises in the United States to re-internalize production that had been contracted out.

Combining technologies is a way of generating these trajectories and thus of boosting current trends.

Recent economic history highlights the potential benefits to large or small enterprises of cooperating with others even if they do not belong to the same sector. The main attractions of this strategy include sharing increasingly heavy R&D costs and taking advantage of complementary features. But it is also more and more a matter of dispelling market risks, producing technological synergies and finding innovatory applications through alliances and cooperative projects. So far, the drive to combine several different technologies has been highly successful, for two reasons.

First, it is often a way of upgrading performance. For instance, the aim might be to obtain a compound with better overall qualities than those of its separate components. With materials, considerable success has been achieved in the development of multiple composites and alloys. In production techniques, technology fusions effectively help to prevent breakdowns, to make processes automatic and to save both time and human resources.

Second, the merger of two technologies operating in separate areas may have unexpected spin-offs and generate totally new products. Such is the case with multimedia products, opto-electronics, and remote data processing ("telematics") through the combination of data processing and telecommunications.

Technology clustering allows firms to make substantial savings (especially in interactions where products are less expensive to manufacture jointly than separately). Marginal improvements to a variety of techniques may also lead to considerable progress after clustering (as with numerical command machine tools). Merging technologies may therefore be a source of substantial technological profit.

The tendency of technologies to coalesce is one of the characteristics of current industrial change. Before the 1970s it was hard to detect a trend towards clustering on any scale; then, about 20 years ago, early signs of the development of mechatronics (mechanical engineering plus electronics) and the first steps of biotechnology were noticed. During the 1980s the trend gathered pace with the emergence of further sectors, such as new materials and environmental protection technologies.

These developments led companies on to more diversified activities, especially in R&D. Many large firms altered their industrial territories by restructuring their production systems according to the Japanese "keiretsu" model of diversified oligopoly. Where they opted to redeploy their assets towards their traditional activities, the restructuring was accompanied by further commitments in enterprise networks and technological consortia.

Governments have access both to the means and the analytical skills to try to forecast technological development. Although the principle of "business knows best" still applies in the markets where firms operate, it no longer holds good at boundaries between different markets or in areas where they have no direct experience. MITI has just published a substantial report on technologies that will be promising at the end of the decade. A fact worth noting from this analysis is that, in terms of turnover, the new chemicals sector (new ceramics, intelligent materials) is expected to overtake information processing by the beginning of the third millennium.

Governments can play an important part in facilitating technology mergers, but the action to be taken must be finely tuned. Premature standardization could encourage second-rate technologies, while putting off decisions often amounts to aligning on proprietary technology that is less desirable for users. Similarly, maintaining or implementing rigid regulations that are out of step with technological change holds back competition and leads to higher prices.

In practice, technology fusion is produced by teamwork that involves scientists and technicians operating in different fields. If such partnerships are to benefit from osmosis, the team members must have an adequate technical background as well as the ability to understand a wide range of disciplines. Governments must therefore ensure that transdisciplinary curricula are established in higher education if they are to avoid shortages in human resources that would heavily penalize companies.

A technological analysis of technical change and a closer examination of clustering effects should foster cooperation and dialogue between governments, industry and services. In particular, it should enable the administrations concerned to draw up sounder strategies, to become more independent of scientific and technological lobbies and to achieve savings in the management of their support to the techno-industrial complex. (Extracted from *The OECD Observer* No. 185, December 1993/ January 1994)

### **Computer makers discover home market**

PC systems are rapidly assuming many of the qualities of the video game player as computer systems and software manufacturers look for an increased share of the home market.

US electronics companies and software publishers see lucrative opportunities in the home and they are attracted by the large profits made by video game machine manufacturers such as Nintendo and Sega systems.

What further attracts companies is that the home market is not necessarily a low-end market. The high demand for multimedia capabilities means that the majority of home PCs being bought are 486 systems. And Intel expects the home market to buy Pentium systems as prices drop later this year.

The US-based Software Publishers Association (SPA) estimates that about 27 per cent of US households own a personal computer. About a third of those PCs were purchased within the last year. As prices continue to fall for PC hardware and software, the SPA predicts that demand for powerful home-based PCs will continue to grow. The SPA says that most of the recently purchased computers are capable of multimedia and have a modem. While many of the home PCs are partly being used to do office work at home and for home-based businesses, PCs are also being bought for entertainment uses.

To penetrate the home market further, prices not only have to drop, but PCs must tackle the video game players where they are the strongest, in graphics. Although most video game players have fairly slow 8-bit or 16-bit microprocessors, they are backed up with custom graphics chips and are not burdened with an operating system enabling them to run fast graphics games.

PCs, on the other hand, are designed for business tasks and have slower graphics but they have more memory, data storage and better resolution monitors. To enable PCs to handle fast graphics, Microsoft and Intel have come up with new software, and PC board manufacturers are developing graphics boards that can display the same kind of dazzling graphics found in video game players.

Intel recently introduced its 3DR application programming interface which helps video game players write PC-based games with fast 3-D graphics. Chip manufacturers Cirrus Logic, Western Digital, Tseng Labs and 3D Labs joined with board manufacturers Diamond Computer Systems and Media Vision to endorse the Intel 3DR technology and promised compatible products.

Intel is also supporting Microsoft's WinG software tools for writing games software on Windows systems that gets around the slow graphics by using a new graphics engine. Microsoft claims that combining its WinG technology with the forthcoming version of Windows 4.0, codenamed Chicago, will change the PC into a powerful games machine.

Market research firm Dataquest believes that PCs have a window of opportunity in challenging video game player companies because the next generation of sophisticated video game machines will not arrive until 1995 and 1996. However, when those video game players do arrive, they could pose problems for PC manufacturers since they will offer high-end workstation graphics performance for as little as £300. (Extracted from *Electronics Weekly*, 1 June 1994)

### **Who needs Information? Maximizing its potential**

All organizations need information and benefit from its effective use. The information itself may be internally or externally generated and will be used in a variety of ways, ranging from daily operational requirements to longer-term decision-making and planning: from research and scholarship to marketing and promotion activities.

Information needs to be able to be stored and organized in such a way as to make its retrieval easy and instant, whatever its format. All departments and functions within an organization are likely both to produce and to hold information, therefore coordination of methods by which it can be produced and systems to manage it to ensure its most effective exploitation and use are essential.

Knowing where to go and how to get externally generated information, and organizing it into a logical arrangement have long been seen as the traditional role of information managers, but many have been doing much more than this. Their professional education and training provides a range of detailed knowledge and skills which enable them to make a considerably broader contribution to their employing organizations.

There are a number of elements to this role. The first factor is that of organizational awareness, with information resources and systems developed with the organization's objectives and its total operation at the front of any planning. A second aspect is communication. Knowledge of organizational structure and procedures allows maximum use of both formal and informal communication mechanisms, encouraging the efficient flow of information across functional boundaries. Promotion is another major element. Access to, and the arrangement and presentation of information, plays an important part in promoting the concept of effective information use. (Extracted from *Information Management Report*, June 1994)

## **II. NEW DEVELOPMENTS**

### **Faster cycles on FRAMs**

Matsushita Electronics is incorporating a new ferroelectric material developed by US materials specialist Symetrix in a low-voltage, high speed non-volatile 256 k memory.

The material, known as Y1, is claimed to support 1 trillion (1 million million) read/write cycles, which is a 10,000-fold increase on existing ferroelectric random access memories (FRAMs) based on lead-zirconium-titanium (PZT) composite oxide technology. The new technology, which Matsushita is designing into a proprietary single transistor, single capacitor cell, is also claimed to support 3 V operation and a 100 ns operating speed.

The low power and high read/write cycle performance of Y1 is a key factor for non-volatile FRAMs, which are rivaling flash as the memory of choice in future generations of portable computers. The important quality in a good ferroelectric material is the ability for its molecular dipoles to align under the influence of an electric field and to retain their orientation once the field is removed.

Traditionally PZT achieves this but can require a 5 V write voltage and a two transistor, two capacitor 1-bit cell design which could limit storage capacity to around

16 kbit. Matsushita has already used Y1 to produce a 256 k FRAM. (Source: *Electronics Weekly*, 13 June 1994)

### **Cool chips run faster**

Superconductor Technologies (STI) and nChip say they will collaborate on producing supercooled multi-chip modules to be used in supercomputers, telecoms equipment and test equipment.

STI says it has developed new technologies that allow super-cooled semiconductors to be used in many different system applications. Large performance increases in systems can be made without the need to redesign components. Simply cooling semiconductors makes it possible to run them at significantly higher speeds.

The STI cooling system is about the size of a juice carton. It uses a special compressor, whose piston is cushioned with helium gas, to cool components down to -173° C. nChip's multi-chip packaging technology will allow systems manufacturers to concentrate the chips that need cooling within a small volume for more efficient cooling. (Source: *Electronics Weekly*, 4 May 1994)

### **Water molecules' behaviour surprises IBM researchers**

IBM researchers recently reported that water molecules at the surface of a metal electrode crowd together at up to double their normal density—contrary to popular belief.

Traditionally experts believed that water molecules formed several distinct layers around the surface of immersed metal electrodes, according to Michael Toney, a materials physicist at IBM's Almaden Research Center (San Jose, CA) who conducted the research with several colleagues.

For the electronics industry the greatest impact of the IBM work may be in understanding electroplating processes and how metals are deposited in wet processes.

Wet etching is another possible area that might be affected by the IBM discovery, Toney said. "In wet etching there is always water at an interface being etched. That etchant needs to get to the surface to scrape off whatever material is there."

The results of the IBM experiments change the atomistic picture of how surface reactions occur. Current molecular water models used in computer simulations are clearly inadequate for predicting many properties, he added.

The scientists' conclusions were reached through an X-ray scattering study, said to be the first direct probe of the arrangement of water molecules at and near the surface of electrodes. (Extracted with permission from *Semiconductor International Magazine*, June 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

### **Fujitsu claims solvent toxic breakthrough**

Fujitsu claims to have made a breakthrough in reducing the toxic effects of solvents used to clean flux waste, with the world's first substitute cleaning agent for trichloroethane. The cleaning agent is made of hydrocarbons, polar solvents and acetic acid. Fujitsu says the solvent features improved dissolving power for flux waste produced during soldering during the semiconductor assembly stage. It plans to offer the agent to other companies next year, through major chemical producers. (Source: *Electronics Weekly*, 22 June 1994)

### Intel memory in flash debut

Intel has introduced its first flash memory chips which can use 5 V power supplies for write and erase functions as well as reading. This is accomplished using voltage-sensing circuitry called SmartVoltage, which allows the chip to use 5 or 12 V lines for write/erase and 3.3 or 5 V lines for reading.

SmartVoltage technology allows the same chip to be used in equipment with single or dual power supplies. The first chip to incorporate SmartVoltage technology is the 28F016SV, Intel's first 16 Mbit flash chip, which is sampling now, and goes into volume production by the end of the year.

Intel also intends to build SmartVoltage technology into its 2 Mbit and 4 Mbit Boot Block family of flash chips by the end of the year.

The SmartVoltage circuitry senses the VPP pin voltage, used for program/erase functions, and if 12 V is available externally the signal is routed directly to the storage cell.

If only 5 V is available it calls up one of two charge pumps: one to perform Fowler-Nordheim tunnelling for erase; another that is optimized for hot-electron injection for write operations.

In this way, Intel says it is giving system builders the flexibility to choose which trade-offs associated with flash best suit requirements.

The read voltage can be reduced independently of the write/erase voltage. Intel claims that 3.3 V read operations use only one third the power of 5 V reads. In some applications the ratio of read to write/erase functions is 4:1, so great power savings are possible. Intel is already working to reduce the read voltage from 3.3 V to 2.7 V.

Furthermore, keeping the programming and read voltage pins apart guards against power surges which can mistakenly write to instead of read from a single-supply flash chip. (Source: *Electronics Weekly*, 22 June 1994)

### Faster emulator for PowerPCs

Apple Computer plans to unveil five new PowerPC-based machines early next year which feature a new 680x0 emulator running twice as fast as the current emulator.

Sources close to Apple report that the five models are code-named Alchemy, Catalyst, Nitro, Tsunami, and TNT. All will be based on different versions of the PowerPC microprocessor in different combinations of add-on slots, video support and system memory.

The five models will be introduced in the first quarter of 1995, with a new 680x0 emulation technology developed by Apple that will run twice as fast as the present software from Insignia Solutions.

Improved emulation should help Apple sell PowerPC-based Macintosh models, since many customers are still buying 68040-based Macintosh models because there is a lack of native software for PowerMac models and their emulation technology slows their performance to that of older 68030 Macintosh computers.

The new emulation technology runs 680x0 software as fast as a 33 MHz 68040 Quadra when running on a PowerPC 601 60 MHz PowerMac. Apple must first complete extensive tests to make sure that compatibility problems are avoided. (Source: *Electronics Weekly*, 22 June 1994)

### NTT team cracks hologram snags

Researchers at NTT in Japan believe they have cracked the problem of full motion holograms. The scientists have developed a highly selective and responsive recording material based on europium doped yttrium silicate.

The material can store a picture every nanosecond but allow about 10 million still pictures to be recorded on a single film—equivalent to 100 hours of television broadcasts. The material has to be used in conjunction with a precision controlled dye laser.

The interference pattern from the object, which forms the hologram, causes a "hole" in the recording medium's optical absorption coefficient at the laser's operating frequency. The material is so selective that a new image can be recorded by changing the laser's frequency by just 1 kHz. Full motion images can be recorded by illuminating the object with a laser whose frequency is being continually changed in 1 kHz steps.

In this fashion NTT scientists succeeded in recording playing simple motion pictures for about 20 seconds. (Source: *Electronics Weekly*, 22 June 1994)

### IBM claims 20x disk breakthrough

In its efforts to push hard drive technology to new limits, IBM research scientists have announced the creation of super-sensitive disk heads making use of the giant magnetoresistive effect (GMR) that can boost disk capacities by as much as 20 times.

The spin valve head is five times more sensitive than today's best magnetoresistive (MR) disk drive heads. IBM says the new head sensor can read data on magnetic disks at a density of 1 billion bits/sq in.

The spin valve's electric signal, one thousandth of a volt per micron of track width, was reported to be five times greater than that of the best MR sensor available in today's products. The researchers expect to improve it substantially in the future as they become more familiar with the spin-valve design's characteristics.

The head gives disk drive makers the option of producing drives with larger data capacities or spinning the disk faster to increase data access rates. (Source: *Electronics Weekly*, 22 June 1994)

### Auriga gets fast fibre

Auriga (Europe) has become the first UK distributor for a novel fibre connection system from Europtics.

Europtics, a company jointly owned by the UK's BICC and Furukawa and NTT of Japan, believes its technology will accelerate the use of fibre to the desk.

The system is based on pre-connected fibre optic cables and patch panels using a miniature multifibre connector developed in Japan.

The system, called CION (Clip-in Optical Node), is said to be up to 25 per cent cheaper than other fibre-to-the-desk techniques. (Source: *Electronics Weekly*, 22 June 1994)

### US Navy works on 3-D display

US Navy scientists have developed what one day may be the basis for three dimensional TV, without the need for special glasses.

The new technology, which uses lasers and vibrating crystals to create the 3-D images, is currently being tested

at the Naval Command Control and Ocean Surveillance Center in San Diego, CA.

Called a 3-D volumetric display, the device is actually a plastic sphere 18 inches in diameter. Inside the sphere, the 3-D images are produced by a laser which passes through a series of vibrating crystals. The laser light splinters into 40,000 separate beams which then fall onto a helical surface that is spinning at a rate of ten revolutions per second.

Behind the scenes is a Unisys Desktop III computer with an Intel 386 CPU and an Intel 387 floating-point unit running at 20 MHz, which controls the vibration of the crystals so as to send the fragmented laser light to exact coordinates on the spinning helix, thus creating a 3-D image.

First uses of the display will be for air traffic control, anti-submarine warfare, and medical applications. (Source: *Electronics Weekly*, 1 June 1994)

### **Comlinear claims ADC goal as architecture reaches 12 bits**

US firm Comlinear believes it has developed an analog-to-digital converter (ADC) architecture capable of providing 12-bit performance at conversion rates as high as 50 MHz.

The sub-ranging architecture uses novel techniques in the second stage to minimize the comparator count, avoiding the associated power dissipation penalty while boosting conversion speed.

The firm has designed a 12-bit, 25 MHz ADC using the architecture, called the CLC950, which it claims has a better performance than any other monolithic converter of its class on the market today.

The CLC950 ADC marks a renaissance in Comlinear's fortunes and is the first device in a family of high performance ADCs.

It is to be followed, early next year, by the CLC951 device with a 12-bit, 30 MHz performance and a third chip with a target conversion rate of 50 MHz. Revision B samples of the CLC950 are expected in July with production anticipated to begin in August. The device is built in a 0.8  $\mu\text{m}$  BiCMOS process with an NPN transistor  $F_t$  of 12 GHz. (Source: *Electronics Weekly*, 1 June 1994)

### **Water: the key to electric cars?**

The Holy Grail of battery researchers is to design batteries capable of powering an electric car. These need to be rechargeable, light, cheap and safe, and must be able to store a large amount of energy relative to their weight. A team from Simon Fraser University in Burnaby, British Columbia, has developed a possible candidate.

The most promising batteries for electric cars are based on lithium, says the team, as these produce a higher voltage than lead-acid or nickel-cadmium batteries. The first lithium cells, developed in the late 1980s, had a lithium metal negative electrode, a positive electrode capable of "intercalating" lithium ions (that is, storing them without distorting its lattice structure), and a water-free electrolyte containing lithium ions. However, when these batteries were recharged several times, the negative electrode became covered with an unstable metal "fur" which could catch fire when the battery was being used.

The Canadian team, working with Moli, a local battery manufacturer, has overcome these problems by developing a lithium battery which uses a water-based electrolyte.

Because lithium metal reacts violently with water, they used two intercalating electrodes. One was made from lithium manganese oxide ( $\text{LiMn}_2\text{O}_4$ ) which, unlike other intercalation materials like disordered carbon, holds lithium inside its lattice tightly enough to stop it reacting with water. The other electrode was made from vanadium oxide ( $\text{VO}_2$ ), and the electrolyte was an aqueous lithium nitrate solution with a trace of lithium hydroxide added to suppress the lithium-water reaction further.

To charge the cell, the team passed a small current from the  $\text{LiMn}_2\text{O}_4$  electrode to the  $\text{VO}_2$  electrode. Lithium ions, dislodged from the  $\text{LiMn}_2\text{O}_4$  electrode by the charging current, intercalated in the vanadium oxide lattice. When the cell was discharged, the ions flowed back, generating 1.5 V of electricity.

As the charging current puts lithium ions inside the electrode rather than plating them on top, the unstable fur cannot form, making these batteries much safer than the originals, claim the researchers. Moreover, the aqueous electrolyte makes them easier to manufacture and many times cheaper. They can be made even cheaper by making both electrodes out of  $\text{LiMn}_2\text{O}_4$ , giving a 1 V cell. Because manganese and its oxides are plentiful, non-toxic and cheap—unlike lead or nickel—such a battery "could have a huge potential market", says the team. (Source: *Chemistry & Industry*, 6 June 1994)

### **Engineers monitor MBE deposition rates**

Sandia National Laboratories (Albuquerque, NM) has a real-time molecular beam epitaxy (MBE) control sub-system that offers unsurpassed accuracy and reproducibility for fabricating compound semiconductors.

The technique uses an optical flux monitor (OFM) to control deposition rates of aluminium and gallium in real-time. Briefly explained, it splits signal and reference beams from a hollow cathode lamp. The signal beam goes through a port in the MBE chamber, passes through the beam of the atomic element being deposited and is picked up by a photodiode. The monitor's computer compares both beams continuously during film growth, providing instantaneous readings of the atomic beam flux and a measure of the rate of surface deposition. A key to the monitor is use of the output of the reference beam photodiode as feedback to reduce lamp variations to less than 0.1 per cent.

In demonstration experiments the Sandia engineers have grown a series of nanometre-scale mirrors with layer thicknesses accurate to within 0.3 per cent.

The system is designed to be compatible with present MBE machines as a simple add-on. (Reprinted with permission from *Semiconductor International Magazine*, May 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

### **New downstream ECR TiN CVD technique**

A way of depositing low resistivity TiN at low temperatures using PECVD has been developed by a team of scientists from AT&T Bell Laboratories and the Fraunhofer-Institut für Schicht- und Oberflächentechnik (Hamburg, Germany).

In the new technique, a metalorganic precursor called DMATi—(tetrakis(dimethylamido)-titanium)—is injected downstream of a nitrogen or ammonia plasma created using an ECR source. Atomic nitrogen and amido radicals generated in the ECR plasma react with the DMATi to form high quality TiN films.



Even at a substrate temperature of 100° C, the researchers were able to grow TiN films with resistivities comparable to PVD methods. The measured resistivities and deposition temperatures are the lowest reported for a plasma-enhanced N deposition process. However, low resistivity films (45–150  $\mu\Omega\text{cm}$ ) are only obtainable at deposition rates below 10 nm/min. (Reprinted with permission from *Semiconductor International Magazine*, May 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

#### **New and safer way to make III-V materials**

Duke University chemists say they have devised a new and safer way to synthesize gallium arsenide and other important III-V semiconductors by looking for new ways to form the chemical bond that links Group III and V elements. The traditional approach to making gallium arsenide, for example, combines trimethyl gallium—which spontaneously ignites in the presence of oxygen—and toxic arsine gas with potentially explosive hydrogen gas. The Duke University team, led by Richard Wells, found it could get the same results by reacting gallium trichloride with tris(trimethylsilyl) arsine at 167° C. In what is called a "dehalosilylation" reaction, the tris(trimethylsilyl) group combines with the chlorine in gallium trichloride to produce gallium arsenide and trimethylsilyl chloride. Dehalosilylation does not need hydrogen gas. Also, toxic arsine is kept bound into the molecules during the reaction and does not escape as a gas at any point. While tri(trimethylsilyl) arsine can itself spontaneously ignite, it also has a high boiling point and so is less risky than arsine gas. (Reprinted with permission from *Semiconductor International Magazine*, May 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

#### **Ultra high-speed light modulator**

Sumitomo Cement Co., Ltd. has commercialized the first ultra high-speed light modulator that paves the way for the realization of multimedia and next-generation optical communications networks with large-capacity information transmission.

The optical communications industry is achieving accelerated growth on a global scale with the establishment of infrastructures such as multimedia and information highway networks. At present, projects are about to be implemented, such as submarine high-speed optical communications systems for the Pacific and Atlantic oceans and a broadband integrated services digital network (B-ISDN) system, and competition is intensifying in the sector of high-capacity optical communications systems.

The light modulator, which changes light intensity and frequency to enable information to be converted into signals, is a key device used with a laser diode in the transmission unit of an optical communications system. It is indispensable for next-generation communications networks which transmit information at a speed exceeding 10 Gbit/s. The DC bias voltage that determines the operating point for modulation undergoes a phenomenon known as DC drift, where the voltage gradually shifts out of the set level resulting in unstable modulation. This had prevented the light modulator from being used commercially.

The new ultra high-speed light modulator employs an optical waveguide structure using a titanium-diffused

lithium niobate (LN) crystal wafer with a fast response. In addition, the DC drift problem was solved to enable the light modulator to operate with stability over a period of several dozen years.

At the same time, the drive (modulation) voltage was lowered to less than 4 V, the same level as that of an IC, while the light extinction ratio that indicates the attenuation of light intensity was also maintained at over 20 dB. In addition, the light modulator is contained in an airtight package for better reliability.

With the modulator commercialization, the company plans to expand its production facility in Funabashi City, Chiba Prefecture, to engage in full-scale production from June 1994. Further details available from Sumitomo Cement Co., Ltd., Public Relations Section, 1, Kanda Mitoshiro-cho, Chiyoda-ku, Tokyo 101, Tel.: +81-3-3296-9670, Fax: +81-3-3295-4578. (Source: *JETRO*, May 1994)

#### **Double brightness LCD backlighting**

Maytac Co., Ltd., a manufacturer of liquid crystal parts, has developed LCD backlighting that has double the brightness of conventional types.

The backlight assembly is placed behind a liquid crystal panel and sends light forward to brighten the display surface. It consists of a light source lamp and a guideplate for diffusing the light over the entire face of the display.

The new light uses an L-shaped lamp that emits light from the top and one side of the display screen. In contrast to the conventional I-shaped light assembly that emits light from a single direction, the light emitting part is longer, and the guideplate for diffusing the light over the entire display surface has also been improved. Whereas the light diffusion part of the acrylic plate used to be printed with ink, the acrylic plate has been provided with cylindrical protrusions to improve light reflection.

According to experiments, the improvements of the lamp and the light guideplate have improved the average brightness of the backlight from 4,362 Cd to 8,029 Cd with the 4-in. type light assembly. Meanwhile, the power consumption has been limited to an increase of only 15 per cent compared with the company's existing types.

This power-saving, high-brightness backlighting system was developed to cope with the growing current market preference for all-in-one camera-video systems, games equipment, and navigation systems equipped with liquid crystal displays featuring great brightness, power conservation and long service lives. The company observes that there is a big demand for high-brightness backlight for colour liquid crystal displays which are expected to come into wide use. Further details available from Maytac Co., Ltd., 1-15-30, Umehayashi, Otsu City, Shiga Pref. 520, Tel.: +81-775-94-0700, Fax: +81-775-94-1700. (Source: *JETRO*, May 1994)

#### **Crystalline structure of new Cu-based high-Tc superconductor determined for single crystal**

The Electrotechnical Laboratory, the Agency of Industrial Science and Technology (AIST), in collaboration with the National Institute of Materials and Chemical Research, has succeeded in synthesizing a single crystal and analysing the structure of a Cu-based high-temperature oxide superconductor, which belongs to the recently discovered new high-temperature non-toxic Cu-based super



conductor family of  $\text{Cu}_{1-x}\text{Ba}_2\text{Ca}_y\text{Cu}_4\text{O}_{12}$  with the critical temperature ( $T_c$ )  $> 116 \text{ K}$  ( $116 \text{ K} = -156^\circ \text{C}$ ), the highest so far reported.

The Cu-based superconductor family is one of the long-awaited high- $T_c$  superconductor families, with superior characteristics to the Hg- and Tl-based superconductor families such as non-toxicity and simple composition. The small  $\text{CuO}_2$ -block spacing suggests a lower anisotropy and higher critical current density ( $J_c$ ), suggesting applicability to superconducting wiring and thin film formation technologies.

The Electrotechnical Laboratory research team treated reaction intermediate  $\text{Ba}_2\text{Ca}_2\text{Cu}_4\text{O}_9$  and  $\text{CaO}_2$  with high purity in the high-pressure heat process under 5 GPa at  $1,100^\circ \text{C}$  for three hours to synthesize a  $0.04 \times 0.04 \times 0.01 \text{ mm}$  monocrystalline sample. The high temperature attained in the process and the use of highly pure materials were essential. The crystalline structure of the product was determined by the National Institute of Materials and Chemical Research using X-ray diffraction (XRD).

The XRD results showed that the fundamental structure is the  $P4/mmm$  space group of a simple tetragonal Cu-1234 phase. The electron diffraction pattern with a very weak superlattice was simultaneously observed. The lattice constants of the synthesized monocrystalline sample were  $a = 3.8526 (18) \text{ \AA}$ ,  $c = 17.974 (5) \text{ \AA}$ . The XRD analysis used a lattice model previously developed from the X-ray powder diffraction analysis as the basic value, and a final reliability factor ( $R$ ) of 4.8 per cent was achieved, converged from the observed 278 diffractive points.

The crystalline structure has two Ba layers sandwiching defective CuO layers entirely different from previously observed superconductive structures, and the refined occupation factors showed the structure has a formula of  $\text{Cu}_{1-x}\text{Ba}_2\text{Ca}_y\text{Cu}_4\text{O}_{12-y}$  ( $x=0.4$ ,  $y=0.6$ ), which is similar to the Ag-based superconductor family but is a new high-temperature superconductor family.

The research team expects the attainment of higher  $T_c$  and  $J_c$  values by doping Ag ions in the defective CuO layers to change the carrier concentration and filling Cu-vacancies to further strengthen the coupling between the superconducting  $\text{CuO}_2$ -blocks. Further details can be obtained from Electrotechnical Laboratory, AIST, 1-1-4, Umezono, Tsukuba City, Ibaraki Pref. 305, Tel.: +81-298-58-5310, Fax: +81-298-58-5349. (Source: *JETRO*, May 1994)

### Quantum cascade lasers

Opening up more of the spectrum to semiconductor lasers, and making it easier to tune them to different wavelengths, would make new applications possible for these useful devices. For some time engineers have thought wishfully of what they could do with semiconductor lasers that produced longer wavelengths—all the way from the mid-infrared to the submillimetre end of the radio spectrum (i.e., from two microns to 100 microns or more). Computer networks could be linked up without costly and cumbersome cables using handy point-to-point laser telecommunications. Miniature radar devices based on them could be mounted on cars to warn of unseen obstacles or other vehicles coming too close. They could also make pollution sensors, able to sniff out toxic chemicals in smokestacks or unburnt hydrocarbons in exhausts.

Those wishes felt a lot closer to realization after an announcement in late April from AT&T Bell Laboratories in Murray Hill, New Jersey. The "quantum cascade" (QC) laser unveiled there has set the world of solid-state physics abuzz, although its principal inventors—Federico Capasso and Jerome Faist—insist that commercial applications could still be a decade or more away. But the promise is there: the QC laser's novel design allows it to be tailored to work over a wide range of different wavelengths. Better still, it can be tuned simply by altering the device's internal dimensions.

Now that the QC laser has been proved to work—albeit in brief pulses and only when very cold—laboratories around the world will try to develop their own versions.

The QC laser is the result of two decades of laboratory work. The concept was proposed 25 years ago by two Russian scientists.

The QC device is quite different to conventional semiconductor lasers. Known as a "unipolar" laser, it uses only one type of charge (electrons). The electrons' usefulness depends on a so-called "tunnelling effect" which allows them to burrow their way through an insulating barrier, provided it is thin enough. The QC laser is made up of 25 sections, each a sandwich of conducting material (indium-gallium-arsenide) between two insulating layers of aluminium-indium-arsenide a billionth of a metre thick.

By careful use of band-structuring and molecular beam epitaxy (MBE), each of the 25 conducting sections in the device is designed to accommodate electrons at a lower energy level than its predecessor. To an electron it looks like an "energy staircase" which it can descend, losing a bit of energy with each step. It loses energy by giving off a photon. From every stair a shower of photons cascades through the device. Bell Laboratories calls it an electronic waterfall.

The QC laser's real advantage is that the wavelength of the light it emits depends on the thickness of its active layers. And that can be easily adjusted by using MBE to spray more or fewer atoms of active material between the insulating layers. Tricky as the band-structuring and MBE processes are, they can be automated. No insurmountable obstacles exist to prevent QC lasers of various different wavelengths from one day being stamped out like computer memory chips. But before that can happen, the QC laser must first be made to run continuously—and at nearer to room temperature.

For now, the electrical current needed to make the QC laser work is so high that the device must be chilled with liquid nitrogen to  $-196^\circ \text{C}$ . Even so, the laser would fry itself to a frazzle if used for more than a brief pulse. Improving the QC laser's efficiency is going to be the trickiest task. And because it works like no other laser yet perfected, a lot more laboratory sweat will be shed before the tunable infrared laser finds its way into everyday gadgets. (Source: *The Economist*, 4 June 1994)

### Superconducting coil for fault current limiters

Tokyo Electric Power Co., Inc., in a joint research project with Toshiba Corp., has developed a new 3,000 Ap/6,000 V-class superconducting coil for fault current limiters, using the principles of superconductivity to instantaneously suppress the fault current generated and maintain an overall network balance.

The new superconducting coil is 50 cm in height and 40 cm in diameter, using multicore superconductive niobium-titanium alloy wires comprised of filaments as thin as 0.14  $\mu\text{m}$  to allow alternating currents to be passed stably through the networks under normal conditions.

The coil usually functions as a connector to enable currents to flow freely without any loss, simultaneously maintaining the network linkages, and becomes superconductive to generate a resistance instantaneously whenever some line fault occurs, preventing the problem from spreading to other parts of the network. Also, the coil winding has achieved the optimum pitch of 8 mm.

In the performance test, a fault current limiter using the new superconductive coil succeeded in the continuous passage of alternating currents of 3,000 Ap, the largest so far recorded, demonstrating extremely high reliability and robustness.

In another experiment that simulated a fault current problem, the new coil alone succeeded in instantaneous suppression of a large current of 28 kAp and current reduction to about 4 kAp. High-speed stable current limiting performance has also been confirmed in the experiment, paving the way for practical applications.

Power plant systems have been tremendously improved to cope with the steady growth of the power supply demand of the ever-thriving information society which requires system extension and high-quality power sources. However, problems in the system facilities have been increasing with more frequent occurrences of the fault current.

No fault current limiter, that normally has no electric resistance but instantaneously suppresses the fault current by generating a tremendous resistance and severing the network linkages to minimize losses, has been commercialized up till now due to the large currents and failure to withstand long-term use.

The company plans to continue research to reduce the size of the overall network system and to minimize AC losses, and to develop a superconducting fault current limiting system for use in 500 kV trunk transmission network systems with the aim of achieving higher voltage and larger currents. The company expects all these technological improvements will contribute to the development of highly compatible independent systems and the reduction of facility costs. Further information is available from The Tokyo Electric Power Co., Inc., Public Relations Department, 1-1-3, Uchisarwai-cho, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3501-8111, Fax: +81-3-3596-8555. (Source: *JETRO*, May 1994)

#### **High field superconducting magnet with 50 mm clear bore**

The National Research Institute for Metals, the Science and Technology Agency, recently succeeded in generating the highest magnetic field by a superconducting magnet of 21.16 tesla (T) using a new high field superconducting magnet with a 50 mm diameter clear bore.

The new magnet is about 1.7 m in diameter and 4.3 m in height, based on a double-layer structure with the innermost Wind & React coil using the newly developed (Nb, Ti, Ta),Sn superconductor. The stainless steel bobbin was removed from the innermost coil to generate higher fields in a larger space and improve training behaviour. Saturated superfluid helium of -279° C was used as the

coolant. Various measurements in high magnetic fields will be possible with this system.

High magnetic fields are very important in development and testing systems for superconducting materials, and also for organic chemical reaction control, combustion reactions, and separation/refining of chemical substances. The institute expects the use of the new system will contribute to the development of advanced superconducting materials. Further information is available from the National Research Institute for Metals, Tsukuba Laboratories, Science and Technology Agency, High Magnetic Field Research Station, 1-1-2, Sengen, Tsukuba City, Ibaraki Pref. 305, Tel.: +81-298-53-1197, Fax: +81-298-53-1199. (Source: *JETRO*, May 1994)

#### **Cleaved GaAs (110) surface observed with ultra-high vacuum atomic force microscope**

Professor S. Morita and his research team at the Faculty of Science, Hiroshima University, in collaboration with the Optoelectronics Technology Research Laboratory in Tsukuba City, Ibaraki Pref., have succeeded in observing the atoms on a clean surface of GaAs (110) with dangling bonds with a new ultra-high vacuum atomic force microscope (UHV-AFM) utilizing the sample cleaving mechanism.

The new UHV-AFM was developed with the help of the research department of the Olympus Optical Co., Ltd., in Hachioji City, Tokyo and achieves a very high vacuum of below  $1.8 \times 10^{-10}$  torr. A tube scanner scans a cantilever and the deflection is detected by a fibre-optic interferometer to measure the interatomic force. Location outside the AFM chamber of the interferometer components excluding the optical fibre enables a compact, lightweight system structure. The mechanical stability and reliability are greatly improved, and operation is much easier.

Dual-axis piezoelectric micropositioners based on the inchworm mechanism cleave the sample by forcing the sample against a wedge-shaped block.

In the experiment, the surface of a n-type GaAs wafer was cleaved to observe the quasi-one-dimensional zigzag chains consisting of alternating Ga and As atoms in the AFM chamber at  $1.8 \times 10^{-10}$  torr. Electron transfer from the Ga dangling bonds to the As atoms and As atom relocation outside the surface were also observed for the first time.

Imaging was performed with a V-shaped  $\text{Si}_3\text{N}_4$  micro-fabricated cantilever with a sharpened pyramidal probe tip, which remained in direct contact with the sample surface at a constant repulsive force of  $5 \times 10^{-2}$  N (constant force mode). The spring constant and mechanical resonant frequency of the cantilever were  $k = 0.1$  N/m and  $f_0 = 27$  kHz, respectively.

The resultant AFM image showed atomically flat terraces separated by single and double atomic steps with directions of mainly [001] and [110] in a  $6 \times 6^7$  nm area, and the rectangular lattice was clearly resolved despite the slight distortion due to creep in the micropositioner, and thermal drift.

Observation of the cleaved surface of a semiconductor crystal was previously impossible due to the adhesion between the AFM probe tip and the dangling bonds. The new UHV-AFM solves this problem by using the fibre-optic interferometer and improving mechanical accuracy and performance so imaging is possible at a weak contact force to prevent the adhesion reactions.

This success demonstrates the feasibility of using the UHV-AFM to investigate semiconductor surfaces with dangling bonds on an atomic scale. Further details may be obtained from the following: Hiroshima University, Department of Physics, Faculty of Science, 1-3-1, Kagamiyama, Higashi-Hiroshima City, Hiroshima Pref. 724. Tel.: +81-824-24-7396. Fax: +81-824-24-0717; Optoelectronics Technology Research Laboratory, Tel.: +81-298-47-4331. Fax: +81-298-47-4180; Olympus Optical Co., Ltd., Tel.: +81-426-42-2119. Fax: +81-426-42-2114. (Source: *JETRO*, April 1994)

#### **Fullerene single-crystal thin film**

Mitsubishi Electric Corp. has succeeded for the first time in producing fullerene  $C_{60}$ , a carbon substance attracting attention as a new electronic device material, as a single-crystal thin film in a size usable as a semiconductor material.

Fullerene is a carbon allotrope with a different structure to diamond or graphite, and is characterized by an inside void like a soccer ball. The discovery of  $C_{60}$  and  $C_{70}$  fullerenes in the United States and Germany in 1990 triggered intensive research world-wide, which revealed semiconductor, superconductor, and photocatalytic properties, paving the way for useful applications including advanced materials, pharmaceuticals for preventing AIDS virus growth, etc.

The ionized cluster beam (ICB) technique is applied to ionize molecules for vapour deposition onto substrates, forming a single-crystal thin film with an area of  $1\text{ cm}^2$ . The film features excellent heat resistivity and radiation resistance and is suitable for large-scale integration, making it possible to produce new semiconductor wafers to replace the conventional silicon and gallium-arsenide wafers. In addition, research can investigate the characteristics of fullerenes, many of which are as yet unknown.

The wafer material used for producing fullerenes as single-crystal thin films is mica heated to  $200^\circ\text{C}$ . Epitaxial growth can be advanced on the mica wafer surface by providing fixed deposition conditions for  $C_{60}$  thin film.

The ICB vapour deposition technique applied this time is a technique for forming films by feeding a new type of organic film ion source into the Ion Engineering Center organic ICB film-forming apparatus and an ultra-high vacuum specifications ICB film-forming apparatus. Molecules are ionized, and the ionized molecules accelerated by the applied voltage for deposition on the wafer.

The ionization conditions and acceleration conditions are optimized to enable single-crystal thin films to be produced in sizes enabling use as semiconductor materials.

Observations with a transmission electron microscope and atomic force microscope have shown that a 20 nm-thick single-crystal thin film is formed over the entire mica wafer of  $1\text{ cm}^2$  area, and that the film molecules in the film are arranged regularly through epitaxial growth.

The organic molecule beam evaporation (OMBE) process has been used for forming  $C_{60}$  fullerene thin films, but this process only provides polycrystalline thin films. Further information is available from Mitsubishi Electric Corp., Public Relations Dept., 2-2-3, Marunouchi, Chiyoda-ku, Tokyo 100. Tel.: +81-3-3218-2172. Fax: +81-3-5252-7119. (Source: *JETRO*, April 1994)

#### **Large electric current stored in compact superconducting SOR ring**

Nippon Telegraph and Telephone (NTT) Corporation recently succeeded in storing an electric current of 1.215 mA, the largest so far, in a compact superconducting synchrotron orbital radiation (SOR) ring, the Superconducting Atsugi Lithography Synchrotron Orbital Radiation Ring (Super-ALIS), developed by the corporate LSI research laboratory in 1989. This was achieved by new technology for controlling unstable vibrations of electron beams inside the ring.

SOR is produced by accelerating electrons close to the speed of light in an accelerator called the synchrotron and bending the electron beams travelling into a circular orbit inside the synchrotron with either a magnetic or an electric field. A wide range of wavelengths from far-infrared radiation to X-rays is available and is usable for LSI superelaborate machining lithography due to the high light intensity and good directivity.

Storage of a large electric current in a SOR ring is needed for practical SOR applications. However, maintaining stable electron beams was previously difficult due to the interaction between electrons and gas molecules and interference from an electromagnetic field generated inside the ring by the electrons travelling almost as fast as the speed of light. Unstable electron vibrations eventually cause collision of electrons with the inside wall of the SOR ring, so no current storage is possible.

The new technology uses an 8-pole magnet and two tuners located in the void of a high-frequency accelerator to control and reduce unstable electron beam vibrations in the SOR ring. The resultant SOR provides light for short exposures comparable to existing lithography using ultraviolet (UV) light.

NTT is planning to further improve the new technology and expand SOR applications to surface analysis technology, superprecision machining of ultra-miniature semiconductors, novel superprecision machining technology using photochemical reactions, etc. Further details available from Nippon Telegraph and Telephone Corp., Press Relations, Public Relations Dept., 1-1-6, Uchisaiwai-cho, Chiyoda-ku, Tokyo 100. Tel.: +81-3-3509-3101. Fax: +81-3-3509-4290. (Source: *JETRO*, April 1994)

#### **Blue light-emitting diode (LED) with brightness of 1,000 mcd**

Nichia Chemical Industries, Ltd., the world's leading manufacturer of fluorescent materials, has developed a blue light-emitting diode (LED) featuring a brightness of 1,000 mcd. This blue LED is about 100 times brighter than counterparts currently available on the market. Red and yellow LEDs of over 2,000 mcd are already available on the market. The development of this new blue LED will provide more flexibility and diversity for higher grade LED light displays. The industry is now keenly awaiting the development of a high brightness pure green (555 nm) LED which is indispensable for producing genuine full-colour LED displays.

The new blue LED is made of gallium nitride, it works with a current of 20 mA, a voltage of 3.6 V, and its brightness is 1,000 mcd. The emitted light has a peak wavelength of 450 nm and a blue colour of high purity.

Gallium nitride emits a blue light, its light-emitting efficiency with respect to the voltage is high, and the company has already acquired 150 patents relating to this blue LED. The blue light LEDs currently commercialized by other manufacturers are made of silicon carbide, with a brightness of roughly 10 mcd and a wavelength of 470 nm giving a tinge of green.

The company is presently preparing a production line in its main plant in Anan City with the schedule of commencing mass production from January 1994 and turning out 1-2 million blue LEDs per month from April 1994.

LEDs are used widely today in the display systems of traffic signs and store front bulletin boards and also as the display lamps of home electric appliances. The emergence of the bright blue LED is certain to make displays more colourful than before. Further details from Nichia Chemical Industries, Ltd., 491, Oka, Kaminaka-cho, Anan City, Tokushima Pref. 774, Tel.: +81-884-22-2311, Fax: +81-884-23-1802. (Source: *JETRO*, April 1994)

#### **Semiconductor film produced by depositing silicon on fluoro-resin substrate**

Professor M. Murahara of the Faculty of Engineering, Tokai University, has developed a semiconductor film that is produced by depositing silicon on an insulating fluoro-resin substrate at room temperature.

The resin surface is reformed by laser projection, after which silicon is bonded chemically and laminated by the chemical vapour deposition (CVD) method. The wafer with the insulating underlayer features high-speed operation and is suitable for miniaturization.

The fluoro-resin is chemically stabilized and features excellent chemical resistance and solvent resistance, as well as excellent corrosion resistance, weatherability and durability, and is therefore an ideal material for use in the manufacture of artificial blood vessels which must have excellent biocompatibility. It also features excellent electrical characteristics of high insulation, low inductance, and induction loss. The new wafer is produced by depositing a semiconductor silicon amorphous layer on the resin. Fluoro-resin has a poor affinity with other types of materials, making silicon deposition quite difficult.

Si atoms were substituted on the defluoridized FEP surface and a non-bonded surface was generated. The Si film was deposited by the optical CVD method using these Si atoms as the nuclei. In this film growth method, the laser beam was irradiated perpendicular to the film to excite the membrane.

The fluoro-resin was placed in an environment of trimethyl boron and monosilane, and an argon-fluorine excimer laser irradiated through a patterning mask. The trimethyl boron reacts with fluorine atoms in the resin, mono-silane is decomposed, and the silicon bonded chemically in its place to a silicon layer serving as the nucleus. The monosilane is then sealed and decomposed optically with a laser beam to deposit the silicon film by the CVD method.

A wafer with a semiconductor layer on the upper part of the insulation has a smaller leakage current than a silicon wafer and therefore allows operation at a higher speed. Wafers made of gallium-arsenide with insulative properties and controlled impurities are used in portable

telephones, but the resin insulation is much more reliable and procurable at a lower cost. Using this resin enables a silicon pattern to be engraved on an insulating fluoride film to produce a thin-film transistor that is applicable to the manufacture of medical electronic equipment which must be biocompatible. Further details are available from Tokai University, Faculty of Engineering, 1117, Kitakaname, Hiratsuka City, Kanagawa Pref. 259-12, Tel.: +81-463-58-1211, Fax: +81-463-58-1812. (Source: *JETRO*, April 1994)

#### **Smallest MOS transistor with 0.04 $\mu\text{m}$ gate length**

Toshiba Corp. has developed a prototype of the world's smallest gate electrode, a 0.04  $\mu\text{m}$  gate electrode n-MOS (metal oxide semiconductor) transistor with 0.01  $\mu\text{m}$  shallow source and drain junctions. Normal operation of the new transistors at room temperature has been confirmed.

Gate electrodes control electric current flow from the source terminal to the drain terminal by changing the voltage supply. The terminals are joined to the electrode by junctions. Smaller gate electrodes and thinner junctions are indispensable for more highly integrated, higher-speed ICs. The 0.04  $\mu\text{m}$  gate electrode of the new MOSFET (MOS field effect transistor) is equivalent to that required for 100 gigabit memories and beyond, as well as highly advanced future generations of high performance ICs, including high-speed microprocessors.

The new technologies are based on three key developments: a new design methodology for small-geometry MOS transistors that adopts an ultra-shallow structure for the junction of the source and drain (0.01  $\mu\text{m}$ —25 per cent of the current minimum), while maintaining the voltage (1.5 V); resist thinning technology by ashing resists that are patterned with excimer lithography, enabling fabrication of the 0.04  $\mu\text{m}$  gate electrode; and solid-phase diffusion technology that enables fabrication of ultra-shallow 0.01  $\mu\text{m}$  source and drain junctions.

After field isolation, the channel region is doped by boron ion implantation. Following this, a 0.003  $\mu\text{m}$ -thick gate insulator is grown through thermal oxidation at 800° C and subsequent deposition of *in situ* phosphorus-doped polycrystalline silicon. Next, gate lithography is carried out with an excimer stepper, followed by a resist-thinning process based on an isotropic plasma resist ashing technique. Following this, 0.19  $\mu\text{m}$ -thick phosphorus-doped silicated glass (PSG) gate sidewalls are fabricated, and, using the gate electrode and the sidewalls as a mask, arsenic atoms are implanted to form deeper source and drain diffusion layers outside the sidewalls. After these steps, rapid thermal annealing is carried out, causing the phosphorus to diffuse into the substrate through solid-phase diffusion. This process results in an ultra-shallow phosphorus source and drain junctions of just 0.01  $\mu\text{m}$ . Further details from Toshiba Corp., Public Communications Office, 1-1-1, Shibaura, Minato-ku, Tokyo 105, Tel.: +81-3-3457-2100, Fax: +81-3-3456-4776. (Source: *JETRO*, April 1994)

#### **High-capacity PLZT thin film for memory cells**

Professor M. Okada of the Engineering Faculty, Chubu University, has developed a PLZT thin film consisting of lead, lanthanum, zirconium and titanium that appears promising as a capacity cell material for next-generation semiconductor memory chips, which is produced by film

growth technology based on the metal organic chemical vapour deposition (MOCVD) method.

The new thin film is characterized by an electric storage capacity that is 100 times that of a silicon oxide film. Technology was also developed for fabricating a ruthenium oxide electrode for use as the capacity cell electrode in place of a platinum electrode.

The MOCVD technique was used to vary the zirconium and titanium ratios and the lanthanum added, to produce a film of unique composition featuring a high dielectric constant and free of fatigue. Producing a uniform PLZT film by the conventional CVD technique had been quite difficult, but this problem was solved by improving the CVD system, optimizing the CVD conditions, and selecting an optimum film composition.

In experiments, platinum was used to produce the capacity cell bottom electrode, and a PLZT film 200 nm thick was grown on the electrode by the MOCVD technique. The CVD material was a metal organic gas consisting of lead, titanium, lanthanum and zirconium, the wafer temperature was 650° C, and the source material gas was reacted for about 20 minutes at a pressure of 660 Pa.

As a result, the film was very smooth, transparent and had minimal strain when the zirconium and titanium ratio was 50:50 and the lanthanum addition was 16 per cent. Hardly any hysteresis was displayed by the polarization-voltage characteristic curve, and the film became paraelectric at room temperature. The relative dielectric constant attained a value that is about 100 times that of a silicon oxide film, while the leakage current density indicating the film quality was 3 pA/cm<sup>2</sup>, about the same as that of a silicon oxide film.

To replace the platinum electrode for which micro-machining is difficult by etching, a ruthenium oxide film MOCVD technique was developed. By using ruthenium tetravaloylmethane as the source material, a ruthenium oxide film with a thickness of 0.5 µm was grown on the silicon wafer at 300° C.

The oxide film is sublimated at 800° C, so it can be worked with ease with a laser beam. Ruthenium oxide does not react with PLZT, so the PLZT film serving as an insulating film can be produced in a thin configuration. The development of this new technology paves the way for the structural simplification of chips beyond 256 Mbit DRAMs as well as the simplification of the manufacturing process. Further details are available from Chubu University, Faculty of Engineering, 1200, Matsumoto-cho, Kasugai City, Aichi Pref. 487. Tel.: +81-568-51-1111, Fax: +81-568-51-1141. (Source: *JETRO*, April 1994)

#### **Smallest scale for submicrometre-level measurement correction**

Hitachi Ltd., in cooperation with the National Research Laboratory of Metrology, the Agency of Industrial Science and Technology (AIST), has developed a diffraction grating scale called Microscale, applying the laser interference exposure method and wet-type anisotropic etching technology used for micromachining.

The new scale is a standard reference for correction of measurements at a submicrometre-level accuracy of 0.2 µm pitches, the smallest so far, to allow microfabrication technology for semiconductor memories to be evaluated accurately. 256-Mbit LSIs which require measurements as small as 0.2-0.25 µm can be measured very easily with the new scale.

Micropatterns of semiconductor devices are presently evaluated with the high-resolution scanning electron microscope (SEM). However, measurement accuracy cannot be evaluated adequately as there has been no standard reference available to correct the submicrometre-order measurements.

Microscale solves this problem by installation in the SEM to correct measurements by calculating the SEM pitches and adjusting the mean to the scale pitches, providing a 0.001 mm-level accuracy.

The company is considering developing technology to mass-produce the new scale to allow installation in the SEM for practical use. Further details from Hitachi, Ltd., Public Relations Secretary's Office, 4-6, Kanda Surugadai, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3258-1111, Fax: +81-3-3258-2375. (Source: *JETRO*, April 1994)

#### **Sony claims double CD technique**

Sony claims to have developed a technique which can double the capacity of compact discs without the need for shorter-wavelength lasers or stacking of recording layers. Sony's trick is to code the signal by modulating the position of the leading and trailing edges of equally-spaced pits on the disc surface. Each edge is used to code a three-bit number, giving a total of six bits per pit. With one pit every 1.67 microns, that gives a data density of 0.28 microns per bit, compared to 0.59 microns per bit for conventional CDs. (Source: *Electronics Weekly*, 8 June 1994)

#### **Benefits from GaAs defects**

A German physicist working in Japan has turned what were once thought to be defects in gallium arsenide crystals into microstructures which could be used in the fabrication of semiconductor circuits. Working at Nippon Telegraph and Telephone (NTT), visiting physicist Richard Noetzel has created a structure of regularly spaced GaAs crystal structures 0.15-micron wide. These structures have been observed in crystals before but were considered defects. If developed the technique could provide an alternative to the present process of etching sub-micron structures into a much larger crystal. No one can yet etch the 0.1-micron structures needed for 1 Gbit DRAMs. (Source: *Electronics Weekly*, 8 June 1994)

#### **Fashioning superconductor models**

Perovskites are a particularly versatile class of materials: layered perovskites of some inorganic oxides are superconductors. Now scientists have come up with a conducting, organic version. With their extra flexibility, this new family may prove useful in tailoring new conducting materials, especially superconductors.

As the number of layers increases, organic perovskites undergo a similar character change to their oxide cousins. With less than three layers, they semiconduct; with more than three, they behave like a metal, report David Mitzi of IBM in Yorktown Heights and his colleagues at the University of Houston.

The advantage of the organic version is its flexibility, explains Mitzi. In the new structure, Mitzi inserts an organic "modulating" layer between conducting tin iodide sheets. By changing the length of the hydrocarbon chains in the modulating layer, Mitzi can control the couplings between perovskite layers.

When the modulating layer contains long-chain organic molecules, Mitzi believes it makes a good model for a lipid

bilayer with its polar head groups and hydrophobic tails. In such a model, the "bilayer" is confined in a lattice, making it possible to use X-ray or neutron diffraction to study conformation changes within it.

Mitzi believes that including more complicated molecules with unsaturated hydrocarbon chains or rings in the modulating layer may make it a suitable model for studying excitonic superconductivity. Although only a theory at the moment, scientists believe this form of superconductivity may be produced through the movement of electrons rather than heavy nuclei. Because electrons are much lighter, scientists believe that higher superconducting temperatures may be possible.

Unlike oxide perovskites, which need high temperatures for stability, organic ones form near room temperature, Mitzi reports. He increased the layers by adding more  $\text{CH}_3\text{NH}_2\text{SnI}_3$  perovskite chunks. (Source: *Chemistry & Industry*, 30 June 1994)

### **Scientists achieve new record for sunpower concentration**

In a breakthrough that could expand the range of potential applications for concentrated sunlight, researchers have achieved a record concentration equal to the power of 50,000 suns.

The record was achieved by researchers at the National Renewable Energy Laboratory's (NREL) High-Flux Solar Furnace at South Table Mountain in Golden, Colorado.

The furnace was built in 1989 to explore using highly-concentrated sunlight for advanced materials processing and detoxification of contaminated wastes. The furnace uses a series of mirrors to concentrate sunlight into an intense, focused beam.

While the furnace successfully proved sunlight is a clean, effective energy source for numerous manufacturing processes, researchers continued working towards the goal of achieving a concentration 50,000 times greater than the normal solar intensity found at the Earth's surface.

Researchers used a reflective secondary concentrator to achieve the previous high concentration to achieve the previous high concentration of 21,000 suns. To achieve 50,000 suns concentration they replaced the reflective concentrator with a lens-like refractive secondary concentrator.

The University of Chicago designed and fabricated the refractive secondary concentrator under an NREL sub-contract. Both secondary concentrators are based on non-imaging optics principles developed by Dr. Roland Winston and his colleagues at the university.

NREL said the breakthrough opens the door to a number of potential applications, including solar-pumped lasers and production of fullerenes.

Solar-pumped lasers use concentrated sunlight for power and are more energy-efficient than traditional lasers. Applications of the lasers include space communication systems, space power systems, terrestrial material processing and photochemistry.

Fullerenes, a stable form of carbon discovered in the mid-1980s, have potential commercial applications in semiconductors, superconductors, high-performance metals and medical technologies. Conventional energy sources produce very small quantities of fullerenes, but concentrated sunlight potentially could produce greater quantities while reducing costs and energy requirements.

NREL's solar furnace was designated a National User Facility in July 1993, opening it to industry, university and government scientists throughout the nation. (Source: *International Solar Energy Intelligence Report*, 16 May 1994)

### **Etching boron-doped SOI etch stops**

At the University of California at Davis, researchers are working to understand how potassium hydroxide (KOH) etch selectivity is affected by the defect density of various types of boron-doped etch stops used in the fabrication of silicon-on-insulator (SOI) structures. So far, they have been able to show that etch selectivity is a function of boron concentration and defect density and, to a lesser extent, defect type. (Reprinted with permission from *Semiconductor International Magazine*, April 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

### **New photoresist etchback technique: better than CMP?**

Motorola engineers say they have developed a new planarization technique that is clearly better than spin-on glass/etchback and equal to or better than chemical-mechanical polishing (CMP). The technique achieves planarization by simultaneously eroding a reverse image photoresist mask and the exposed underlying dielectric layer.

Using a single wafer, isotropic etch system manufactured by MATRIX and an experimental negative resist from Shipley, engineers Gordon Grivna and Ray Goodner of Motorola's works in Mesa, AZ, say they were able to obtain an average interlevel dielectric thickness variation of 230 Å across 100 mm wafers. Yield results were also impressive: on test structures with 0.6 µm dimensions, yields were equivalent to structures using advanced two-layer planarization or CMP techniques. Having demonstrated the new technique on submicron ULSI four-layer multilevel metallization structures, Motorola is already using the new technique in production to fabricate multilevel GaAs chips.

The Motorola engineers say the global planarity achieved by the new reverse photoresist mask erosion technique exceeds that demonstrated by SOG/etchback techniques, and is equal to or better than that displayed by CMP techniques. The new technique has the added advantage that previous global nonplanarity is maintained and a uniform thickness of dielectric is left over all metal features enabling precise control of via depth. (Extracted with permission from *Semiconductor International Magazine*, March 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

### **Thermal uniformity in LPCVD furnaces**

The way to reduce wafer temperature variations in hot-wall multiwafer LPCVD furnaces is to increase the end-zone temperatures, which can be easily accomplished without any significant changes to the reactor configuration. These are the conclusions of scientists at Rice University in Houston and the University of Texas at Austin who have developed a mathematical model to predict both axial (wafer-to-wafer) and radial (across-wafer) temperature profiles within a hot-wall multiwafer low-pressure chemical vapour deposition reactor. Sponsored by SEMATECH and

the Semiconductor Research Corp. (SRC), the work has resulted in what is probably the most accurate hot-wall reactor modelling programme to date.

The researchers say the best candidate for reducing wafer temperature variations is to increase the end-zone temperatures. Although one might expect the radial non-uniformity of the end wafers to increase as the end-zone temperatures are raised, model predictions show that this is not the case. (Reprinted with permission from *Semiconductor International Magazine*, March 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

#### **One way to achieve dry resist process**

A group of engineers at AT&T Bell Laboratories (Murray Hill, NJ) have found that plasma polymerization of various mono- and di-substituted organosilanes provides a simple and effective new approach to organosilicon resists. For example, photosensitive films can be deposited from low power discharges in methylsilane with a parallel plate plasma system. Such films undergo photo-oxidative crosslinking and bleaching when irradiated with mid-deep UV light in the presence of oxygen. Quarter micron thick films are converted to siloxane network materials having an Si:O ratio over 1 on exposure to 100 mJ/cm<sup>2</sup> at 248 nm. These researchers propose using this resist in an all-dry or hybrid bi-level process scheme using standard deposition, exposure and etch equipment. (Reprinted with permission from *Semiconductor International Magazine*, March 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

#### **Array lens technology targets FPD manufacturing**

Newly formed Hugel Lithography S.A. (Neuchâtel, Switzerland) has laid plans to commercialize a novel lithography system for flat panel display (FPD) manufacturing. The idea and company have come from industry veteran William Hugel.

Hugel explains that while the anticipated system will have many subsystems common to existing lithography tools (for example, conventional alignment and mercury-lamp illumination), the key competitive advantage will come from using a "lenslet array". Briefly explained, this is a two-dimensional arrangement of lenses formed on a flat glass substrate. Each lenslet projects a 1X image from the appropriate mask, "sandwiched" with the lenslet array, onto a corresponding area of the substrate; the method is similar to full-field proximity printing. "Each lenslet is capable of 2 µm resolution, or better, and acts independently. There is no limit to the image field size, obviating any need to step across the image field, thus eliminating defects associated with field stitching", he says.

The lens-array method allows improvements on two accounts: first, unlimited field size is achievable from a single optical element. Second, there is no requirement for dynamic alignment between adjacent exposure fields.

Hugel perceives several production advantages with lenslet array lithography:

- Throughput advantages, possibly double what is now achieved in FPD manufacturing, will result because the approach bypasses conventional stepping and settle times;
- Yield advantages are associated with the elimination of stitching errors;

- The cost of a lenslet array could be one-twentieth the cost of a conventional stepper lens.

Hugel Lithography has begun with the goal of producing the first system by the end of 1994. Initially, the array will be made with refractive lenses. However, subsequent designs may use diffractive or binary optic lenses. (Reprinted with permission from *Semiconductor International Magazine*, April 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

#### **Micropumps enhance analytical results in chemistry**

Sensors that have bioelectronic coupling represent a way of continuous on-line monitoring of chemical processes. But this only becomes possible with miniaturized chemical analysis systems, which are now being developed by the Institute for Microtechnology of the University of Neuchâtel, Switzerland, in cooperation with the chemical company Ciba-Geigy, the university reports.

These are microsystem components which contain miniaturized analytical systems such as colour reactions or chromatography. In addition to the detection systems, the mechanical elements such as pumps and reaction chambers are also integrated. These components are being produced in Neuchâtel by means of photolithography.

At this time micropumps are available which are able to convey volumes of up to one millilitre per second. A specially developed flow sensor is used to control the flow. The pumps can be used in a pressure range of up to two metres of water head. The miniaturized detector cells measure volumes between 10 picolitres and 100 nanolitres and show good detection limits, it is further said.

The miniaturization makes it possible to utilize effects which do not occur in macrodimensions. Among these are, for example, electro-osmotic control of flows. In capillary systems of less than 100 micron diameter it is possible to move and control aqueous electrolyte solutions without using pumps and valves by means of electroosmotic effects.

The speed of flow is several millimetres per second. The direction of the flow can be altered in microseconds and directed towards branches. Stackable microflow systems are also being built in Neuchâtel. They combine analytical systems with functional elements and enable three-dimensional flows.

Another component is the glass chip for capillary electrophoretic separation of mixtures of substances. This separation takes place under high electrical voltage and lasts 20 to 60 minutes in normally large-sized analytical systems. With the glass chip the analysis time can be reduced to a few seconds, without major influence on the separation performance.

The goal of the Swiss research work is to produce a miniaturized total chemical analytical system, called Mikrotas, for short, which can be used for as many chemical analyses as possible and to help monitor chemical processes electronically. The principal application area is said to be chemical process technology, biotechnology, environmental analysis and medical-pharmaceutical research. A contribution which should not be underestimated is the saving of reactances and solvents, the reduced time of analysis as well as the reduced space requirement through the miniaturization. (Source: *Frankfurter Zeitung*, 23 February 1994)



### **Scientists seek multifunction chip**

Surface layers which are as hard as hard metals but are significantly more wear-resistant and possess lower frictional resistance can be used for many industrial applications. Metallic hydrocarbons are particularly suitable for extremely thin coatings. They can be used to produce multifunction layers.

Which structural parameters are important and how they are to be related to production parameters and macroscopic material properties is something scientists in Braunschweig, headed by Professor Dimigen and diplomat physicist Schiffermann, of the Fraunhofer Institute for Layer and Surface Technology, will study using the scanning tunnel electron microscope and the scanning force microscope.

Multifunction layers do not only have remarkable mechanical properties. The layers can also change electrical conductivity. Before being able to "tailor" such nanocomposites somewhat to the individual application, their structures must be analysed and precisely understood.

Initial experiments have shown that the metal is not homogeneously distributed in the layers but forms tiny metal or carbide particles, which are embedded in a polymer-type, overcured hydrocarbon matrix.

These particles, only a few millionths of a millimetre large, are now to be made directly visible. It is hoped that by so doing knowledge about their form, their distance from each other and potentially favourable orientations will be gained. The resolution of the microscopes used also allows for the expectation that even individual atoms would become visible.

In addition to mapping the nanostructures, another application field for the scanning probe microscopes will be the electrical and mechanical properties of such layers. It is to become possible to use the equipment to take measurements with a local resolution of one-millionth of a millimetre at specific places of the sample. (Source: *Frankfurter Zeitung*, 26 January 1994)

### **Electronics cooling technique has potential for further miniaturization through micromachining**

Certain components only achieve optimum performance at very low temperatures. That is particularly true for particle detection, infrared retinas, and hyperfrequency components, notably to reduce background noise. Given this limitation, Peltier effect modules are one solution, although, unfortunately, in practice they are restricted to -40° C. Certain "conventional" machines use the Stirling cycle. In the Stirling cycle, cold is generated using pistons to subject a gas in a cycle to successive operations of compression (heat release) in a so-called hot chamber, and expansion (heat absorption) in a so-called cold chamber make it possible to bring the temperature down as low as -100 Kelvin, but in this case miniaturization capacities are insufficient. As Gerard Claudet, head of the low temperatures department of the material science section of France's Atomic Energy Commission (AEC) explains: "No lubricant exists that can be used with pistons at less than a few dozen degrees below ambient temperature". For all these reasons, it became necessary to find refrigeration processes that were specifically adapted to the needs of cryoelectronics. The AEC has been studying this question for some two years now. The new technique it has come up with uses what is called a pulsation tube. In the pulsed

gas refrigerator, a succession of contractions and expansions constitutes a kind of sounding board in which the pressure waves propagate and are reflected in such a way that the expansion effect (of the Stirling cycle) always occurs in the zone where temperature needs to be reduced. Without the need for moving parts, sound waves perform the compression and expansion operations common to all refrigerators. There are a number of ways of producing these sound waves at ambient temperature, including piezoelectric oscillators and resonating membranes. Gerard Claudet states: "Compared with a piston compressor, the absence of any cold moving parts increases reliability, reduces vibration, and simplifies manufacture". The AEC currently has the resources needed to manufacture devices with tubing 1 cm in diameter which can produce temperatures as low as -247° C. The heat flows generated can reach four to five Watts at around -173° C. Below that, helium remains the only solution. For the time being assembled with a stainless steel body, these micro-refrigerators could very well, thanks to their composition, be adapted in the medium term to silicon technology. Micro-machining would then make it possible to miniaturize the fluid circuit to a much greater extent and obtain "components" measured in millimetres. (Source: *Electronique International Hebdo*, 3 March 1994)

### **BMFT funds joint project on microsystems engineering**

To date it has been impossible to measure the reaction of very small quantities of pharmaceuticals, substances, or pollutants on individual cells, so in the next few years microsystems the size of a hair will be developed containing plant or animal cells on supersmall "open" sensors. The sensors will be used to detect and amplify the very small electrical signals. The BMFT (Federal Ministry of Research and Technology) is funding this project with 2.7 million German marks (DM). Existing methods of showing the effects of substances are very complex and time-consuming. This completely novel process is able to measure the effects of substances on cells at a very early stage. This makes it economic to test not only the effect of individual substances but also the combination of several, as normally present in our environment. It could, for example, be possible to determine allergenic agents for patients much more specifically and rapidly.

Cell biologists from Berlin's Humboldt University and Würzburg University are cooperating with specialists from Berlin's Fraunhofer Institute of Microelectronics on this three-year interdisciplinary joint project. They must make a thorough investigation of how biological cells can be connected to semiconductor surfaces. They will have to both select the cell cultures and investigate their short- and long-term stability and their growth behaviour. The form and quality of semiconductor surfaces will also have to be examined. Apart from the electrical measurement signals, cell movements, cell growth, and cell activities may provide information about the effects of substances.

Further information may be obtained from Dr. Sven Peter Heyn at the VDI/VDE (Association of German Engineers/Electrotechnical Engineers) Technology Centre, Information Technology Ltd., Potsdamer Strasse 12, 14513 Teltow, Tel.: 03328/435184, Fax: 00328/435141. (Source: *Technologie-Nachrichten Management-Informationen*, 14 January 1994)



### Semiconductor laser used as logic element

Fibre-optic cable could transmit virtually limitless amounts of information in the form of light. Terminals and signal switching centres are still electronic, however. In effect, this switch from fibre-optics to electronics limits the fibre-optic system to a mere fraction of its theoretical bandwidth: Only 0.005 per cent of the available bandwidth of fibre-optic networks is actually utilized. However, this electronic "bottleneck" of broadband technology may soon be a thing of the past. Scientists at the Heinrich Hertz Institute (HHI) in Berlin have taken the first step towards the development of laser-based circuitry.

Scientists have known for some time that semiconductor lasers can not only be used to produce light pulses for fibre-optic communications, but can also be employed as optical amplifiers. Now researchers at the HHI have established that they can also serve as logic elements (logical AND circuits) while also performing additional functions (as demultiplexers and frequency converters). Thus, optical signal processing (photonics) offers a solution to a problem associated with the microelectronic message switching technology heretofore used in high-speed fibre-optic communication networks.

As a rule, the output signals from optical amplifiers, despite their increased intensity, must exhibit the exact same pulse form as the input signal. Any deviation from the linear behaviour generally reduces the quality of the transmission. This is frequently a necessary evil. By changing their perspective, however, HHI researchers have now made a virtue out of necessity: For certain applications, nonlinear optical processes such as the so-called "4-wave mixing" are actually extremely useful.

The principle is as follows. If two input signals of different frequencies are sent into an optical amplifier, the output will be a total of four signals: In addition to the two amplified signals of the original frequencies,  $f_1$  and  $f_2$ , there will be an additional two sideband signals,  $f_3$  and  $f_4$ .

This effect is strongest when the operating point of the amplifier is set in the saturation region, the curved portion of the  $\xi_{\text{opt}}$  curve. With the proper selection of the  $f_2$  frequency, the sideband frequencies can be adjusted. For frequency conversion, only one of the two sidebands are used; the other is filtered out.

If the input signals are clock-synchronous pulse trains, the sideband signals exhibit the same pulse rhythm. However, if the bit rate of the second input signal is set at one fifth the bit rate of the first, the 4-wave mixer effect will only occur with every fifth bit pulse. This allows every fifth bit to be converted to a new frequency.

Using this procedure, Ronald Schnabel, Wilhelm Pieper, Reinhold Ludwig, and Hans-Georg Weber were able to experimentally demonstrate the purely optical demultiplexing of 20 gigabit/second signals.

The net result is that this functional element makes it possible to directly link time-division and frequency multiplex techniques, ultra-fast optical bit selection in the multi-gigabit range paired with simultaneous frequency conversion. The essential components are semiconductor laser amplifiers that can also be integrated in larger functional elements. Such components could potentially be used to create purely optical as opposed to micro-electronic circuits for the interconnection set up for fibre-optic networks. (Source: *VDI Nachrichten*, 4 February 1994)

### Chemists know their onions

The chemical world never fails to surprise. Molecule-sized spheres, tubes, beads and links are now well-known, but at Iowa State University's Ames Laboratory, John Corbett and Slavi Sevov have now discovered molecule-size onions.

The Iowa onion is a carbon-free fullerene, but it is very different from the familiar footballs of Kroto, Smalley *et al.* These spheres are neither hollow nor formed from carbon. Instead, they are formed from an indium/sodium mixture doped with nickel, and consist of an indium fulleride sphere "stuffed" with nested layers of metal polyhedra, locked inside the shell. For example, one onion consists of a nickel atom inside an  $\text{In}_{10}$  cluster inside a  $\text{Na}_{30}$  polyhedron inside an  $\text{In}_{74}$  fulleride; in another, the two outer spheres are  $\text{Na}_{32}$  and  $\text{Na}_{12}\text{In}_{48}$ .

According to Corbett, the researchers noticed that "the indium-sodium phase diagram was a bit of a mess" and decided to "poke around in one of the dusty corners". The nickel doping was an attempt to make as many electrons as possible available for bonding. The results were a complete snook—"no one would ever have predicted this", exclaims Corbett.

To make the onions, Corbett and Sevov simply stewed the metals together in a sealed tantalum tube and cooled the molten soup from 700° C at 5° C/hour. The peculiar structure is due to the sizes of the three metal atoms, says Corbett; the onions do not form if sodium and indium are replaced with potassium and gallium, which have very similar chemical properties to the original metals but are different sizes.

The onions are paramagnetic, air sensitive semiconductors, and so strongly reducing that any catalytic properties of the transition metals are likely to be cancelled out. "They would reduce any substrate to hydrogen", Corbett comments. (Source: *Chemistry & Industry*, 15 November 1993)

### Superconductor hits a new high

A mercury compound first made six months ago has broken the temperature record for superconductivity. When cooled to 160 K (E 113° C), the material loses all electrical resistance, researchers at the University of Texas have reported.

This is the highest critical temperature  $T_c$  achieved, but to reach it, the team led by Paul Chu had to crush the material with a pressure 100 times that at the bottom of the deepest ocean. At normal atmospheric pressure, the compound's critical temperature is 25 K lower.

To increase the  $T_c$  to 160 K, a sliver of the material— $\text{Hg-1223}$ —was placed in a clamp and pressure of more than 150000 atmospheres was applied. According to Chu, at higher pressures,  $T_c$  increases by about 0.02 K for each extra atmosphere.

The pressure of Chu's clamp squeezes the superconductor atoms together. While admitting that there is still an element of trial and error in the experiments, Chu believes that mercury compounds seem the most promising for high critical temperatures. The team is now performing experiments at 600000 atmospheres to see if the  $T_c$  can be further raised. (Source: *The Hindu*, 1 December 1993)

### Highest recorded temperature for novel compound

While compounds maintaining superconductivity at the highest temperatures are copper oxide compounds,

scientists at AT&T Bell Laboratories (Murray Hill, NJ) report a record transition temperature of 23 K for a yttrium-palladium-boride-carbide compound. It is the highest superconducting temperature recorded for a bulk intermetallic compound, says AT&T. And the scientists say the material could be only the first of a new family of superconductors. (Source: *Chemical Week*, 19 January 1994)

### **Cheaper superconductors**

Researchers at the University of Queensland (Brisbane, Australia) claim a breakthrough in the production of high-temperature superconducting materials. The team says it has found an inexpensive method for making yttrium-barium-copper oxide material in large quantities, potentially opening up industrial application of superconductors. Conventional production of copper oxide superconductors involves heating the precursor materials to high temperatures, yielding small quantities of product. (Source: *Chemical Week*, 19 January 1994)

### **Superconductor applications**

Outside the laboratory, high-temperature superconductivity (HTS) is making real progress. The liquid helium needed to cool earlier superconductors, which worked only at exceedingly low temperatures, is too expensive for most practical uses. But Dr. Paul Chu's discovery in 1987 pushed the temperature at which superconductivity was possible above -196° C, the boiling point of nitrogen. Because liquid nitrogen costs only pennies a litre, a host of applications suddenly became feasible.

This was the cue for the Electric Power Research Institute (EPRI) in Palo Alto, CA to push ahead with research on power transmission. This year EPRI has asked Pirelli Cable to make an experimental 30 metres of superconducting cable. Don Von Dollen, who manages the project, says that it will be tested as a possible replacement for the underground copper cables that carry electricity in most cities. Replacing them as they wear out with lines that could carry twice as much power in the same space would help utilities cope with the increase in demand since they were first installed.

With projects like this afoot, those involved in the commercial application of HTS are keen that there should be no furor over the French work. Too much hype is bad for business, they say. (Extracted from *The Economist*, 22 January 1994)

### **Photobioelectrochemical fuel cell using marine algae**

Professor T. Horigome and his research team of the Faculty of Technology, Tokyo University of Agriculture and Technology, and the Institute of Physical and Chemical Research, have jointly developed a photobioelectrochemical fuel cell with a power generation over 100 times greater than the conventional bioelectrochemical fuel cell.

This device utilizes the photosynthesis functions of plants to convert solar energy into electric energy. The photobioelectrochemical fuel cell converts internally stored carbohydrates and other forms of energy into electric energy even in the dark. This is a clean process that applies the energy conversion function of microorganisms, and is expected to be a significant milestone in the development of technologies that use solar energy, on which intensive research is being advanced today to cope with global

environmental disruption problems and the impending shortage of fossil fuels.

Bioelectrochemical fuel cells have been developed before, utilizing *Coilbacillus* and other microorganisms to generate electrons when decomposing sugars. The present microorganism was a marine algae (*Synechococcus* sp. (UTEX 2380)) that has the photosynthesis function. Electrodes were placed in the algae suspension to form a photosynthetic microorganism fuel cell with an excellent electricity generating function. This technology is based on 2-hydroxy-1, 4-naphthoquinone (HNQ) as the electron transfer mediator to transfer electrons generated by photosynthesis to the electrodes.

Experiments showed that electricity is generated by the marine algae regardless of whether or not light is present. The current output at the initial stage of light irradiation is large, but when electricity is generated continuously, the power decreases rapidly with time. The energy conversion mechanism and the conversion characteristics were elucidated by conducting experiments and studying the relationships between the irradiated light wavelength and generated electricity, the rate of decrease of carbohydrates inside the algae and the volume of electricity generated, and the parts from where electrons are extracted.

In plant photosynthesis, chlorophyll receiving solar energy decomposes water into oxygen and hydrogen ions, and electricity is generated in this process. Electrons are transmitted which promote a reaction between carbon dioxide and water, forming carbohydrates by the carbon dioxide fixation reaction. Experiments showed that when light is irradiated, electricity is generated by capturing the electrons generated in the initial stage of the water decomposition process. When light is not present, the electron transfer medium captures the electrons generated in the process of metabolism (respiration) of the carbohydrates stored inside the algae, for conversion into electric energy.

Electricity generation, using the electrons generated by water photolysis will be highly effective, but when electrons are removed at this stage, the carbon dioxide assimilation reaction will not occur in subsequent stages. Experiments showed that the carbohydrates inside the algae are decreased more than normal, suggesting that the energy necessary for maintaining the water decomposition reaction is supplied by the carbohydrates inside the algae. Therefore, to prolong the fuel cell service life expectancy, after a fixed period of electricity generation, whether by light irradiation or otherwise, the algae must be separated from the electron transfer medium to store carbohydrates. Further details may be obtained from Tokyo University of Agriculture and Technology, Faculty of Technology, 2-24-16, Naka-machi, Koganei City, Tokyo 184. Tel.: +81-423-81-4221. Fax: +81-423-85-6729. (Source: *JEIRO*, December 1993)

### **High-performance field effect transistor**

Kansai Electronics Research Laboratory of NEC Corp. has developed a high-performance field effect transistor (FET) that is compatible with the millimetre band of over 30 GHz. The indium-phosphide based alloy semiconductor wafer enabling rapid electron transport is used and the chip is miniaturized by superelaborate fabrication technology, achieving operation at frequencies about three times higher than those handled by existing products.

Conventional types of microwave communications devices use a gallium-arsenide (GaAs) wafer, but in

millimetre wave communications working at higher frequencies, devices of higher performances are necessary.

NEC's R&D team succeeded in fabricating a device with a structure enabling high-speed electrons to move in higher concentrations by using an indium phosphide substrate (InP) enabling electron transfer at higher speeds than the GaAs substrate, introducing an electron channel layer with a new structure laminating InGaAs at the centre, and shortening the transistor gate length to 0.1  $\mu\text{m}$  through superelaborate fabrication using an electron beam.

The maximum oscillation frequency that indicates the high-frequency performance of a device was 571 GHz, and the cut-off frequency 185 Hz, both three times those of existing products. Since a new material is used for the wafer, more time for reliability confirmation will be necessary before commercialization.

Microwave development is proceeding, and the millimetre wave is a new source of radio waves. The millimetre wave is presently under study as a new tool for new services, such as the radiowave local-area network (LAN) system, collision prevention radar for automobiles, and non-contact use IC cards. Further details may be obtained from NEC Corporation, Public Relations Div., 5-7-1, Shiba, Minato-ku, Tokyo 108-01, Tel.: +81-3-3798-6511. Fax: +81-3-3457-7249. (Source: *JETRO*, January 1994)

#### **Infrared LED for spatial light communications**

Tottori Sanyo Electric Co., Ltd. has developed an infrared light-emitting diode (LED) for spatial light communications with the fastest and most powerful performance based on a double heterostructure containing gallium (Ga), aluminium (Al) and arsenide (As).

Spatial light communications using infrared light are being used more and more in various applications in radio communications, which are restricted by many regulations. Conventional GaAlAs LEDs, however, tend to have a reduced output with improved response, that is increased cut-off frequency. A spatial light communication LED with a short response time is required to allow fast modulation and, at the same time, provide enough power.

The new LED double heterostructure consists of a GaAlAs p-clad layer, an active layer, and an n-clad layer, all between a pair of contacts. The compositions of each layer and the concentrations of impurities have been adjusted, so that the new LED has a cut-off frequency of 20 MHz and an output of 15 mW, the best performance achieved so far.

The emission wavelength is about 850 nm, suitable for fast transmission of video, sound and data. The quick-response LED is the best to employ in 15-MHz video signal transmission. Among possible applications are optical remote controls for TVs and VCRs, cordless headphones, and video signal transmission in TV game sets and PCs.

Spatial light communications will make audio and video appliances easy to handle, and much more attractive to amusement industries and compatible with the general aging of society. The company considers there will be considerable demand for the new LED. Further details are available from Tottori Sanyo Electric Co., Ltd., 7-101, Tachikawa-cho, Tottori City, Tottori Pref. 680, Tel.: +81-857-21-2001, Fax: +81-857-21-2034. (Source: *JETRO*, January 1994)

#### **Low voltage operation GaAs power FET**

Matsushita Electric Industrial Co., Ltd. has developed gallium arsenide power field effect transistors capable of operating at 3.5 volts, 1.2 volts lower than those available so far.

Use in portable telephones is expected to make the phones 15 per cent smaller and 10 per cent lighter by reducing the number of batteries required from four to three. The transistors are undergoing final reliability tests at Matsushita Electronics Corp. before launching.

Power FETs used to amplify the transmitting power of portable phones have required a minimum voltage of 4.7 volts. A breakthrough could be provided only by increasing the voltage amplitude and saturation current of the FETs, but no success had been achieved by conventional technology.

The new FETs were developed by a new process which halved the cycles of depositing insulating films and etching on GaAs substrates, and also used wet etching and defect-prone dry etching. This process made it possible to lower source-drain resistance and increase voltage amplitude by reducing the turn-on voltage. Heat treatment was used to increase saturation current by coating the substrates with a film of refractory metal (silicon tungsten nitride). As a fall in saturation current is caused by As evaporation from the substrates due to the heat treatment and the lower activation factor of the implanted silicon ion, the refractory metal coating helped to control the As evaporation during annealing, and consequently increased the saturation current. Further details available from Matsushita Electric Industrial Co., Ltd., International Publicity Tokyo, 1-1-2, Shibakoen, Minato-ku, Tokyo 105, Tel.: +81-3-3578-1237, Fax: +81-3-3437-2776. (Source: *JETRO*, January 1994)

#### **White light-emitting organic EL device**

Assistant Professor J. Kido and Professor K. Nagai and their research team at the Department of Materials Science and Engineering, Yamagata University have succeeded in developing an organic electroluminescent (EL) device that uses a low molecular weight dispersion type polymer to emit a bright white light like a fluorescent lamp.

This is a laminated type EL device using poly-N (vinylcarbazole) (PVK) as the light-emitting layer, containing a small quantity of dispersed low molecular weight fluorescent dyes to generate light in the colours blue, red and green, which combine to provide a white light.

The organic EL device is a sort of light-emitting diode using a thin organic fluorescent film, but in contrast to a light-emitting diode (LED) using a semiconductor, it emits light in a planar form and can provide a brightness of 100,000  $\text{cd}/\text{m}^2$ , 10 times higher than that of a fluorescent lamp, with a drive voltage of about a dozen volts, so fierce competition is being waged by manufacturers to develop a highly efficient device.

In general, an organic EL device is formed into a thin film by the vacuum vapour deposition technique, so it is difficult to form a thin film containing a large number of low molecular weight fluorescent dyes. Therefore, emitted light of a single colour (blue, red or green) has been generated, but since a white colour demands the simultaneous generation of light beams of the three primary colours, it is difficult to obtain a white light of high brightness. Therefore the researchers had been developing

a device in which low molecular weight materials are dispersed in polymer materials in the molecular state.

The polymer film, compared with the low molecular weight film, can be formed into a film with ease by coating, and since it resists crystallization, the durability and strength are improved. The film is produced by coating in a solvent, so various kinds of low molecular weight fluorescent dyes can be dispersed in the polymer film and their concentrations can also be changed with ease.

With the new device, a light-emitting PVK layer is coated on a glass substrate coated with indium-tin oxide (ITO) transparent electrode (anode), over which an electron transporting triazole derivative (TAZ) and an aluminium complex, and finally magnesium-silver alloy are vapour deposited as the cathode.

Dispersing fluorescent dyes in the PVK light-emitting layer increases the brightness of the device. A layer containing tetraphenyl butadiene (TPB) that emits a blue light provides a brightness improved threefold, and a layer containing cumarin yields a brightness increased by more than sixfold. The prototype laminated type EL device fabricated by simultaneously dispersing 0.2-5 mol per cent of blue TPB, red DCM, and green cumarin in the PVK light-emitting layer generates a white light with a brightness of 3,000-4,000 cd/m<sup>2</sup> at a voltage of 14 V, a brightness never achieved previously for the white colour.

Due to the high brightness, the white light-emitting organic EL device has diverse applications, such as a backlight for liquid crystal displays and an illumination light source, so it is expected to be widely used. Further details may be obtained from Yamagata University, Department of Materials Science and Engineering, 4-3-16, Jyonan, Yonezawa City, Yamagata Pref. 992, Tel.: +81-238-21-5750, Fax: +81-238-24-7241. (Source: *JETRO*, January 1994)

#### **Semiconductor laser system with world's highest output**

Mitsubishi Electric Corp. has developed a semiconductor laser system with the world's highest output. The beam has a brightness of 360 mW, and this high output enables a larger volume of information to be transmitted simultaneously to enable use in a wider scope of applications, including optical communications.

With the conventional laser element manufacturing method, the element construction allows an electric current to leak near the activated layer that emits light, so obtaining a high output was impossible. The company introduced the metal oxide chemical vapour deposition (MOCVD) technique that prevents element damage into the element manufacturing process, and succeeded in producing laminated crystals of excellent quality.

In conventional types of laser systems, the current volume that generates the laser beam tends to decrease when a pressure is impressed on the crystals of the activated layer that emits the light beam. To cope with this problem, a growth technique was established to generate strain on the indium-gallium-arsenide-phosphorus crystal comprising the activated layer on an indium-phosphorus wafer. As a result, a laser beam of 360 mW can be oscillated at a wavelength of 1.48  $\mu\text{m}$ , equivalent to about double the magnitude of the maximum output of conventional types of laser systems. Further details may be obtained from Mitsubishi Electric Corp., Public Relations Dept., 2-2-3, Marunouchi, Chiyoda-ku, Tokyo 100,

Tel.: +81-3-3218-2172, Fax: +81-3-5252-7119. (Source: *JETRO*, January 1994)

#### **Superconducting bearing with smallest vibration amplitude**

The Superconductivity Research Laboratory of ISTEK, in cooperation with NSK Ltd., which has the largest share of the Japanese bearing market, has successfully developed a superconducting bearing utilizing the attractive force due to flux pinning between Melt-Powder-Melt-Gross (MPMG) processed Y-Ba-Cu-O superconductors and Fe-Nd-B magnets which can suspend a 2.4 kg rotor in mid-air. The vibration amplitude has been reduced drastically from 130 mm to 1.8 mm at 12,000 rpm, the smallest so far achieved.

The new superconducting bearing is an improved version achieved by increasing the levitation force of the MPMG-Y-Ba-Cu-O material to triple that of the existing material and optimizing the bearing design.

This achievement demonstrates the feasibility of constructing bearings with high accuracy and rotational speed utilizing non-contact suspension based on superconductors and paves the way for various applications including semiconductors, molecular turbo pumps, and rotational devices used in outer space and clean environments. Further details available from Superconductivity Research Laboratory, International Superconductivity Technology Centre, 1-10-13, Shinonome, Koto-ku, Tokyo 135, Tel.: +81-3-3536-5703, Fax: +81-3-3536-5717. (Source: *JETRO*, January 1994)

#### **New high-performance shape memory alloy**

T. Masumoto, Y. Furuya and M. Matsumoto of the metallic materials research team, Tohoku University, have succeeded in developing a titanium-nickel-copper-based high-performance shape memory alloy that, compared with conventional types of shape memory alloys, features thermal energy convertibility that is 5-6 times greater, corrosion resistance in the rapidly solidified (RS) material of over 100 times that of the conventionally processed material, and transformation temperature range of minimum 6.5° C, which shows the alloy is suitable for temperature difference power generation.

This new alloy, containing five columnar microstructures with high crystal anisotropy and homogeneous smooth surface of less than 1  $\mu\text{m}$ , was developed by applying the rapid quenching process that is used to produce amorphous metals. The superlative characteristics make the new shape memory alloy ideal for the manufacture of shape memory composite materials and micromachines, as well as for temperature difference power generation in narrow temperature ranges.

Copper is known to improve shape memory alloy strength and reduce the transformation temperature range. However, the addition of 8-10 per cent of copper was the limit by the conventional manufacturing process (i.e. melting-mechanical working) and at higher ratios the alloy became brittle and manufacture was more difficult.

The rapid quenching process was newly introduced to optimize the domain prior to transition to the amorphous state, allowing continuous manufacture of Ti-Ni-Cu memory alloy ribbons with widths of 2-4 mm and thicknesses of 30-120  $\mu\text{m}$  containing hyperfine columnar crystals of less than 1  $\mu\text{m}$  and featuring excellent crystal directivity.

The thermal energy convertibility reached the maximum value at copper content of 13 per cent, 5–6 times greater than conventional types, the transformation strain of the shape memory is doubled, and the temperature range (copper 17 per cent) at below 10° C is a minimum of 6.5° C. Also, the thermal fatigue resistance has been increased tenfold, and the corrosion resistance and vibration damping properties have also been improved considerably.

The improved characteristics, especially the improvement of thermal fatigue resistance by 10 times, is attributed to the simultaneous generation of a phase change inside the material since it has a monocrystalline structure, so that there is a minimal internal loss compared with the phase change associated with conventional types of random polycrystalline structures. Further details are available from Institute for Materials Research, Tohoku University, 2-1-1, Katahira, Aoba-ku, Sendai City, Miyagi Pref. 980, Tel.: +81-22-227-6200, Fax: +81-22-215-2202. (Source: *JETRO*, January 1994)

### **STN plastic LCD with high information density, image quality and contrast**

Sharp Corporation has developed a prototype 4.9-inch super twisted nematic (STN) plastic liquid crystal display (LCD) with high information density, image quality, and contrast comparable to LCDs based on glass substrates, based on new technology developed by the company. The display features a thin profile, light weight, high ruggedness and enough flexibility to handle rough pen input, and is applicable to portable information tools with communication functions and office automation (OA) equipment which is becoming increasingly compact.

The new STN display uses a 0.4 mm thick special plastic substrate with high surface smoothness and rigidity, and a high precision spacer, treated by the newly developed plastic surface treatment technology for the panel fabrication process. This technological evolution has dramatically improved the reliability of the plastic substrate.

The plastic surface treatment technology provides gas permeability resistance and scratch resistance (surface hardness), and the spacer blocks the effects of external forces and provides uniform through-gap precision. No characteristic deterioration occurs when the display operates at 60° C and 90 per cent humidity over 1,000 hours.

The company also redesigned its glass LCD production line to allow manufacture of the STN plastic LCD in the same way as conventional glass substrates.

The company plans to introduce the new display with resolutions of 336 x 240 dots and 640 x 480 dots by next spring. Further details are available from Sharp Corporation, Corporate Public Relations Division, 1-9-2, Nakase, Mihama-ku, Chiba City, Chiba Pref. 261, Tel.: +81-43-299-8210, Fax: +81-43-299-8213. (Source: *JETRO*, January 1994)

### **Near-field scanning optical microscope using a metallic probe**

Professor S. Kawata and his research team at the Department of Applied Physics, Osaka University, have developed a near-field scanning optical microscope (NSOM) using a metallic probe for surface profile measurement with an accuracy of 10 nm.

The stainless steel probe tip of 0.1 mm radius is oscillated by a piezo-electric element driven by a sinusoidal

signal to change the distance to the surface of the sample by a small amount, and is inserted into the evanescent field localized near the sample surface to convert the field to scattered light.

The scattered light is then modulated at the frequency of probe oscillation for signal processing and is detected by the external condenser optics with a photodetector. The semiconductor laser is suitable for the NSOM since it has excellent stability, requires only a supercompact oscillation system, and allows high-speed modulation. The laser beam illuminates the sample surface under conditions of total internal reflection to measure the sample structure.

The lock-in amplifier measures the intensity of the modulated component of the scattered light, which exponentially decreases as the distance increases between the probe position and the sample surface. The probe moves vertically to keep the output of a lock-in amplifier constant with a servo control system, simultaneously maintaining the distance between the tip and the sample constant to allow scanning of the probe laterally.

The new NSOM utilizes a metal-coated dielectric probe in place of the non-coated dielectric probe (or sharpened optical fibre) to avoid resolution degradation and deterioration of the signal to noise ratio, which occur due to interference of the evanescent field with the LP01 propagation wave-guide mode of the optical fibre. The metallic tip provides a better scattering efficiency as metals absorb the signal.

The NSOM is compatible with the conventional scanning tunnel microscope (STM) for analysis of the composition of the sample, measurement of DNA, cells, or chlorophyll of organic substances, etc., without damaging the surface structure. Further details are available from Osaka University, Faculty of Engineering, 2-1, Yamadaoka, Suita City, Osaka 565, Tel.: +81-6-877-5111, Fax: +81-6-876-6235. (Source: *JETRO*, January 1994)

### **Ultra-miniature electron gun for stereomachining of micro-machines**

The Electrotechnical Laboratory of the Agency of Industrial Science and Technology has developed an ultra-miniature electron gun usable for stereomachining of micro-machines, and has confirmed the operating performance.

The field emission effect has been applied and a technique developed for fabricating a super-miniature field emitter capable of generating strongly focused electron beams, which can generate the energy necessary for stereomachining. Conventional micro-machining techniques have been applied to the plane machining of semiconductors, but were unsuitable for stereomachining. This is the first development of an ultra-miniature electron gun enabling the stereomachining of micro-machines.

The ultra-miniature electron gun consists of a silicon-based field emitter, which is surrounded with a duplex insulating film, a gate electrode (niobium) for controlling the electron emission, and a convergence electrode for creating parallel electron beams. The emitter at the base part has a height of 1 µm, while the radius of the gate electrode hollow part is 2 µm.

The electron gun is manufactured by heating a silicon substrate to cover the surface with a thermally oxidized film of 0.5 µm thickness, and formed into a disk with a diameter of 2 µm. The silicon substrate is formed into a cone-like shape by reactive ion etching (RIE). The thermal

oxidation process is applied again, and then vacuum vapour deposition of the insulating layer and electrode layer is performed twice. Finishing is performed by lift-off in buffered hydrofluoric acid. This manufacturing method is so called the self-aligned process which eliminates the need for highly accurate positioning in all the manufacturing processes.

The radius of curvature of the emitter tip is 0.01–0.02  $\mu\text{m}$ , which enables the field emission phenomenon to occur between the tip and the gate electrode, by which electrons are emitted at high efficiency. The laboratory plans to further increase the current density by reducing the diameter of the gate electrode hollow part to 1  $\mu\text{m}$ .

Commercialization of this ultra-miniature electron gun will allow three-dimensional machining such as cutting, growth and bonding. Especially in bonding, the electron gun has a broad range of applications, including the fabrication of stereo-structures that is quite difficult by semiconductor technology. Further details may be obtained from Electrotechnical Laboratory, AIST, 1-1-4, Umezono, Tsukuba City, Ibaraki Pref. 305. Tel.: +81-298-58-5310. Fax: +81-298-58-5349. (Source: *JETRO*, December 1993)

#### **Pulse oscillation at room temperature with lowest threshold**

NEC Corp. recently succeeded in generating a laser pulse in a prototype surface-emitting semiconductor laser at room temperature with a threshold of 190 mA, one third less than the lowest reported. An optical output of 50 mW was obtained at an injection current of 2 mA.

The new semiconductor laser is about 5 mm in diameter, 4 mm high, and based on a cylindrical structure called "air post". It consists of a single quantum well indium-gallium-arsenic (InGaAs) active layer and aluminium-gallium-arsenic (AlGaAs) barrier layers, which are sandwiched by multilayer reflectors, so the resonator is formed vertically. This enables laser oscillation in the vertical direction. The space between the multilayer reflectors is the same as the wavelength of the laser beam in the semiconductor medium. All the semiconductor layers are successively grown by molecular beam epitaxy (MBE), and reactive ion beam etching (RIBE) technology provides the cylindrical structure. The great difference in refractive indices between the semiconductor and air leads to large optical confinement in the device. Also, the damage on the air-post sidewall is low.

Development of a highly integrated laser array operating at a low threshold is indispensable for optical communications. However, the high consumption of electric power has held back successful development of the conventional system. The lowest thresholds reported are 650 mA for a surface-emitting laser, and 250 mA for the edge-emitting semiconductor laser which radiates light in the horizontal direction. The company solved this problem by utilizing the MBE and RIBE technologies to form the new laser with a threshold of 190 mA. This is the first step to achieve continuous operation of the laser array at an ultra-low threshold and high conversion efficiency between electric power and laser beams.

The company plans to further reduce the threshold to below 100 mA through technological improvement to develop a highly integrated laser array with ultra-low consumption of electrical power applicable to optical computing and interconnections. Further details are

available from NEC Corp., Public Relations Office, 5-7-1, Shiba, Minato-ku, Tokyo 108-01. Tel.: +81-3-3454-1111. Fax: +81-3-3457-7249. (Source: *JETRO*, December 1993)

#### **Highest capacity 64-megabit ROM**

Sharp Corp. has developed a prototype 64-Mbit ROM with the highest capacity in the industry utilizing 0.6  $\mu\text{m}$  CMOS process technology and special high-density NOR flat-cell technology developed by the company. The chip for the new mask ROM is 24.38 x 8.14 mm with half the memory cell area of the conventional type so the encapsulation of the chip in a compact surface-mount package (44-pin SOP) is possible, maintaining pin-compatibility with existing 16-Mbit and 32-Mbit mask ROMs. It can store a tremendous amount of data equivalent to one week of newspapers containing approximately 4 million characters.

Mask ROMs, which are currently available in a maximum of 32-Mbit capacity, are applied to computer software, word processors, laser printers, electronic musical instruments, etc., to write necessary information onto the chips in the wafer fabrication process and serve as read-only memory after the process is completed. The information is retained as permanent data on the chips and cannot be rewritten once stored. The demand for memory devices with higher capacities is increasing steadily as office automation (OA) equipment improves functions at an ever-increasing rate. The new 64-Mbit mask ROM serves this purpose perfectly.

The new mask ROM has other outstanding features in addition to the highest memory capacity. The company has achieved faster access time with better stability utilizing the high-speed bank-selection logic to reduce bit-line load capacity and the internal timing-signal generating logic to reduce timing-signal variations due to changes in ambient temperatures. The chip achieves a rapid 150 ns access time even with a capacity of 64-Mbit. The current consumption is also reduced by adopting a logic design which divides the memory array into 4 memory blocks so only the desired memory block is selected when executing the read operation.

The company is considering starting mass production of the new mask ROM in 1995 since the 16-Mbit version is widespread at present. It will continue to improve mask ROM designs for better performance and broader applications. Further information may be obtained from Sharp Corp., Corporate Public Relations Division, 1-9-2, Nakase, Mihara-ku, Chiba City, Chiba Pref. 261. Tel.: +81-43-299-8210. Fax: +81-43-299-8213. (Source: *JETRO*, December 1993)

#### **2.0 T magnetic field generated with bismuth superconducting magnets**

Sumitomo Metal Industries, Ltd. has used bismuth superconducting magnets to generate a magnetic field of 2.0 T (20,000 G), the most intense magnetic field created by oxide superconductors, in a non-magnetic environment at liquid helium temperature ( $-269^\circ\text{C} = 4.2\text{ K}$ ).

The superconductors are of the bismuth-based 2212 phase, in which the atomic ratios of bismuth, strontium, calcium and copper are 2:2:1:2. These superconductors are widely used due to the excellent superconducting characteristics. The magnet is produced by first filling powdered raw material in a silver pipe, passing the pipe through a die and drawing into wire form by the silver sheath process, by which a tape-form wire 3 mm wide and

0.15 mm thick is obtained. This wire is wound in pancake form, then laminated to produce a magnet with an outside diameter of 68 mm, an inside diameter of 17 mm, and 78 mm height.

The silver sheathed wire has a uniform thickness that provides a better critical current density, and the main reason for the generation of the intense magnetic field is the adjustment of the composition and optimization of sintering conditions. Previously, the maximum magnetic field generated using an oxide superconductor had been 1.6 T even if the same Bi-based 2212 phase silver sheathed wire was used. The superconductivity of conventional metal superconductors is destroyed in an intense magnetic field of over 10 T, making it impossible to obtain a more intense magnetic field.

The company will further improve the wire characteristics and increase the magnet size with the aim of attaining a magnetic field intensity of over 10 T. Further details may be obtained from Sumitomo Metal Mining Co., Ltd., Tokyo Public Relations Sec., 5-11-3, Shinbashi, Minato-ku, Tokyo 105. Tel.: +81-3-3282-6067, Fax: +81-3-3482-6692. (Source: *JETRO*, December 1993)

### III. MARKET TRENDS AND COMPANY NEWS

#### Market trends

##### **Boom year for production equipment**

The world semiconductor production equipment market is experiencing explosive growth, according to market research firm Dataquest.

Dataquest has revised its forecast for 1994 to predict 37 per cent growth. The main impetus is the rush to add memory chip production facilities to meet huge demand for 16 Mbit devices from PC manufacturers.

In Europe, 1994 growth in the wafer fabrication market will be nearly 54 per cent. Japanese growth is expected to be 15 per cent.

A massive thirteenfold increase is forecast for the Asia/Pacific market as South Korea, China and other countries add new fabrications. (Source: *Electronics Weekly*, 27 July 1994)

##### **Hard disk glut will knock down prices**

Prices for hard disk drives will drop rapidly as supply shoots ahead of demand during the rest of 1994, according to market research firm Dataquest.

The sharply lower prices, expected to hit by the end of the third quarter, could cause a market shake-up resulting in the elimination of some hard disk drive manufacturers. A similar drop in hard disk drive prices in 1993 caused losses for all major producers, and 1994 could be worse according to Dataquest.

Dataquest says that as data storage capacities increase at more than 60 per cent annually, production costs fall, with IBM leading this race with its magneto-resistive head technology.

Dataquest predicts that IBM, Seagate Technology and DEC should survive the coming shake-out. (Source: *Electronics Weekly*, 13 July 1994)

##### **Multimedia—current trends and prospects**

Mass distribution of multimedia-supported technology is upon us. For instance, virtually all major players in computer games hardware have incorporated cheap CD-ROM technology into their leading-edge products since 1993. It is now expected that all desktop PC suppliers will incorporate CD-ROM technology as standard within two years.

Behind the scenes the changes are even more striking. In 1992 there were only 80 multimedia firms identified in the *European Multimedia Yearbook*. In 1993 there were 1,500. A variety of players are expanding into multimedia. There are mergers and alliances between software houses and traditional publishers, and there is growing interest in multimedia by the media industry itself. Telephone, cable and television companies are taking an active interest, given the technological potential that fibre-optic cables have released for long-distance high-volume data transfer, supported by other data compression techniques such as digitalization.

Among the potential multimedia applications are multimedia geographical information systems. Already the availability of secondary data sets on CD-ROM is becoming routine and is now easily linked to mapping software. An extension to include 2-D photographic records is becoming more common. Inclusion of video clips, rather than 2-D still photos, is an obvious next step, now readily available technically. Further steps may include 3-D visualization or animation. (Extracted from *BURISA*, May 1994)

##### **CTI market set for huge growth**

The integration of computer and telephone technology will result in a market in North America worth \$2.3 billion a year by the end of the decade, according to market research firm Dataquest. They say that 1994 will witness a major boost to what it terms the computer telephone integration (CTI) market. It will grow this year to a value of \$234 million in North America, from last year's \$130 million, and will become a \$2.3 billion market in 1999.

Much of the growth will be due to standards being set by Microsoft TAPI and Novell TSAPI applications, which will allow the market to develop useful applications, according to Dataquest.

CTI brings together an organization's computer system with its telephone system, allowing users access to improved communications and a central database. Advanced telephone functions will, for example, allow computer systems to display a caller's file on a computer monitor as an operator answers the call. (Source: *Electronics Weekly*, 1 June 1994)

##### **US chip growth strong**

The US semiconductor market continues apace with the March book-to-bill ratio at 1.01 and a provisional figure of 1.17 for April, according to latest figures from the Semiconductor Manufacturers Association (SMA). With the industry very close to maximum capacity, the SMA expects the current level of shipment to continue late into the year. The SMA believes the UK semiconductor market will grow 30 per cent in 1994. (Source: *Electronics Weekly*, 1 June 1994)



### Shortage of DRAMs looms

A shortage of 16 Mbyte DRAM chips is forecast for later this year with demand exceeding supply by as much as 20 per cent, causing problems for smaller companies that do not have long-term supply agreements.

Market research firm Dataquest said it identified the coming shortage after analysing the DRAM market and price trends.

Dataquest said that shortage will occur as 16 Mbyte DRAMs cross over into becoming more cost-effective than 4 Mbyte DRAMs in the second half of 1994.

Dataquest predicts that the shortage may only last a few months if new fabrications come on-line as expected and manufacturing yields improve. Otherwise it may last for most of 1995. (Source: *Electronics Weekly*, 22 June 1994)

### Chip boom set to roll on for three years ...

The boom in the world semiconductor market will continue for at least the next two to three years, fuelled by world economic recovery, new silicon-hungry markets and a continuing shortage of chip manufacturing capacity, according to Jean-Philippe Dauvin, chief economist at SGS-Thomson. His analysis shows that the familiar boom-bust silicon cycle has been broken.

The key factor preventing a downswing will be under-capacity, according to Dauvin. This is because the time between the decision to build a fabrication and first silicon is now more than two years.

The world semiconductor market will be worth \$96 billion this year, says Dauvin, \$118 billion in 1996 and \$200 billion in the year 2000, representing a compound annual growth of more than 13.5 per cent to the end of the century. Asia and the Pacific will lead the growth table, followed by the United States and Europe.

Dauvin believes the PC market, in which he includes multimedia hardware such as set-top decoder boxes, will continue to take the lion's share of silicon. He says the PC market alone will need additional silicon equivalent to around 30 new fabrications between 1993 and the year 2000.

Dauvin expects other "hot" markets driving chip demand over the next few years will be CD-ROMs, cellular phones, video-conferencing and automotive electronics.

US and European firms will benefit most from the booming markets of the 1990s, Dauvin adds, because the Japanese are weak in key markets such as advanced PCs and mobile phones. (Source: *Electronics Weekly*, 22 June 1994)

### Autumn price slump in 486s

The predicted slump in the price of 486 micro-processors, due to new suppliers coming on-stream, will start this autumn. Both IBM and Cyrix have announced debut prices for their 486 chips up to 30 per cent below Intel's present levels.

IBM's Cyrix-designed clock-doubled 486 micro-processors, announced mid-June, have Q3 list prices between 25 and 30 per cent lower than equivalent Intel parts.

Almost simultaneously Cyrix announced its own identical family of processors with prices even lower than IBM's

IBM's new processors, which will carry the name Blue Lightning, offer a range of options including 3 or 5 V

operating voltages, PGA or PQFP packaging and speed variants of 50, 66 and 80 MHz.

The thousand-off price for IBM's 3 V processors at internal clock speeds of 50, 66 and 80 MHz are \$195, \$270 and \$325 respectively. Cyrix's corresponding prices are \$194, \$249 and \$294.

Intel has promised that 486 prices will fall. The IBM and Cyrix announcements are likely to make the cuts even more dramatic. (Source: *Electronics Weekly*, 22 June 1994)

### Organic solid-state material requirements

It has been predicted that a second technological revolution will occur during the first half of the twenty-first century based upon exploitation of optical signal processing: or so say researchers at the University of Southern California (USC). They say that the stage has been set for this revolution by the discovery of the diode laser and efficient fibre-optic transmission lines. The remaining requirement is to exploit the phenomena of optical non-linearity (analogous to electronic non-linearity of the semiconducting diode) to develop non-linear optical circuit elements that will permit rapid processing of electronic and optical signals.

The USC researchers say there are "many requirements" that must be satisfied to fabricate integrated polymer/semiconductor modulators. Not only must polymeric materials used as the active component of modulators possess adequate optical non-linearity, these materials must be capable of being:

- Processed into optical quality thin films by spin casting methods processed into a non-centrosymmetric ultrastructure lattice (a requirement for non-linear optical activity);
- Hardened to withstand elevated temperatures experienced either in device operation or in deposition of metal drive electrodes;
- Processed to yield buried channel waveguides that route light through the electro-optic modulator interfaced (pigtailed) to fibre-optic transmission lines or diode lasers.

The USC team has used polymeric non-linear optical materials, made with a novel polymer synthesis scheme involving double-end crosslinkable chromophores, to fabricate prototype electro-optic modulators.

One company that is developing chromophores, EniChem America Inc., has been pioneering the use of heteroaromatic moieties as conjugating units in donor-acceptor molecules, and say they have developed new classes of heteroaromatic chromophores that provide much enhanced thermal and chemical stability. Chromophores possessing molecular non-linearity as high as  $9100 \times 10^{18}$  esu and thermal stability as high as 300 °C have been developed and incorporated into high-temperature matrices and have shown non-resonant linear electro-optic coefficients ( $r_{33}$ ) in excess of 15 pm/V and long-term stability at temperatures of 150 °C for more than 500 hours. (Reprinted with permission from *Semiconductor International Magazine*, May 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

### EUV lithography's potential by 1997?

A broad range of linked government cooperative research and development agreements (CRADAs) are now in place targeting 0.12 µm lithography for 4 Gb DRAM design rules. Dubbed "extreme ultraviolet" or EUV at



13 nm wavelength, the CRADA recipients see this technology as yet another extension of optical projection lithography and the future "workhorse" in the semiconductor industry: 13 nm lithography has been called "soft X-ray" in the past.

The perceived end results for this research, implemented through the various CRADAs, is the extension of optical projection lithography down beyond the cut-off for refractive optics: the concept is a fully reflective 13 nm wavelength system yielding minimum feature sizes of 0.12  $\mu\text{m}$  with a reasonable depth of focus around 2.0  $\mu\text{m}$ . Some even foresee this technology being used for 0.05  $\mu\text{m}$  features.

The list of players, which reads like a "who's who", illustrates the scope of the industrial-level research still needed to make EUV work in production:

- Hoya Micro Mask—defect-free reflective masks;
- Ultratech Stepper—underlying stepper alignment and overlay technology;
- AT&T—resist technology with process latitude and  $\leq 10 \text{ mJ/cm}^2$  sensitivity;
- Tropel—"challenging" precision aspherical optics with a 5 Å figure;
- KLA Instruments—reflection mask inspection;
- Micrion—reflective-mask repair;
- Jamar—laser source technology where target vaporized debris can be controlled.

From the start, semiconductor manufacturers, including AMD and Intel, were involved. Also, Lawrence Livermore, Sandia and Lawrence Berkeley national laboratories and NIST are involved. EUV lithography is a technology where the United States can claim an absolute lead from the billions of dollars put into fundamental research at national laboratories over the last decade. For example, high power laser illumination of targets for EUV radiation and associated X-ray optics are rooted in weapons and inertial confinement fusion programmes.

By 1996, the CRADA players expect to demonstrate that "show stopper" problems can be solved.

While ultimate goals are beyond the turn of the century, with appropriate funding an "alpha" EUV stepper could be ready as soon as 1997. (Extracted with permission from *Semiconductor International Magazine*, May 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

### Electronic chemicals

The combination of changing technologies, environmental concerns and explosive demand for electronic devices augurs solid growth for electronic chemicals. Both major segments of the electronic chemical market, semiconductor chemicals and circuit board chemicals, are benefiting. These segments, which both supply set chemicals and liquid polymers, are distinguished principally by issues of circuit size, chemical purity and process technology.

In the semiconductor segment, suppliers report a record year for chemical sales, as their customers utilize every bit of chip capacity they can muster. And at a recent industry meeting, a senior vice-president at Motorola projected that by the end of the decade more than 60 new wafer fabrication facilities will be needed. These device fabrications cost \$1 billion to build and equip, and typically consume an annual \$5 million in speciality electronic chemicals. If all this comes to pass, "suppliers to the semiconductor industry

will be dancing in the streets", suggested the president of one of the largest semi equipment suppliers.

Growing by roughly 10 per cent, chemical sales to the semiconductor industry exceeded \$1 billion world-wide in 1993. For 1994, sales may grow overall by another 10 per cent to more than \$1.1 billion. Most of the more mature products will see increases of 5 to 7 per cent, with some niches, such as the highest purity process chemicals and advanced photoresists, expanding at more than 30 per cent.

In the process chemicals area, which includes acids, bases and solvents used to clean and etch microprocessors and memory devices, the demand for increasing purity is accelerating. Prices on most process chemicals have been trending upwards this past year, and the new ultra-high purity products will carry an additional premium.

Higher prices for the advanced quality products are readily accepted if the users can show better performance, usually expressed as yield improvements, market observers note.

One of the hottest issues being addressed by the semiconductor industry is the manufacture of chemicals at the customer's site. The concept is to purify gases, such as ammonia, and blend them with the customers' deionized water to make super quality ammonium hydroxide for wafer cleaning. Currently, several companies, including the team of Air Products and Applied Chemical Solutions, and Chemical Suppliers, a joint venture of L'Air Liquide and Startec, are promoting this approach. At issue is the claim by the suppliers of on-site equipment that this is the only way to reach the ultimate quality needed, and that they can match the economics of chemicals by eliminating the packaging cost and disposal of used packages. Traditionally, electronic chemicals suppliers have been able to come up with the ever-increasing quality standards demanded, and so the market will be watching this dual race to perfection.

Chemical reprocessors, particularly those designed to recover and recycle sulphuric acid, are accepted as a viable technology and an environmental plus by the larger semiconductor companies, and use is expanding.

Increasingly, semiconductor companies are teaming up with their suppliers to provide services well beyond the traditional sale of chemicals. For instance, Total Chemical Management is a service that often includes taking over the customers' procurement, inventory, delivery to point of use, operating chemical reprocessors, laboratory analysis and waste disposal.

Another area of consumables for the semiconductor industry is the slurry used for chemical-mechanical polishing (CMP). This slurry is usually made up of fumed or colloidal silica particles in an alkaline base such as potassium or ammonium hydroxide. While this process has been used to polish raw wafers in the past, it is now gaining favour for planarization, or smoothing the sub-micron peaks of leading edge devices.

Consequently, the demand for greater consistency, purity and reliability has been magnified. Currently, the industry has more than 300 polishing units in place. As improved equipment becomes available, this niche could be on the threshold of explosive growth, industry observers note.

Like many specialities, electronic chemical firms operate as world businesses. Most of the US companies claim a significant and growing portion of their business

offshore. And although few foreign speciality companies have made inroads on the US market, the Japanese Ohka America started up a new facility in Hillsboro, Oregon last April to produce ultra-high purity photo-resist developer.

The other major consuming segment for electronic chemicals, printed circuit boards or electronic packaging, also showed better growth in 1993, leaving most suppliers upbeat for 1994. New products and processes driven by environmental concerns, customer cost benefits and technology improvements are creating some real excitement in the industry.

Another development is direct plating technology or DPT, which has been introduced as a replacement process for the traditional electroless copper system. DPT is reported to improve customer process time, eliminate objectionable formaldehyde and reduce waste water by as much as 80 per cent.

Other rapidly growing new products are pre-flux protective coatings, liquid solder masks and plasma forming of substrate holes. (Extracted from *Chemical Marketing Reporter*, 25 April 1994)

## Company news

### **Fujitsu cuts on-chip load with transmitter**

Fujitsu has developed a multi-emitter quantum effect transistor which will make it possible to design logic gate and memory functions with one tenth the on-chip circuit elements.

The simple on/off functions of previous quantum effect transistors have been replaced by more sophisticated logic functions which Fujitsu claims will make it possible to create a 3-input AND/NOR gate from one multiple emitter quantum effect transistor and a resistor. In the past up to 18 components, transistors and resistors would have been needed.

The potential of the technology is that it could significantly reduce the number of device elements needed in high-density semiconductors such as memories up to 1 terabit. (Source: *Electronics Weekly*, 13 June 1994)

### **SGS-Thomson joins flash memory alliance**

SGS-Thomson is joining the AMD/Fujitsu flash memory alliance, a move that signals the start of a concerted attack on Intel's lead in the key flash market.

The Franco-Italian chip maker will build devices which use AMD's Jeduc-standard single 5 V architecture.

It anticipates having 4 Mbit samples by the end of the year and a 16 Mbit chip early in 1995, using AMD's 5 V sector-erase architecture based on NOR-type cells.

However, SGS-Thomson has not ruled out a second-source agreement with AMD.

AMD and SGS-Thomson are also to collaborate on the design of 3 V-only flash memories. The firm's wafer plant in Phoenix might also be equipped to produce flash.

AMD claims its architecture is the only one that is hardware and software compatible with the Jeduc standard on 5 V flash memories.

The firm believes the weight of the alliance behind the architecture will place Intel's dual 5/12 V Smart Voltage at a disadvantage. AMD's Bernie Perrin added that the AMD flash is inherently easier and cheaper to produce than Intel's.

The alliance with AMD will not affect SGS-Thomson's existing collaboration with Mitsubishi on dual voltage

NOR-type flash. However, SGS-Thomson is now unlikely to extend its Mitsubishi alliance to cover the DINOR-type memories Hitachi and Mitsubishi are jointly developing. (Source: *Electronics Weekly*, 22 June 1994)

### **Intel to break with x86 architecture**

Sources close to Intel claim that the US microprocessor giant's next-but-one device will break with the existing x86 architecture, relying on x86 emulation to maintain compatibility with older systems.

Also the P6, the Pentium's immediate successor, is now expected to be sold as a two-chip multi-chip module.

Sources say that the P7, that will appear close to the end of this decade, will be a "pure RISC (reduced instruction set computing) design", unlike the current Pentium and its successor, the P6, which mix RISC and CISC (complex instruction set computing) designs.

A source close to Intel said that the company chose an all-RISC design for the P7 in order to keep up with RISC microprocessor rivals such as the PowerPC. The P7 will be able to separately process CISC and RISC instructions, the source said, with the CISC instructions being processed in a hardware emulation of an x86 microprocessor.

The success of such a strategy would depend upon Intel's ability to persuade software developers to write new applications that take advantage of its RISC microprocessor.

By the end of 1995, Intel plans to introduce its successor to the Pentium, code-named P6. This device is expected to be sold as a two-chip module featuring the CPU with 256 kbytes of high speed cache memory. The P6 will be designed to be easily integrated into multiple-processor systems and the first version will run at around 133 MHz.

In the meantime, Intel plans to boost the performance of its Pentium microprocessor to as much as 200 MHz with slight changes in the microprocessor's design and a move to new manufacturing technologies that will allow Intel to fabricate the chip in 0.4-micron geometries.

PowerPC microprocessors from IBM and Motorola are the target for Intel's efforts.

IBM and Motorola are working on next generation PowerPC microprocessors in 0.5-micron geometries for introduction in early 1995. (Source: *Electronics Weekly*, 8 June 1994)

### **Compaq moves into big computers market**

Compaq Computer, the Houston-based firm, recently edged aside both IBM and Apple Computer to become the world's biggest personal-computer (PC) maker, with a 9.5 per cent share of the world market by volume, according to Dataquest.

Compaq has not had a life of uninterrupted success. Having broken the \$2-billion-a-year sales barrier in 1988, only six years after it was formed, Compaq at first ignored the trend towards cheap, basic PCs.

Compaq began to wage brutal brand warfare. It cut costs and prices, and kept on cutting them, using its brand name to build market share. The offensive was launched in June 1992, when Compaq caught its competitors on the hop with a range of PCs that were sold for a third less than their predecessors. Since then, Compaq has cut its prices at an annual rate of almost 30 per cent. As rivals have struggled to keep pace, their profits have shrivelled or vanished. But even though Compaq's gross profit margin

has fallen from 43 per cent of sales in 1990 to 27 per cent in the first quarter of 1994, its net profit has soared. In the first quarter the company made \$213 million—more than double its net profit for the first quarter of 1993—on sales of \$2.3 billion, up 41 per cent. Its sales for the year could easily reach \$10 billion.

Compaq is in a "cost-leadership mode". In practice that means increasing output to meet demand (this year it is expanding production in Houston, Singapore and Scotland, and building new plants in China and Brazil), while finding new ways to run its factories more intensively.

Compaq has also deployed the most modern management techniques. To make its manufacturing operations leaner it claims to be "re-engineering" its production processes with help from management consultants. Thanks to "design-for-manufacturing" techniques, such as common components and snap-together construction, its big computer "servers" now use one third fewer parts and screws than they did in 1989. And it has introduced "activity-based costing", an accounting technique that Compaq claims has allowed it to apportion overheads accurately to individual products.

Compaq's sales force, which is a third smaller than it was in 1991, works mostly from home, to save on office costs. And now the company's suppliers are under pressure to cut the cost of materials—which account for as much as 85 per cent of total costs. Compaq is encouraging them to open facilities closer to its Houston factory, so that they can supply parts "just in time", and save Compaq the expense of storing components in its own warehouses.

As a result of all this, Compaq's combined labour and overhead costs per computer have fallen by 75 per cent over the past two years—indeed, labour now accounts for as little as 2 per cent of some of its products' total costs. Each of Compaq's 10,500 employees accounted for an average of \$716,000 in sales last year, up from \$305,000 in 1991; that works out at \$1.5 million of revenues per manufacturing employee.

Compaq has shrunk its product life-cycles to just nine months—and it has designed into each product the potential for a 25 per cent price reduction during its life cycle. If competitors undercut a new product, Compaq can lower prices in retaliation—and still make money.

Now Compaq wants to apply the same strategy to other markets. One is the big-computer business. Compaq's new rack-mounted ProLiant servers, stacked in glass-fronted, freezer-sized cabinets, look for all the world like old-style minicomputers. The new machines have service contracts, software flexibility and installation protocols like big computers. But they undercut the prices of competitors by close to 80 per cent. If Compaq can overcome its image as "just a PC maker" in the corporate-computer market, it may do well.

Most of Compaq's consumer PCs already contain a CD-ROM player; that was for long the firm's only nod in the direction of multimedia. In the past three months, however, Compaq has unveiled a venture with Microsoft to develop powerful servers and software for "video on demand", and an alliance with PictureTel which will focus on video-conferencing systems. Compaq has also announced ventures with KidSoft, which makes children's educational software, and with Micrografx and Binney & Smith, which sell Crayola art software for children. (Extracted from *The Economist*, 2 July 1994)

### **NEC flashes in at 64 Mbit**

NEC is to enter the flash memory business at the 64 Mbit density level in 1997. As an interim measure it is considering running a 16 Mbit device starting in 1996.

Hajime Sasaki, senior vice-president at NEC and the main board director responsible for semiconductors, says that NEC's flash strategy is to concentrate on "highly integrated" flash chips.

NEC's 64 Mbit device was shown at the International Solid-State Circuits Conference earlier this year. It is a single power-source 3.3 V device made in 0.4-micron technology with a chip size of 19.3 mm x 13.3 mm, a DRAM-equivalent normal access speed of 50 ns and a page mode access time of 30 ns.

NEC uses the NOR type of cell for flash, in contrast to the Toshiba/IBM NAND approach. (Source: *Electronics Weekly*, 8 June 1994)

### **IBM goes solo for next generation**

IBM says it is working on next generation PowerPC microprocessor designs even though the fourth and most powerful PowerPC, the 620, will not be announced till the end of 1994.

Unlike the 620, which is being developed with partner Motorola, IBM is working on its successor, the 630, by itself. IBM is planning to use the 630 in high-end servers and in its mid-range computers such as the AS/400 models.

The PowerPC 630 will not be ready until at least mid-1997 and will offer twice the performance of the PowerPC 620. It will compete against Intel's P6 microprocessor, the successor to the Pentium.

IBM is working on the 630 because it needs high-performance RISC chips for its mid-range systems, but it may license the design to Motorola or other companies. (Source: *Electronics Weekly*, 8 June 1994)

### **Siemens to turn electronics green**

Siemens is lobbying the European Union and the German Government to adopt a wide-ranging set of guidelines for the development of environment-friendly electronic products.

The guidelines, which are already being implemented within Siemens, would involve a fundamental change in the way virtually every European electronics firm operates if adopted by the EU. They cover everything from designing for disassemblability and selecting recyclable materials to reducing energy consumption of finished products and minimizing the amount of packaging. They include a list of prohibited materials which "should not be used in any new or upgraded product".

Plans to introduce European-wide legislation for product recycling, waste disposal and environmental protection are already well advanced. But nowhere are they more advanced than in Germany.

Siemens believes that in implementing an environmental strategy now it is responding to growing public concern, the second priority after unemployment according to opinion polls. Some 75 per cent of Siemens' sales are in Europe and 15 per cent in the United States, both regarded by Siemens as environmentally aware regions.

Siemens already recycles a number of its electronics products, including a "green PC" from Siemens Nixdorf, which is 90 per cent recyclable. The Euroset 821 telephone is 96.7 per cent recyclable, and a coffee machine from Bosch-Siemens Hausgeräte is also largely recyclable.

As part of the company's environmental strategy, it has produced flame retardant printed circuit boards and component packages at its research laboratories in Erlangen. The plastic material is expected to be commercially available next year.

The material, which does not use bromide compounds and does not give off the toxic fumes associated with halogen, has been used to produce multilayer boards with up to six layers to date. It can also be easily recycled or disposed of. (Source: *Electronics Weekly*, 1 June 1994)

#### **Fujitsu queries ATM data rate**

Fujitsu has questioned the feasibility of a 51 Mbit/s data rate for the widespread introduction of the asynchronous transfer mode (ATM) broad-band communications protocol to the desktop.

Fujitsu is one of a growing number of companies which is questioning last year's decision by the ATM Forum industry group to define the standard LAN interface rate at 51 Mbit/s rather than the lower 25 Mbit/s data rate proposed by IBM. The real issue with 51 Mbit/s is the transceiver. The carrierless amplitude protocol CAP16 which is specified for 51 Mbit/s transmission over category 5 unshielded twisted pair is proving expensive and troublesome to implement. It is felt that a 25 Mbit/s ATM PC card may be priced well below \$500, even by using a token ring receiver to keep costs low.

Fujitsu has introduced single chip ATM network termination controllers for both the 51 and 25 Mbit/s data rates, but the company expects the 25 Mbit/s device to be the clear market leader. One feature of the lower rate is its suitability for providing an ATM interface for portable machines. (Source: *Electronics Weekly*, 1 June 1994)

#### **MEMC steps into China**

MEMC Electronic Materials, the American electronics firm, will start manufacturing silicon wafers in the Republic of China in 1996.

MEMC's joint venture with the Chinese partners China Steel Corporation, China Development Corporation and Chiao Tung Bank will set up the facility early next year at the Hsinchu Science and Industrial Park. The plant will cost around \$150 million.

MEMC also reported it had purchased the assets of Kawasaki Wafer Technology, a subsidiary of Kawasaki Steel Corporation, which makes wafers in Santa Clara, California. (Source: *Electronics Weekly*, 1 June 1994)

#### **Battery trio join forces**

Japanese Toshiba Battery, German Varta and American Duracell International are forming an international alliance to start producing nickel-metal hydride rechargeable batteries used in laptops and mobile phones. The deal is expected to be completed before the end of this year. The companies plan to build a US factory which will produce 100 million batteries a year, starting in 1996. (Source: *Electronics Weekly*, 27 July 1994)

#### **Next generation of wafers set at 12 inches**

The next generation of silicon wafer size has been fixed at 12 inches at a closed-door meeting between major non-Japanese chip users and equipment suppliers at the Semicon West exhibition held in San Francisco.

The Japanese Ministry of Trade and Industry (MITI) has proposed that an international consortium should be formed involving German, US and Japanese chip makers to work together on the next-but-one wafer size—16 inches. To make sure that Japanese companies have a major say in it, MITI is offering to put up 70 per cent of the \$176 million estimated cost.

The 12 inch decision, which has the support of the US Government-backed semiconductor consortium Sematech, is also supported by Europe's Joint European Submicron Silicon Initiative, whose representatives attended the meeting.

Ten-inch wafers were rejected because they would only give a 56 per cent increase in area over today's 8 inch wafers, whereas 12 inch wafers give a 125 per cent increase.

The decision has not met with universal approval. Most Japanese companies are still trying to fully utilize their 8 inch wafer fabrications. The world's largest supplier of wafer fabrication equipment, Applied Materials, would have liked to have seen the industry agree on 14 inch wafers—such a move could have squeezed out smaller equipment manufacturers. (Source: *Electronics Weekly*, 27 July 1994)

## **IV. APPLICATIONS**

#### **Multimedia (presentation) hardware.**

Although manuals on presentation techniques describe how effective use can be made of text or graphics projected onto a screen—provided they are clearly visible to the audience—comparatively little attention has been paid to multimedia presentation requirements. This article briefly reviews some of the hardware available.

The simplest method of displaying data from a small computer display to a larger group is by using an LCD panel—sold for about £1,300 (monochrome) or £2,500 (colour) in the UK—on an overhead projector. A brighter, larger image, however, can be produced with an LCD projector, typically providing 640 x 480 resolution with 24-bit colour. An example is the £9,500 (UK price) Proxima 8300. Even better results are obtained with light valve or CRT projectors, but these are considerably more expensive.

The new generation of multimedia PCs (MPCs) incorporate CD-ROM drives, audio adaptors and speakers or headphones. Upgrade kits, such as those from Creative Labs, are also available. Apple, IBM and Silicon Graphics (but not Commodore, which has discontinued its CDTV system) all have a presence in the MPC market.

The Apple Quadra 840AV includes a 40 MHz processor and 230 Mb hard disc, and sells in the UK for £3,575, although the full cost of assembling a comprehensive multimedia presentation system using 1993 technology would be nearer £10,000. In March this year, Apple launched the RISC-based PowerMac 7700-66 (£3,000) in the UK, with a performance rated at three times that of the Quadra. In May 1993, IBM launched its low-cost PS/1 Multimedia System, essentially aimed at the educational and home markets. Silicon Graphics sells its Indy multimedia machine for about \$5,000 in the US; the emphasis is on video applications. (Extracted from *IT Link*, 7(6), July/August 1994).

### **New applications for buckyballs**

Since their discovery in 1985, chemists have been fooling around with fullerenes, fascinated by the array of their possible applications. Now American scientists suggest that fullerenes may prove useful for storing hydrogen, while fluorinated fullerenes look promising for new types of batteries and lubricants.

Robert Compton at the Oak Ridge National Laboratory and his colleagues at the University of Tennessee and the Naval Research Laboratory claim to be the first to hydrogenate  $C_{60}$  without a catalyst. At 400° C and under high pressure, Compton managed to add up to 18 hydrogen atoms to the fullerene.

According to Compton, fullerenes would have many advantages over current hydrogen storage materials like palladium. They are lighter, cheaper and hold more hydrogen per storage atom, he explains. Some buses in California run off hydrogen because it only produces water vapour emissions, he points out, so there is tremendous interest in such materials for vehicle fuel systems.

Compton and his co-workers also claim to have achieved the highest degree of fluorination in fullerenes where the carbon cage has not been "cracked". Compton discovered that these fluorofullerenes,  $C_{60}F_{48}$ , had unusual electronic properties: they hold on to binding electrons very tightly.

Then, unexpectedly, Compton found that a second electron could be added to gas-phase  $C_{60}F_{48}$ —to produce a doubly charged anion. He believes that his team is the first to prove that this anion is stable. In fact, Compton reports the "intriguing result" that the doubly charged anion is more stable—that is, less likely to lose electrons—than the singly charged anion.

Modifying fullerenes dramatically affects their electronic and ionic properties, concludes Compton. Understanding these effects may push forward the "selective design" of fullerene-related compounds as new materials, such as superconductors and semiconductors, he thinks. (Source: *Chemistry & Industry*, 2 May 1994)

### **Multiprocessor chipset**

A new chipset to implement cache control functions in multiprocessor computers with up to 12 Pentium processors is available from GaAs specialist Vitesse Semiconductor. The set comprises the VSP947 cache controller which is built using Vitesse's proprietary GaAs process, and the VSP948 datapath chip which is made in standard CMOS. The chipset will be in production in September. (Source: *Electronics Weekly*, 8 June 1994)

### **The tiny DSP (Digital Signal Processor): the miracle-chip of modern telecomputing.**

The world of electronic signal processing has recently undergone a revolution. Specialized microprocessors have been developed with sufficient capabilities to effectively perform many of the mathematical calculations at a pace that enables real-time operation, and at a size and cost that has revolutionized the way many electronic functions are implemented. The revolution is driven by the digital signal processor, DSP. Although the DSP has not necessarily got more raw speed or power than the CPU, it is optimized to perform specialized operations. DSPs typically incorporate a significantly different internal architecture and implement addressing modes that are not found in the typical CPU.

There are many reasons for the DSP's popularity as it is possible to perform functions to any arbitrary degree of accuracy using mathematical calculations. With DSP technology, the required modern functions are performed mostly not by the use of hardware, but the driving software. There are many applications that could be greatly aided through the use of DSP technology. As the cost declines, it is likely the standard desktop PC or workstation will include a DSP. Natural applications include telephony; data compression/decompression; data communications; speech recognition and synthesis; interactive voice response; sound synthesis; image processing, etc. DSP technology is extremely attractive to integrate it into workstations, personal computers and other portable units. It also should be suitable for sophisticated multimedia applications. DSPs are already being used in cellular phones, portable wireless terminals, high-speed modems, fax machines and other telecommunications-related devices. (Extracted from *Current Awareness Abstracts*, June 1994)

### **Developing a long-term strategy for document management**

It is becoming more difficult to develop a long-term strategy for any technologically based business solution. The mix and match of hardware platforms, operating systems, networking topologies and application software packages have become a robust option, potentially capable of supporting mission critical applications in the core business areas of organizations. By categorizing the support requirements of the core business processes within an organization, it is possible to see which elements of today's technology mix can be of immediate use. The objectives in this process should be to gain experience; develop organizational skills; and determine the real barriers to productive improvement. The business benefits of document management are determined by the selection of an appropriate application area; agreement on business objectives; quality of system implementation; and the business fit of the application software.

It is only possible to describe a long-term document management strategy once business requirements are clear. The mission statement should be "to drive the highest levels of return on investment from available technology at acceptable level of risk to the business". Some of the benefits of adopting an electronic document management strategy can only be available through corporate restructuring with reduced levels of management; increased organizational flexibility; reduced learning curves for new staff; improved job content and increased responsibility; and improved quality and timeliness of management information, etc. The selection of appropriate application areas for immediate implementation of document management systems is a matter of corporate choice. In the mass market, developed work-flow systems are being sold as add-ons or application templates for generic activities by organizations such as Lotus, WordPerfect and Microsoft. In the operating systems area, Novell are competing with Windows, while peripheral manufacturers such as Hewlett Packard, Ricoh and Hitachi are seeing openings in sales of mass storage devices. The only IT strategy that guarantees survival in the long term is one which keeps its host organization effective, competitive, and in business today and tomorrow. (Extracted from *Information Management & Technology*, 27(3), May 1994)

### **First all-solar telephone switch installed in remote area**

The first telephone switch in North America fully powered by solar energy has been installed in California by Siemens Solar Industries.

The equipment was installed for GTE Telephone Operations to provide telephone service to a remote community of 20 homes located near San Bernardino, Calif.

Siemens Solar, of Camarillo, Calif., provided the photovoltaic power supply for a digital loop carrier manufactured by the Siemens Stromberg-Carlson Company of Boca Raton, Florida. GTE wanted to expand its subscriber base in the remote area near San Bernardino, but no commercial electrical service was available and all telephone lines from an existing switch four miles away were being utilized.

Since the expense of running additional electrical and telephone lines out to the site was too great, GTE decided a photovoltaic power supply was the most cost-effective way to power the 24-line phone system.

"GTE serves dozens of rural areas in the United States that do not have commercial power available 24 hours a day", said Chuck Richoz, GTE manager for switching standards. "Solar-powered switching may be an ideal solution from an economic standpoint to meet these rural customers' needs."

The power supply for the GTE equipment is composed of 12 Siemens M75 solar panels, generating up to 576 watts of peak power, and a 48V, 350 amp-hour battery bank. The photovoltaic power supply was designed to supply 33 amp-hours daily to the phone system based on annual usage.

The Siemens Stromberg-Carlson digital loop carrier can accommodate up to 24 multiplexed conversations simultaneously from a single outdoor housing. The compact housing can be installed on a pad or pole. (Source: *International Solar Energy Intelligence Report*, 16 May 1994)

### **PDA acts as electronic wallet**

A 13-strong consortium called Cafe (Conditional Access for Europe), led by the Dutch firm DigiCash, will unveil a prototype of a "truly unique and sophisticated" electronic wallet, according to DigiCash's chairman David Chaum.

Expected to be on the market by 1996, the wallet is a pocket-calculator size PDA which can handle financial transactions and hold personal information while preventing access to this information without the user's knowledge.

"Banks cannot trace your movements and it is totally secure", said Chaum. "It is an open system, enabling technology for all types of transactions ... to happen and protect the individual's privacy at the same time."

Amongst the partners in Cafe are Siemens from Germany, Gemplus from France, Card-Ware from the UK and universities and research institutions from the Netherlands, Denmark and Germany.

The wallet contains a microprocessor, memory, miniature keyboard, display, a balance reader and a microcontroller which acts as a two-way "guardian" to all transactions and encryptions. It communicates with shops and banks via a built-in infrared transceiver. A combination of "public key" and "private key" cryptography is used to keep the information stored on the card secure. (Source: *Electronics Weekly*, 8 June 1994)

### **First 256 kbit ferro PAMs due next year**

Hitachi and Ramtron say they expect to have 256 kbit ferroelectric DRAMs (FRAMs) in commercial production next year. Hitachi reckons ferroelectric technology could be the route to the "ultimate memory".

The Holy Grail of semiconductor memories is one that is fast to write to, fast to read, non-volatile, dense, low-power, electrically reprogrammable and infinitely rewritable.

Ferroelectric technology already provides many features. Rewrite cycles are in the billions compared to the hundreds of thousands of flash, and power requirement is ten times less than flash. Speeds are in the DRAM range. But the problem of the technology remains density.

Flash memories and DRAMs with densities of 16 Mbit are already in volume production but the earliest we will see even a 256 kbit ferro memory is 1995. Hitachi and Ramtron say they will also develop 1 Mbit and 4 Mbit memories but declined to give dates for their commercial availability. 64 Mbit DRAMs are already being sampled and are expected to be produced in volume next year. In five years time, the first 1Gbit DRAMs are expected to be around. (Source: *Electronics Weekly*, 4 May 1994)

### **Cheap radar for safer cars**

An antenna designed by Philips' research arm is at the centre of a novel braking system for cars. The system, which allows a constant time interval between the vehicle in front and your car is called Autonomous Intelligent Cruise Control (AICC) developed by the Philips Research Centre.

The AICC needs a sensor to sense the distance to the car in front at all times and one strong candidate to emerge first on the consumer market will be the millimetre-wave radar, so far extensively used in military applications.

It comprises front-end hardware consisting of antenna, microwave head and associated control circuitry and a signal and data processor subsystem where the sensor data is processed.

The user interface is connected to the vehicle controller via a bi-directional link. The controller's decisions are based on information gathered from the radar and the driver and then passed onto the brake and throttle actuators. The driver can at any stage override the systems' actions.

The most novel part of the whole concept is the antenna designed by the Philips Research Centre.

The antenna, 160 mm in length, is an array of 28 smaller phase-array antennas as radiation elements based on Frequency Modulated Continuous Wave (FMCW).

FMCW works on the principle of mixing the transmitted and received frequencies (usually in the GHz range) to generate a beat frequency (in the KHz range making it easy to process).

The prototype system operates at a typical range of 150 m.

The project is part of Prometheus and started two years ago under the ARIADNE (Application of a Real-time Intelligent Aid for Driving and Navigation Enhancement), part of the DRIVE 2 initiative.

The system was developed a year ago and tested on a Rover, and more recently on a Jaguar Sovereign. It is expected to go in upper range model cars with a volume price of around £100. (Extracted from *Electronics Weekly*, 4 May 1994)

### Designers take asynchronous ARM chip into second stage

Design work is well under way on the second version of an asynchronous implementation of the ARM 32-bit RISC microprocessor, according to Professor Steve Furber of the University of Manchester.

Dubbed Amulet 2, the chip's design will include improvements to remove some performance limitations in the original Amulet 1 processor.

The Amulet processors are implementations of the ARM machine architecture employing asynchronous logic in which a synchronizing clock signal is not required. This is a radical departure from conventional IC design in which individual elements of a circuit operate in lock-step under the control of a global clock signal.

The potential of asynchronous logic is dramatically reduced power consumption because there is no clock source to consume power even when the processor is idle. In asynchronous logic the circuit elements operate—and dissipate power—only when there are calculations to perform.

However, designing asynchronous logic is not as simple as removing all clock sources from conventional synchronous circuits. Although combinatorial logic elements such as adders and multipliers remain the same, new logic primitives are required to control the flow of data.

The design style Professor Furber chose to employ was a micropipeline structure first proposed by Ivan Sutherland. This scheme uses a simple handshake protocol to pass data between functional blocks. The protocol employs transition signalling: both a rising and a falling edge have the same meaning. Local timing signals are transmitted with a bundle of data bits presented as conventional binary values.

The synchronous ARM device is a conventional register based RISC microprocessor in which arithmetic operations require two operands to be read from the register bank and a single result value returned. The instruction execution stage is not pipelined (it is a single stage of the fetch-decode-execute pipeline) and an operation is completed within a single clock cycle.

However, in the asynchronous ARM the instruction execution stage is decomposed into a number of pipeline stages. This was done to improve performance.

Unfortunately, this pipeline proved to be cumbersome. Amulet 2 has a smaller and tighter design with less logic and should have a significantly better performance.

Professor Furber's team also took the opportunity to implement a scheme equivalent to register forwarding to overcome the problems of data dependency in the instruction flow. A typical program often makes immediate use of a result computed by the previous instruction. The processor would be slowed if all instructions had to wait for results to be written back to the register file and to avoid this penalty a register bypassing mechanism is needed.

Such a mechanism is relatively simply implemented on a clocked processor; the global clock ensures that different functional units operate at fixed relative times making the comparison operation easily scheduled. However, in an asynchronous processor there is no such fixed relationship and so explicit synchronization is needed to make a similar result and operand address comparison.

The Amulet 2 design is also more flexible in its use of resources in the execution pipeline. For example, the barrel

shifter is bypassed by all instructions that do not need to use it.

The design of Amulet 2 is scheduled to be completed by mid-1994 and will incorporate a memory management unit and cache as well as the integer core on the chip. A complete working system is due by March 1995 to coincide with the end of the project. (Source: *Electronics Weekly*, 8 December 1993)

### Sample-and-hold circuit for LCD driver ICs

Toshiba Corp. has developed a driver IC for thin-film transistor (TFT) type liquid crystal displays (LCDs) used in workstations (WSs) and high-definition TV sets, by which the operating speed has been increased substantially.

In conventional LCD driver ICs, a switch transistor in the sample-and-hold circuit generates an output error due to an error charge, which appears as a vertical stripe on the display screen, so a separate transistor has to be used to absorb this error charge. However, a mismatch between the transistors and the differences in the timing of error absorption are obstacles to completely eliminate the vertical stripes.

In addition, for high-definition image processing, the necessary enlargement of the transistor size will increase the output error, making the attainment of high-accuracy and high-speed operation difficult in principle. The conventional LCD driver IC was unsuitable for the displays of workstations and high-definition TV sets.

With the proposed new sample-and-hold circuit, the switch transistor reabsorbs the error charge generated by itself. So, in principle, it is possible to completely eliminate the error charge. Also, since this technique can be applied to any size of switch transistor, it is possible to enlarge the transistor for achieving high-speed operation.

Measured results show that the mean square of output deviation of the sample-and-hold circuits including buffer circuits is 4.7 mV, which is a considerable error reduction compared with the deviation of 20-33 mV of the conventional circuits. A substantial increase in frequency bandwidth, an index of high-speed operation, to 60 MHz is possible compared with the practical level of 10-14 MHz. Further details from Toshiba Corporation, Public Communications Office, 1-1-1 Shibaura, Minato-ku, Tokyo 105. Tel: +81-3-3457-2100; Fax: +81-3-3456-4776. (Source: *JETRO*, May 1994)

### SiGe looks to plug GaAs leak

The future for gallium arsenide (GaAs) as a mainstream semiconductor process is looking increasingly bleak following the announcement last year that Analog Devices and IBM are to develop silicon-germanium (SiGe) ICs.

The semiconductor industry has been galvanized by the collaboration which aims to deliver its first chip, a 12-bit, 1 GHz digital-to-analog (DAC) converter to the market this year.

However, Analog Devices and IBM will concentrate on developing single chip RF front-end circuits and other chips for wireless communications. The deal calls for Analog Devices to design a range of ICs, which will be manufactured by IBM at its Advanced Semiconductor Technology Centre in Hopewell Junction in the US.

Highly integrated ICs for wireless communication systems were seen as an ideal area in which the high performance potential of a GaAs process would allow it to



carve out a niche. Some of the crucial system building blocks such as antenna switches, low noise amplifiers and down converters require a transistor performance of several GHz—beyond the capabilities of a silicon CMOS process.

Silicon bipolar circuits have the performance potential but are power hungry—a significant disadvantage for handheld systems. Silicongermanium semiconductors are now seen as the natural successor to CMOS for high-speed circuits. The IBM process gives transistor speeds of 75 GHz and utilizes 8 in. wafers and can operate from 3 and 1.5V supplies.

The process employs a SiGe heterojunction bipolar transistor (HBT) in which an epitaxial film of boron doped SiGe alloy, deposited on the silicon wafer, forms the base region of a vertical npn transistor. The film was grown using ultra-high vacuum chemical vapour deposition.

A relatively small number of the HBTs can be integrated on an otherwise conventional silicon CMOS process, minimizing the changes to the production steps, or the HBT may form the basis of a highly integrated BiCMOS process. In the short term, though, the former option is likely to be taken for reasons of process simplicity and to avoid isolation problems.

The limited number of changes needed to incorporate the SiGe HBTs into a CMOS process is the key because the incremental wafer processing cost is minimal. (Extracted from *Electronics Weekly*, 12 January 1994)

#### **OptiComp runs the RISC faster**

A hybrid optical/electronic computer which is claimed to operate at up to 12 billion operations per second has been developed by OptiComp, a US firm based at Lake Tahoe, Nevada.

The digital optoelectronic computer (DOC II), which uses light-producing laser diodes as switching elements, works alongside a conventional computer workstation. Each laser diode can broadcast to hundreds of gates, while a transistor can only drive three or four.

OptiComp says DOC II runs RISC at peak speed of one trillion bit operations per second. The company says the real commercial potential is in full text database searches but other possible uses of the machine include image processing, real-time signal processing, logic simulation, symbolic processing and numerical analysis. (Source: *Electronics Weekly*, 12 January 1994)

#### **LSI chip for high-speed processing of static and dynamic images**

Sharp Corp. has developed and started marketing an LSI chip for the high-speed processing of static and dynamic images.

Previously, an LSI board performing the same operations used as many as six LSIs and microprocessing units (MPUs) of three types, but the new LSI chip is available at a price that is about one tenth and on a single chip, so can be incorporated in a CCD camera.

The new LSI "DR0P300" features diverse processing functions such as image synthesis, contour extraction, colour and brightness conversion, and calculation of the graphical centre of gravity positions, and over 350 kinds of image processing are possible by applying these functions in combination. It is also capable of instantaneously processing dynamic images photographed with a 200,000-pixel CCD camera that is widely used in the field of factory automation (FA).

Examples of the high functional LSI applications include fabricating an automatic calculator that calculates the food prices on a tray from the food colour or shape in a self-service cafeteria, a crime prevention monitoring camera, and a control system that automatically switches traffic signal equipment in conformance with the car flow.

The monitoring camera vision can select specific colours to generate an alarm whenever a vehicle of different colour intrudes, or it can be used in combination with a doorphone for face discrimination and door opening. There is therefore no need for workers to monitor images around the clock, which translates into labour conservation and improvement of system reliability. Further details are available from Sharp Corporation, Corporate Public Relations Div., 1-9-2 Nakase, Mihama-ku, Chiba City, Chiba Pref. 261. Tel: +81-43-299-8210; Fax: +81-43-299-8213. (Source: *JETRO*, January 1994)

#### **SCAN combining bar code with data carrier IC**

Tokimec Inc. has developed an electronic tag with a printed bar code and a built-in non-contact memory IC data carrier. A dedicated scanner has also been devised. The memory IC contains data to be re-written by the scanner, and can hold current purchase information such as inventory volume and order quantity. Working with point-of-sales (POS) machines and portable terminals, the tag and scanner allow workers to perform specialist work including sales, inventory management and reordering goods. Such a system is promising as a new POS data manager to replace the existing types. The company emphasises the system potential to cut logistic costs and is entering the market for POS data managing systems.

The 2 x SCAN handy scanner is a combination of a bar code reader and reader/writer for the data carrier built into the electronic tag. Linked to a portable electronic terminal, the scanner enters necessary data into tags on article racks. Data to be written include purchase volume and reasonable inventory quantity, and indicator of reorder point. The scanner switches to the bar code reading mode if necessary, and is plugged to a POS machine to serve for sales management. The host PC of the POS system can provide portable terminals with sales information, which will be compared with inventory data from the data carriers, so that inventory management and the automatic issue of ordering sheets is easy.

Most supermarkets, convenience stores and department stores use POS systems, in which every bar code indicates no more than the identification number of the article. The price is referred to another place by a computer. The inventory management and reordering goods are often left to another computer system. Those tasks require operating specialists. Any worker can easily use the new system to sell and reorder goods and manage inventory.

Resembling a pebble, the data carrier is 3 cm in diameter and 0.5 cm thick. It has a capacity of 1 kilobit and needs no power. The data can be read unlimited times and rewritten up to some 100 thousand times. The tag has a bar code seal on the face. The scanner measures 17.95 x 7.82 x 12.8 cm<sup>3</sup> and weighs about 230 g. Further details are available from Tokimec Inc., The New Business Development Div., Technoport Kamata, 2-16 Minami-Kamata, Ota-ku, Tokyo 144. Tel: +81-3-3730-0011; Fax: +81-3-3730-0017. (Source: *JETRO*, January 1994)



### **New high-performance YAG laser system for precision machining**

Toshiba Corp. has developed a yttrium-aluminium-garnet (YAG) laser system for precision machining that is ideal for manufacturing small parts. The system achieves precision machining using a new YAG laser system that is about 200 times more intense than conventional systems and a high-performance condensing lens, by which the beam spot diameter has been contracted to about 10  $\mu\text{m}$ , roughly one fifth compared with before. The company plans to apply the new technology to the manufacture of micromachines and to the fabrication of prototype super LSIs.

Laser machining consists of irradiating a laser beam to melt and remove surplus metal parts to produce the target products. Precision machining without adverse influences from the heat can be achieved more effectively with a greater laser beam intensity and smaller irradiation spot.

YAG laser machining requires no die masking and the machining speed is faster than that of electric discharge machining. Since machining is non-contact, the material is not deformed by the application of an external force.

However, with the conventional YAG laser system, beam concentration has to be sacrificed to obtain the energy for cutting metal plates as thin as several hundred micrometres, so it was difficult to machine at cutting widths of less than 50  $\mu\text{m}$ . The new technology enables miniature parts to be machined rapidly with precision and can be applied, for example, to the manufacture of lead frames with fine pitches and screen masks for use in soldering and printing.

Metal plates as thin as 0.2 mm can be machined accurately with a machining tolerance of less than 20  $\mu\text{m}$ , and metal plates with thicknesses of up to 2 mm can be cut at an aspect ratio (ratio between sheet thickness and tolerance) of over 10. In addition, by using a numerically controlled machining table, cutting is possible at an accuracy of  $\pm 5 \mu\text{m}$ . Further, precision machining will also be possible by using the laser system in combination with CAM technology for converting CAD data directly into laser cutting data. Further details from Toshiba Corporation, Public Communications Office, 1-1-1 Shibaura, Minato-ku, Tokyo 105. Tel: +81-3-3457-2100; Fax: +81-3-3456-4776. (Source: *JETRO*, January 1994)

### **First mass-produced combustion chamber pressure sensor**

In an internal combustion engine, nitrogen-oxide and carbon-dioxide pollutants can be minimized by increasing the air-to-fuel ratio for the engine.

Running at a much higher air to fuel ratio dramatically reduces these emissions but at the same time will increase the chances of misfiring which in itself increases emissions of unburnt fuel.

To minimize this effect, Toyota has developed a pressure sensor that fits in a vehicle's combustion chamber enabling the engine management system to detect misfiring and adjust the vehicle's air-to-fuel ratio accordingly, thus controlling the air-polluting nitrogen-oxide emissions.

Toyota claims that this is the first combustion chamber pressure sensor in the world to be mass-produced as an automotive part. It has been fitted in the Toyota Carina E, at the moment only available in Japan.

This sensor cannot be retrofitted in a car but it looks set to become an integral part of future car engines.

Although Toyota sensor's prime objective is to keep the nitrogen-oxide emissions low, it also improves fuel consumption without affecting vehicle performance, and therefore lengthens engine life. (Extracted from *Electronics Weekly*, 27 July 1994)

## **V. SOFTWARE**

### **Communications system for remote regions**

Australian firm Codan has just completed trials in the Australian outback of a system based on high-frequency radio which makes it possible to transmit fax and computer data in the world's remotest regions. Codan claims to have solved the problems of poor transmission quality which have dogged previous attempts to build high-frequency data communications systems. Its "selective repeat ARQ" system sends blocks of data repeatedly until it receives a signal confirming the data has been transmitted without error. "The system we have developed is a world first in the non-military sector", claimed Codan's sales manager, Bob Potter. (Source: *Electronics Weekly*, 11 May 1994)

### **COMPInfo: a prototype hypertext guide to company information sources**

Company information is of considerable importance to the business community, but finding the right information is not easy. There are many possible information sources in a variety of formats which are often difficult to identify and control. Accurate and current guides to information sources are important, and a prototype hypertext guide to sources of company information has been developed to examine the feasibility of utilizing this technology to overcome some of the limitations of paper-based guides.

COMPInfo has been developed using GUIDE software. The structure of the system and the way in which this attempts to fulfil the requirements of a good company information guide are discussed. The advantages and problems of the prototype are considered, along with areas in which further development of the structure would be beneficial. In spite of its limitations, COMPInfo indicates that hypertext technology could provide a viable solution to the problems of producing an effective guide to the complex field of company information. (Extracted from *The Electronic Library*, 12(3), June 1994)

### **Entry level. Getting on the Internet**

When establishing an Internet link, the novice user should first decide whether it is to be used for the exchange of E-mail messages only, or for participation in news groups and accessing data remotely. This will help determine which of the many possible options is most appropriate.

The easiest route for many potential users will be via their employing organization's link. If this is not available, it is a straightforward matter to obtain a connection via a local bulletin board system (BBS), many of which offer an Internet link at modest cost. Alternatively, there are (in the United States) a number of nationwide commercial on-line services—notably, America Online, CompuServe, GENie and Prodigy—offering the facility of sending and receiving E-mail via the Internet.

If more than simple messaging is required, the solution is to employ a public-access dial-up service provider. These

vary widely as regards the facilities they offer. Some key questions to ask—including those regarding tools available, technical support and news groups subscribed to—are suggested in the article.

Another method of obtaining a connection is to employ a SLIP (serial link internetworking protocol) or PPP (point-to-point protocol) connection. Essentially, this connects the user's PC directly to the Internet over an ordinary telephone line. Standard communications software cannot be used for this purpose: a program such as *Mosaic* or *WinGopher* must be purchased. This gives more control over how the Internet is accessed and allows the PC's graphical user interface to be used—but at the cost of some additional complexity at set-up. (Extracted from *Internet World*, 5(5), July/August 1994)

### **Managing electronic records**

Surveys within United Nations organizations in 1988 and 1991 indicated a shift from the use of telex to that of fax and E-mail. The US Government estimated in 1990 that three quarters of all governmental transactions will be handled electronically by the end of the decade.

Problems associated with poor records management are not peculiar to electronic systems, but arise more quickly and acutely than when the system is paper-based. Records can be destroyed more easily, unless proper controls are built into the system. There is also the issue of electronic systems requiring close collaboration between a range of professional disciplines.

There are five main technical issues associated with electronic records: storage media, hard- and software, data exchange standards, integration with other record-keeping systems, and access/security. Particular concerns include retrieval in the future, as media deteriorate and systems become obsolete. The costs of migration to new media can be very high. The issues of access and security relate to management decisions regarding what controls are necessary.

Concerns of access also have relevance in the context of legal questions. There may be a legal requirement to maintain records laid down in company law or sector-specific regulations. The law does not specify the media to be employed, but the position of electronic records is still uncertain. In particular, their admissibility as evidence has yet to be determined. A key requirement is to be able to demonstrate that records are authentic, and electronic systems must incorporate such facilities as the maintenance of audit trails. (Extracted from *Records Management Journal*, 4(1), June 1994)

### **Remote access software**

DCA's *Remote LAN Node 2.0* (RLN) provides remote access to LAN facilities for those working from remote sites. Representing perhaps the best attempt yet at overcoming the usual remote access problems of speed, data integrity, security and transparency, it is priced at £640 for two users (Token Ring £800), £1,810 for four users, and £3,050 for eight users.

As in the previous version, it is a combination of server and client software. The server is usually a dedicated PC attached to the LAN, supporting up to 16 clients simultaneously. The minimum configuration for a two-port system is a 486SX/25 with 2 Mb of RAM and a 16-bit slot. An SMC Ethernet adaptor is supplied with the software. The server uses FTP Software's PC/TCP as the

standard packet driver interface, and several transport protocols can be supported at once, including ODI, NDIS, IPX and TCP/IP.

Setting up the client software entails installing a *Client Maker* program which creates customized client floppies containing the necessary RLN and other files required to log onto the LAN seamlessly. The client program works as a TSR requiring just over 50 Kb, but offers the choice of either a DOS or Windows interface. It uses a number of compression techniques—as well as standard run length compression and proprietary header compression, it employs the technique incorporated in the industry standard Point to Point protocol—to improve communications speeds. The inclusion of a client API means that RLN functionality can be built into Windows applications if required. There are a number of impressive security features. (Extracted from *PC User*, 4-17 May 1994)

### **Computers help drug developers**

Scientists from a Department of Energy laboratory and a Texas pharmaceutical company are writing new computer programs to dramatically cut the cost and speed of developing new drugs for treating cancer and heart disorders.

Lawrence Livermore National Laboratory has joined with San Antonio-based BioNumerik Pharmaceuticals Inc. to use computer simulations in an effort that the company says could cut in half normal drug development time at a potential cost savings of millions of dollars per drug.

The goal is to develop pharmaceutical discovery software in a short time so that studies can be pursued to expedite cancer and cardiovascular drug discovery.

Simulation technologies produced through the cooperative research and development agreement will be applied to cancer and heart drugs already under development by BioNumerik. (Extracted from *Chemical Marketing Reporter*, 27 June 1994)

### **Software for radio spectrum management**

Over the past few years, a growing number of administrations have requested engineering software to support their national and international frequency management activities. To meet the changing requirements of the members of ITU in the fields of computer-assisted spectrum management and to improve access to information concerning such software, a common computer information system called "ITU Software Data Base (ITUSOFTDB)" has been developed. The system contains a detailed description of available computer programs which might be of interest to radio spectrum management units in the member administrations and to other interested parties. The system is now accessible electronically through the ITU computer network (TIES).

The first catalogue was published in July 1992. Since then, some of the programs which have not been subsequently confirmed by their originators had to be deleted. On the other hand, some new programs submitted by the participants in the work of the Radiocommunication Study Groups or by the Radiocommunication Bureau have been included in the ITUSOFTDB system. The second updated edition of the catalogue can be obtained free of charge from the ITU Sales Service.

The software and accompanying written materials are provided on an "as is" basis without warranty of any kind, and no user may copy or distribute copies of the software or accompanying written materials to other persons or

entities, or create derivative works based on the software or the material, unless expressly authorized by the originating source.

The programs listed in the database can be obtained from ITU or from the other originating source, as indicated in the description of each program. The software is distributed against reimbursement of the cost of material, processing and postage. Pricing information on the software available from ITU is also available from the ITU Software Data Base through TIES. Inquiries should be addressed to: International Telecommunications Union, Sales Service, Place des Nations, CH-1211 Genève 20 (Switzerland), Telefax: +41 22 730 72 56, Telex: 421 000 uit ch. (Source: *ITU Newsletter*, 3/1994)

### **Software brings DOS up to speed on PowerPC**

The Arizona-based firm Utilities Unlimited International (UUI) claims to have developed 486 emulation software which will run Windows and DOS software on a PowerPC system at speeds comparable with a Pentium-based PC.

If true, the software could give a major boost to Apple Computer and other PowerPC systems manufacturers in their bid to snatch part of the huge market for 486 and Pentium systems.

Current emulation of Intel-compatible PCs on PowerPC systems comes from the UK firm Insignia Solutions but its performance is slow, reducing a PowerPC system to the performance of a 386 system when running DOS-based software.

Insignia says it is developing a 486 emulation system but it will not be ready until late 1994.

UUI says that its software emulation technology emulates the whole 486DX chip, including its memory management unit. The unnamed software is designed to run on Apple PowerMac models. The company says that the high performance of its emulator relies on writing code in assembly language instead of relying on a C compiler.

UUI plans to introduce its emulator in the third quarter for about \$150. If its product succeeds in living up to its promise, it could make Apple and IBM rethink plans to produce PowerPC chips with on-chip 486 emulation to overcome the problem of maintaining high-performance Intel-compatibility. (Source: *Electronics Weekly*, 8 June 1994)

### **Neufuz software**

National Semiconductor, the California-based chip maker, is combining two techniques that a short time ago were considered esoteric and uncommercial to provide accurate control algorithms for its 8-bit microcontroller:

The technologies in question are neural networks and fuzzy logic. Neural networks are circuits that go some way towards mimicking the self-learning facilities of the human brain. Fuzzy logic is now in increasing use in cheap commercial appliances like cookers, microwave ovens and even toasters.

In the future, fuzzy logic algorithms will be used in more complicated applications like antilock braking systems, speech recognition and language processing. The problem, according to Emdad Khan, head of intelligent systems for National's embedded systems division, is that the more complex the problem, the more difficult and time-consuming it is to develop it.

Fuzzy logic, like traditional or "crisp" logic, is based on set theory, but unlike crisp logic, where something is either a complete member of a set or not a member at all, fuzzy logic has variable set membership. That is membership of a fuzzy set varies between 0 for non-membership and 1 for certain membership.

The point about fuzzy logic is that something can be a member of more than one set. The terms like warm, cool, hot and cold are known as membership functions. In a control system, temperature might be just one of the parameters measured. Others like speed, pressure or humidity could also be included, each having their own membership functions.

The output from a fuzzy logic control system is calculated from a series of rules operating on the membership functions.

This discrete output from a list of rules is known as defuzzification. The advantages of fuzzy logic are the increased accuracy of response to changing input stimuli, the ability to describe a system using fairly simple linguistic descriptions and the chance to avoid brain-straining mathematical modelling of a system. Once defuzzified, they also allow inexpensive microcontrollers to take charge of a system at relatively low cost.

In simple systems, membership rules vary linearly between membership and non-membership. In complex systems the membership functions can be non-linear, and the problem becomes the time and effort necessary to design the algorithm.

The result is then that generating rules and membership functions can take a long time: for increasingly complex systems it is difficult to develop correct sets of rules and membership functions and for large sets of rules and membership functions it can be difficult to relate the rules.

National's approach is to use neural network techniques to learn the process iteratively based on given inputs and ideal outputs.

Neufuz software cuts the development time of control algorithms from weeks to a matter of hours, according to Khan. It allows initial conditions to be set up whereupon the program can be left to execute and the neural network algorithms learn the required results.

Neufuz software is a Windows-based program that runs on standard IBM-compatible personal computers. The software available now starts with a relatively simple two-input/one-output system. This allows users to develop a system with two parameters (e.g. heat and pressure) and a maximum of three membership functions.

More powerful Neufuz software allows systems with four inputs and one output to be developed. These can have seven membership functions.

At the moment Neufuz is being restricted strictly to the development software stage. However, Khan foresees specialist neural network hardware supplied with microcontrollers to provide self-learning capabilities on embedded systems in the future. (Source: *Electronics Weekly*, 5 May 1993)

### **CFD and the quiet revolution**

Imagine a tool that can perform reams of complex calculations at the touch of a button and provides a method of designing pollution-stopping, waste-cutting, cost-saving, reaction kinetics-predicting elements into process design. It seems these things are now within reach through the

combination of hard work by researchers and the stunning maturation of the personal computer.

Computational fluid dynamics (CFD) is essentially a modelling process, but instead of being an interpolative method—like the old "human" way of modelling through interpolation of experimental data—CFD avoids cumbersome correlations.

Instead, it breaks down the system under review into many small manageable pieces. These pieces are then dealt with individually under the premise that within these small volumes the engineer can be confident that Newton's laws of motion and the other fundamental equations of life all apply exactly to the parameters—be they mass, temperature or what have you—flowing through each tiny, finite element. CFD solves all these for each element, then sums the result to produce a solution for the whole.

The sheer volume of data being processed has limited the practical use of CFD. In the past the only way of crunching such a large number of numbers was to use a supercomputer, but this took time; the rise of the PC has changed this for ever. Increased computing power at lower costs has put complex data transfer and design concepts on the desk of every designer who wants it, and this has dramatically shifted the circles in which CFD has seen practical applications.

"In the process industries CFD has long been seen as a valuable tool", says Graham Westmacott, the marketing manager for AEA Technology's CFD Service. "In the past a lot of work has gone into the front end development—developing effective meshes (the complex nets of tiny finite elements into which the body is divided), but now the emphasis has shifted towards developments of engineering and physical modelling to make the most of CFD".

In Westmacott's view, the real big area for CFD to conquer now is in multiple-phase flows. After all, particle-laden gas streams, mixed flows of oil and water and bubbly-flowing fluids and sludges are all much more common in the real world than ideal Newtonian fluids.

The other area where AEA sees CFD achieving great results is in incorporating reaction kinetics into the design of process equipment and process streams.

Micro-mixing is the fluid movement and mixing that takes place on a molecular level and which physically allows reacting molecules to contact each other. Usually CFD models turbulence, which is the total combination of mixing from macro—the liquid movements you can see—right down to these micro movements, but by adapting ordinary CFD software with your own engineered CFD codes for micro-mixing potentially CFD could give you great benefits.

By designing reactors and mixing equipment to match the mix rate with the kinetic rate, engineers can design reaction vessels and mixers around the reaction they want to encourage in such a way that there is no waste or by-products.

As well as reaction kinetics being incorporated into CFD, the codes can also be used to focus on process intensification and energy efficiency.

The other practical benefit that any CFD application offers is that of scale-up—design work done in the laboratory can easily be upgraded into detailed design criteria for a full-scale process vessel.

AEA has moved with the times and now offers software to allow design engineers to do CFD analyses in the comfort of the office. But AEA is not alone. American

CFD software pioneers CHAM have been a major force in the UK CFD market since 1991. Initially selling the company's EasyFlow software, CHAM now offers a whole host of CFD software for many applications in a wide range of industries through its perpetually developing Phoenix software.

The latest version of this highly versatile package is Phoenix-2. This product shows the other area of development that has been concentrated on—the user interface. Phoenix-2 incorporates another important feature: it is, claims CHAM, the only CFD code which is self-documenting and self-teaching, so it is adaptable to the user's needs and can be tailored to perform all the functions that AEA sees as the future for CFD. It also makes the most of modern developments such as Windows and idiot-proof, menu-driven, mouse-operated software. The power of the CFD tool is now readily accessible to anyone who wants it, with minimal training and computer skills.

One area of particular interest is in the linking of CFD codes to the other rapidly evolving computer technology that no designer should be without: CAD (Computer-Aided Design) packages.

With the development of data transfer standards such as STEP (Standard for Exchange of Product models), which will allow for transfer of data between non-compatible computer systems without degradation of data quality, the link between such advanced and vital tools as CAD and CFD will, eventually, form such powerful design tools that can draw on such vast data resources that engineering design will be totally optimized.

We are in the midst of a revolution, but one that has been kept very quiet. But the noise will come, in the shape of the money saved by these tools falling into the coffers of every company sensible enough to use them. (Extracted from *Manufacturing Chemist*, June 1994)

### ***Cruising the Internet***

Almost all on-line services provide at least some form of gateway into the Internet, usually by means of E-mail. Some offer more than this. CompuServe, for instance, is now offering full Internet connectivity via *Telnet*. The Personal Computer User Group (PSUG) has been offering Internet access for six years. As a result of an agreement with Computer Witchcraft (supplier of the Windows-based WinNET software), PSUG offers connection at £3.75 per hour with a graphical user interface. The thousands of databases on the system, therefore, are available to anyone with access to a terminal or a PC connected to a modem. There are, however, a number of problems associated with use of the Internet.

Although E-mail is straightforward enough, direct connection is more complex. There are three levels of access, of which E-mail is the lowest. The next step up is to employ anonymous FTP (file transfer protocol) or to log on to remote servers using *Telnet*. The third level is to connect your machine directly via a TCP/IP variant such as SLIP or PPP, which effectively converts the telephone wire into a (slow) network cable. If the local machine runs UNIX, this should present no difficulties, but for other machines there may be problems. Once connection is made there is the problem of identifying what is useful and relevant. Although there is plenty of useful information, there is also a large amount of rubbish.

One of the better programs available for direct access is NetManage's Windows-based *Chameleon NFS 4.0* (£395

or £195 for a more limited version). The Ventana Press *Windows Internet Tour Guide* is a 350-page book which comes with a cut-down version of the same software, *Chameleon Sampler*. (Extracted from *Personal Computer World*, June 1994)

### **Taking advantage of developments in the world information industry**

The world information industry is defined as "those industries in all countries which manufacture or create for the market information services or information products". The role of all kinds of information technology is to act as an infrastructure to support people in using knowledge. There must be a balance between investment in getting information, adding value to it, and delivering it to the market, and the technology to support these activities. Technological innovation is leading to many information goods and services competing against each other, such as printing, publishing and electronic publishing; postal services such as fax, E-mail, EDI; and CD-ROMs and on-line databases. The implications for purchasers are the need to know their business and organizational needs, and skilled multidisciplinary monitoring of market trends. Vendors need to know the purchasers' business, and understand and respect these requirements. Potential purchasers need to consider the implications of Local Area Networks, Wide Area Networks (especially for academic exchange); and problems of subject access and natural language communications.

Pitfalls to avoid are vendor over-selling; products for which accepted standards are not yet established; and incomplete or misleading information from vendors. Successful information vendors will help purchasers achieve strategic objectives; support innovation; and maintain their competitive position. The major issues for the future of the world information industry are concerned with document distribution; on-line databases; and the integration of the on-line data network with the public telephone system through the national packet switching network. (Extracted from *Aslib Proceedings*, 46(2), February 1994)

### **Imaging on networks: up close and in depth**

Only a couple of years ago, the idea of using a local area network (LAN) as the infrastructure for document image management could not be taken seriously. The most important issue was performance: networking technologies simply did not have the bandwidth available to give the kind of performance that would be acceptable for all but the most trivial applications. However, today bandwidth is no longer an issue. Even where there are budgetary constraints, imaging technology and system architectures can make document image systems work on today's LAN standards.

There was also a time when image data was restricted to scanned monochrome images. Today's image data can include multiple monochrome and colour images, as well as textual and layout data, in a single document. Images can also contain file clips, animations, hypertext links and even program code. A document image can range from around one megabyte for simple monochrome data and 20

to 50 megabytes for high-quality colour images, and to several tens of megabytes for complex multimedia documents.

However, the implications of moving large quantities of image data across today's expensive and relatively low-speed wide area network (WAN) links are sobering. Wide area connections are currently very costly and the price of enough bandwidth to effectively integrate multiple, geographically distributed document image systems would probably necessitate a significant payback.

Document imaging on LANs is very much in its infancy. This is not surprising as the demands of imaging stretch LAN and many aspects of dealing with very large data sets is still mainly unexplored territory. The good news is that the major network operating systems vendors are actively planning strategies and have started developing products specifically geared towards document imaging. It could be that in the next 12 months the pieces will come together, and document imaging systems on LANs will become one of the most cost-effective solutions for image storage and retrieval. (Extracted from *Inform*, 8(1), January 1994)

### **Voice training for speech command of keyboard entry**

Only a few audio cards can recognize voice commands and translate them into keyboard equivalents: one such is Microsoft's \$289 Windows Sound System. This resembles a standard 16-bit audio card and software package, and like the ProAudio Spectrum and SoundBlaster cards, enables the user to record and play back sound bites in documents or spreadsheets. What sets the Sound System apart, however, is the Voice Pilot feature.

The software includes a vocabulary recognized by Windows Program Manager and Windows applications such as Aldus Page-Maker, Lotus 123 for Windows, Micrografix Designer and MS Excel. The word list corresponds with the menu structure of the respective applications. If newer versions of the programs introduce new commands, users can modify the vocabulary accordingly. An additional feature is that of a proofreading facility for Lotus 123 and MS Excel spreadsheets.

Before employing the Voice Pilot, users must "train" the system by repeating each command three times into the microphone, as prompted. This represents the most tedious part of the set-up procedure. It is necessary to train the Sound System for each application, since not all share a common vocabulary.

In tests, it was found that main-level commands could be executed more quickly using voice input than by using the keyboard or mouse, although this was less likely to be the case with submenu options. Overall, however, execution was speeded up with voice input. Some problems were encountered with ambient noise, which the system interpreted as commands.

Comparable products include IBM's VoiceType Control, Covox's VoiceBlaster and—at the high end of the market, priced at \$995—Verbex Voice Systems' Listen for Windows. (Extracted from *CD-ROM World*, 9(2), February 1994)

## VI. COUNTRY NEWS

### Germany

#### **German Government starts network programme**

Germany is the latest country to start a government-led programme for the introduction of a national broadband communications network; it has ruled out large amounts of public investment preferring to rely on private investment expected to be promoted by greater competition. Siemens chairman Heinrich von Pierer will head a multimedia task force which will look at the technical issues including setting up a standard PC interface to the network. The Government predicts that telecommunications will account for 5 per cent of the gross domestic product by 2005. (Source: *Electronics Weekly*, 1 June 1994)

#### **Deutsche Telekom Inaugurates TEL cable network**

Deutsche Telekom has announced that the first segment of its Trans Europe Line (TEL)—a vast project to link Frankfurt to the principal East European and Balkan cities by a glass-fibre cable network—went into service on 13 January.

The first section links Frankfurt, Warsaw, Prague, Bratislava and Budapest, then continues on into Slovenia, Croatia and Austria. Some 3,700 km of cable were put into service, and the final network should cover 14,000 km.

TEL is also expected to reach Lithuania, Belarus, the Ukraine, Romania, Bulgaria and Moldavia. Extension of the network to Moscow and Helsinki is under discussion.

Deutsche Telekom floated the idea of a trans-European cable network in 1990. West European telecommunications companies such as France Telecom, British Telecom and Belgacom are not partners in the venture, but are purchasing transmission capabilities to cover their needs.

In addition to the Trans Europe Line, Deutsche Telekom has 30 projects in the works with east European countries to develop their communication systems. It is negotiating with the Russian firm Rosttelecom to construct a digital system in Russia that will link 50 towns via 50,000 km of fibre optic cable. (Source: *AFP Sciences*, 20 January 1994)

#### **Micro- and opto-electronic research centre**

Initiatives by Hessian businessmen and the support of the Wetzlar Chamber of Industry and Commerce about five years ago have led to the founding in Wetzlar-Blankenfeld of a technology centre for micro- and opto-electronics as an independent Institute for Microstructure Technology and Optoelectronics (IMO).

In cooperation with interested enterprises, the IMO develops microelectronic sensor circuits based on magnetostrictive reactions. They are now produced on a small scale. Mechanical engineering companies can use them for precise control of automatic CNC equipment. There they are used to determine position, measure length or measure flows. Another job development involves precision sensor tips for the increasingly important atomic force microscope.

The Institute for Microstructure Technology and Optoelectronics also develops primarily application- and cus-

tomers-specific integrated circuits, which can be developed and produced specifically according to customer requirements as ASICs in thin-layer technology. (Source: *Frankfurter Zeitung*, 7 February 1994).

#### **Federal Ministry funds neural computing project**

Corporate and scientific research teams from the new and original Federal Länder (Atlas Elektronik GmbH, Bremen, OECOTEC, Rostock, BEST Data GmbH, Berlin, the University of Dortmund, the Zittau/Goeritz Technical College, and the Institute of Energetics in Leipzig) have formed the NEUPRO (Neural Systems for Complex Technical Real-Time Process Analysis and Operator Support) project with the ambitious goal of using the most advanced neural computing technologies to develop substantially simpler, safer, improved operating systems for major power supply corporations.

The researchers base their work on the fact that neural networks are capable of constantly extending their pool of knowledge from operating sequences and successful control manoeuvres or troubleshooting measures. Via this learning process, the neural network acquires the ability to react to the occurrence of an identical or similar operating state, about which only incomplete information may be available, with appropriate operating or troubleshooting prompts. The neural network can provide the operator with valuable decision making aids in the event of all process variations of practical relevance. Action can be taken to rectify the process in real time, i.e., in a matter of seconds.

Information from "historical" process sequences will be used to render neural networks capable even of forecasting how future processes will run and of giving the appropriate operating prompts.

High hopes are placed in the NEUPRO project, which the BMFT (Federal Ministry of Research and Technology) is funding to the tune of 5 million German marks over the period from 1993 to 1995. An actual power supply process will first be used to demonstrate that advanced neural computing technologies point the way to mastery of the complex real-time control processes that occur in many areas of the industry.

Further information is available from the BMFT's Information Technology Project Manager, German Aerospace Research Institute (DLR), Rudower Chaussee 5, D-12489 Berlin, tel. (030) 69545746. (Source: *Technologie-Nachrichten*, 12 February 1994)

### Japan

#### **How to get Japanese Information: Japan Documentation Centre holds Inaugural conference**

A conference on technical requirements for accessing Japanese information: problems and solutions was organized at the Library of Congress on 18 March 1994, to mark the opening of the Japan Documentation Centre. Experts presented papers on the challenges and suggested online strategies for accessing Japanese research documents. Topics included assessments of available English and Japanese language databases, information access through the Internet, and troubleshooting hardware and software. It was pointed out that many researchers are unaware of the vital information in Japanese documents. There are discrepancies in US and Japanese computer development since 1980. The Japanese use various types of character

sets that may differ between one vendor or one machine and another. Japan lags far behind the US in its use of the Internet to publicize research information, with the number of Japanese computers connected standing at only 3 per cent of all US connections. (Extracted from *Library of Congress Information Bulletin*, 53(10), 16 March 1994)

## Taiwan Province of China

### *Taiwan to privatize research institute*

Taiwan's Industrial Technology Research Institute (ITRI) is preparing to privatize the Sub-Micron Laboratory set up to develop half-micron processes. Only one bidder for the laboratory has emerged, a consortium led by Taiwan Semiconductor Manufacturing Corporation (TSMC) including the China Development Corporation and three computer companies. (Source: *Electronics Weekly*, 27 July 1994)

## United Kingdom

### *The British Library: Initiatives for Access*

To meet the British Library's strategic objectives for the year 2000 as set out in "For scholarship, research and innovation", there is an extensive programme of work under way under the name *Initiatives for Access*. The purpose of this programme is to gain experience and expertise with projects based on the use of networking and digital material. Some of the more important and heavily used material from the microform collection has been digitized with over 5 gigabytes of data comprising six months of 1,789 newspapers already available in digital form. A demonstration system will be available in the Library's reading rooms by summer. PixTex/EFS is a document management system which has a wide range of standard information retrieval and DIP functionality which also incorporates automatic indexing and retrieval capabilities for fuzzy matching—the ability to search documents according to pattern recognition rather than absolute spelling.

Two experimental workstations have been installed at BL's London and Boston Spa sites. In the former, PixTex/EFS is being used to index some of the eighteenth century newspaper images produced by the digitization project. At Boston Spa, experiments are concerned with remote delivery of the Document Supply Centre's specialist bibliographies to selected customers and enhancing BL publications. The St. Pancras Treasures Digitization Project began in 1994 with the scanning of surrogate colour images—photographic transparencies in varying formats. The first stage of this project aims to identify the best methods of obtaining and managing the digitized images and explore its value as an archival process. In addition, the BL is making its catalogue available on JANET: applying the Z39.50 standard to its catalogues and finding lists; and will be integrating the process of identification, access and document delivery through new gateway services. (Extracted from *Managing Information*, June 1994)

### *Patent information services from the UK Patent Office*

During the last 20 years, rapid progress has been made in the supply of patent documentation, first in various microforms and more currently using optical media. No

more than six years ago it was uncommon to find any scientific or technical literature being produced in CD-ROM format. Today there is hardly a major patent office in the world that is not using this medium to a greater or lesser extent to make patent information more widely available.

The use of CD-ROM as a search aid, complementing on-line investigations, arises most often in technical areas where the investigator may not be entirely familiar with current terminology. It is a convenient and relatively inexpensive way to investigate possible search terms and classification areas using the off-line facilities of CD-ROM. With the additional knowledge gained by this approach, it is possible to create more accurate strategies which can be used to interrogate on-line databases yielding results with a higher level of precision.

This cooperation between on-line and CD-ROM is being actively investigated in the UK Patent Office under a project carrying the acronym ESTEEM (ECLA Search Trial Evaluation using Electronic Media). ESTEEM is a document imaging system for patent examiners who in the first place would produce a hit list of potentially relevant patent numbers from the EDOC database by using ECLA marks as search terms. Using software developed in-house, these patent numbers are selected and used automatically as search terms to interrogate a number of parallel arranged INCOM jukeboxes, each holding 100 CD-ROMs. The front pages corresponding to the hit list may be retrieved, stored and viewed at the examiner's terminal. (Extracted from *World Patent Information*, 16(2), June 1994)

### *Virtual reality project*

Glaxo Research and Development is teaming up with the University of York and the UK computer software company Division in a £600,000 (\$895,000) project to develop interactive protein modelling systems using virtual reality. The project is the latest stage of a £6.35 million UK Government-sponsored LINK protein engineering programme. (Source: *European Chemical News*, 25 March 1994)

### *Recycling turns PCBs into gold*

A recycling scheme could save British electronics companies throwing away millions of pounds a year in unwanted printed circuit boards.

Newbury-based Computer Salvage Specialists has devised a novel scheme, called The PCB Bank, under which companies put their scrap boards in wheelie bins which CSS collects on a regular basis, paying the company an agreed sum.

CSS then separates the precious metals in the semiconductor devices and sells them.

The initiative has grown from a pilot scheme of 50 companies in London and the Home Counties to over 400 companies nationwide. The aim is to widen the scheme later this year. (Source: *Electronics Weekly*, 1 June 1994)

### *UK electronics firms slow to turn green*

The UK electronics industry and the Department of Trade and Industry (DTI) are lagging behind Europe in adopting environmentally friendly manufacturing policies.

This was the conclusion of UK delegates to an international seminar on Environmentally Compatible Electronics, organized by the Swedish Institute of Production Engineering Research and held in Gothenburg, Sweden.



The consequences of failing to keep up with Europe in environmentally friendly manufacturing could have disastrous consequences for UK exporters if the EU makes such methods compulsory for goods sold in the European market.

Many papers covered the need for ecodesign—making products that can be disassembled and re-used or destroyed when their use is ended. (Source: *Electronics Weekly*, 8 June 1994)

## United States of America

### **Newspapers top US poll**

In one of the most extensive surveys of high-tech use in US homes, the majority of respondents said that they would miss newspapers more than their high-tech equipment such as cable TVs or personal computers.

The wide range of findings from the 107 questions distributed to 4,000 US households by the Time Mirror Centre for the People & the Press will be used to determine demand for multimillion dollar interactive TV and on-line services projects being planned by hundreds of US firms.

The survey found that nearly one third of all US households have a personal computer and that teenagers are the heaviest users of computers with 46 per cent having access to a home PC.

However, only about 12 per cent of households have a modem, indicating that few are currently able to gain access to the much discussed "information superhighway". Of those with modems, only one in five say that they log onto on-line services for email or reading news services. (Source: *Electronics Weekly*, 1 June 1994)

### **Industry and Government meet at technology summit**

Officials from the Advanced Research Projects Agency (ARPA) and the National Institute for Standards and Technology (NIST) outlined how the Government plans to advance electronics technology at a "Technology Summit", held late last year. According to a summary prepared by the Berkley Roundtable on the International Economy (BRIE), government representatives said it was important to advance electronics technology for two reasons:

- Competitiveness of the US electronics industry is critical to the nation because it represents the largest manufacturing sector.
- Major competitiveness issues are facing the US electronics industry.

Unique business challenges also face electronics companies, such as short product development windows, rapidly increasing capital equipment costs, shrinking product lifetimes, rapid change along a wide range of technology fronts, and close relationships between Government and the electronics industry in foreign countries.

Government representatives acknowledged that, because of business and competitive constraints, US electronics companies are focusing R&D efforts on product-specific projects. Therefore, basic and high-risk research that does not have obvious short-term returns must be carried out with the help of the Federal Government.

Two trial electronics programmes are under way. First, the Electronics Partnership Project is working with the AEA and the SIA to establish a public-private forum in electronics to gain input on government policy from universities, industry and the national laboratories. Second,

the Federal Electronics Inventory Project is aimed at cataloguing and disseminating the large volume of information about electronics that already exists with the Federal Government, as well as gaining input on the requirements of the users of this information.

NIST's Advanced Technology Programme funds projects in private companies (individually or in groups) on a cost-sharing basis to perform R&D projects. The programme, which is designed to support high-risk R&D that companies would not be able to carry out on their own, uses technical and business criteria to screen ideas submitted by private industry. Projects must have a high potential to contribute to national economic growth, and NIST will be looking for "technical non-linearities", not incremental advances, to identify high growth potential. The funding level for individual projects will range from \$20 million to \$50 million per year.

Finally, both the administration and industry recognized an inherent conflict: the electronics industry is global in nature, but the Government wants to encourage only domestic production. Industry participants argued that US firms need to manufacture outside the United States to remain competitive, and that many participants in Government-sponsored R&D programmes have foreign business partners. (Reprinted with permission from *Semiconductor International Magazine*, March 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

### **Semiconductor Technology Council**

The US Government is in the process of forming a high-level Semiconductor Technology Council, the aim of which is to help implement the SIA technology roadmap. The Department of Defense is putting together a proposed list of council members, to be presented to President Clinton for final approval. (Extracted with permission from *Semiconductor International Magazine*, May 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

## VII. AUTOMATION

### **Electronics In Industry**

Flexibility in responding to fast-changing market conditions is a prerequisite of modern manufacturing conditions. Resources and facilities have to be linked together to develop and make products that will be profitable, and the integrated information system provides that link. Computer Integrated Manufacturing (CIM) answers today's need to integrate business and manufacturing processes, incorporating new data functions, hardware and technologies.

A critical factor in them responding to shorter product life cycles is flexibility in making the greatest variety of customized products in the shortest lead time, which is where CIM comes into play.

The traditional response to these challenges is automation, with the use of computer-aided design and manufacturing processes and instrumentation systems, backed up by business information systems. Increasingly, there is informational interaction between the various levels of a company.

Traditionally the shop-floor operates in real time, with control systems responsible for turning valves on and off,

and a whole host of other mechanical functions, controlled by electronic instrumentation.

Programmable logic controllers using program language that is specific to particular machines form the basic groundwork for modern manufacturing techniques. A large number of suppliers tap into this market; current estimates have between 50 and 100 companies of the calibre of Texas Instruments and General Electric.

But employees at shop-floor level need to feed production information upwards in any company's chain of command. Data collection terminals, a primitive form of PC, and now more frequently bar-coding, allow this information to be moved to supervisory and managerial levels. Time factors govern this electronic process to some extent. At shop-floor level, mechanical decisions are put into practice in a matter of milliseconds, while at supervisory level, the resultant data is recorded on a daily basis. At the top of the company pyramid, the corporate level, the decision time-scale is positively leisurely: mostly monthly.

The use of electronic information systems is finding its greatest current growth at the supervisory level. There is more demand for electronically-based systems that will allow supervisors to have the complete production picture, rather than just part of it. That information has to be passed down the line to shop-floor level. In theory, companies can use PCs linked to a LAN to store and disseminate this data.

While electronics enable shop-floor workers to be given wider access to overall production plans and targets, they should also help the conversion to a paperless factory. But in practice, very few manufacturing organizations have gone paperless. Nevertheless, newer levels of electronic capability are helping to close the gaps.

Increasingly, Manufacturing Executive Systems (MES), a middle-level system in a factory hierarchy, are helping to narrow, if not wipe out the gap between MRP company-level systems and shop-floor level systems.

Distributed Control Systems (DCS), another variant on electronic controls, are seen especially in food and pharmaceutical industries.

Manufacturers who integrate processes and management will stay in the lead, while those who ignore information systems will simply be left behind. (Extracted from: *Technology Ireland*, July/August 1994)

#### **Unmanned Robot for boring dynamite holes**

The construction of large-capacity power transmission lines involves the construction of steel towers in mountainous areas consisting of hard rock, so hole boring work under these harsh conditions limits the use of boring machines and generally depends on manual work. The work of boring dynamite holes for rock blasting, in particular, is done manually or by remote controlled boring machines, and involves hard labour performed in an environment of unbearable noise, vibration, and dust. Therefore, the development of an unmanned performance system was needed.

Maruzen Kogyo Co., Ltd. and Toyko Electric Works Co., Ltd. have jointly developed an unmanned robot operating at night for boring dynamite holes that is designed to expedite the work of constructing the foundations of power transmission line steel towers. This unmanned boring robot will be used in the Tokyo Electric Power Co., Inc. North Tochigi Trunk Power Line Con-

struction Project, and has been under demonstration operation from July 1994.

The new boring robot uses a computer to control the hydraulic pressure unit that operates the boring machine, and boring scraps are blown out by injecting air into the holes with a compressor. Programming the robot in the evening causes it to bore a multiple number of dynamite holes at the prescribed spots unmanned at night. The next morning, dynamite is inserted into the bored holes for detonation to excavate the foundations for steel towers.

Up till now, a full day had been required to bore 1-metre deep foundation holes, so the unmanned boring robot shortens the construction schedule substantially. The robot is capable of boring dynamite holes with a maximum depth of 1.3 metres and diameter of 32 mm within a working range of 2.5-4.0 metres. The companies plan to improve the hole pattern and to incorporate the robot with diversified programs for application to general civil engineering works including the construction of subway systems. Further information is available from Maruzen Kogyo Co., Ltd., Overseas Trade Dept., 155-8 Nagahuse, Mishima City, Shizuoka Pref. 411. Tel: +81-559-77-2140; Fax: +81-559-77-2184. (Source: *JETRO*, May 1994)

#### **World's first autonomous intelligent robot to inspect cables**

Kokusai Denshin Denwa Co., Ltd. has built a prototype underwater robot AQUA EXPLORER 1000 to search for submarine cables, and succeeded in the automatic tracking of submarine cables laid at a water depth of 210 metres without using a control cable. Ultrasonic data links between the robot and a motor vessel operated successfully, and the cables were also photographed with a video camera.

The information from various sensors mounted on the underwater robot are discriminated by a built-in computer to approach and search for the submarine cable, and since no cable from the mother vessel is necessary, cable searching is possible with high mobility. The future plan is to use ultrasonic waves for the transmission of video signals and to conduct experiments to improve the submergence capability to a water depth of 1,000 metres, with the aim of completing a practical system in the near future.

KDD has the large MARCAS 2500 underwater robot for submarine cable maintenance and searching, but a large mother vessel is necessary, which involves huge costs. The AE 1000 model underwater robot specifically for cable searching is capable of moving about freely in the water, and since it is compact and lightweight, a fishing vessel is usable as the mother vessel. That reduces the operational cost notably. Also, compared with existing underwater robots, the manufacturing cost can be decreased considerably. Therefore, it is usable for submarine cable searching and for conducting marine environmental surveys of seabed organisms and natural resources.

In experiments, the robot engaged in automatic submarine cable tracking, discriminated the water depth and direction in real time, and the automatic manoeuvrability and submergence functions were fully confirmed. Further information is available from Kokusai Denshin Denwa Co., Ltd., Overseas Communications Japan, Public Relations Office, 2-3-2 Nishi-shinjuku, Shinjuku-ku, Tokyo 163. Tel: +81-3-3347-6934; Fax: +81-3-3347-6953. (Source: *JETRO*, May 1994)

## VIII. STANDARDIZATION AND LEGISLATION

### Standardization

#### **Data traffic cops to join forces**

With increasing numbers of PCs linked to communications networks, the problems of interoperability is now focusing the minds of network suppliers and users alike.

What happens when information is to be shared between different network architectures, from different vendors?

Suppliers and operators have aligned themselves into three groups each concerned with network interoperability for specific data traffic. Two of the consortia are considering merging in order to develop a common standard which will allow multi-platform, multi-vendor computer networks to work together without creating restrictive proprietary systems.

The two consortia are MCCOI (Multimedia Communications Community of Interest) and CATS (Consortium for Audio-Graphic Teleconferencing Standards).

Currently the members of each consortium are voting on the forthcoming merger and if everything goes well the merger is expected to happen this September.

By the end of 1995 most of the base standards will have been proven and most of the software and hardware manufacturers will have manufactured products that will satisfy the audio and video standards.

The new organization will address private packet networks as well as the public networks. Public networks will need to be sorted out first and then it will focus on the proprietary solutions and how good they are across the networks and platforms.

It will be three to four years before the body focuses on asynchronous transfer mode (ATM). Public telephone operators and private networks have already begun trials of ATM, the broadband communications architecture which will straddle both public and private networks. Today ATM is not fully defined for video-conferencing.

At present the CATS consortium has its priority in the data end of computer networking, for the transfer of both data and graphics.

CATS has based its work on the T.120 series standard only, which covers the real-time data transmission. It is seen as a subset of the MCCOI organization whose standards belong to both T.120 and the broader H.320 series, which includes real-time audio and video data transmission.

The MCCOI consortium consists of 45 companies and was founded in 1993. Its aim is interoperability of video and audio in the real-time transmission arena.

Now there is the possibility of a third consortium joining the merged CATS and MCCOI group.

If MMCF (Multimedia Communications Forum) joins the two consortia and all three organizations end up exchanging working documents then the end-user will also enjoy the benefit of standardizing the API (Application Programming Interface) which will be brought to a de facto status.

The MMCF and MCCOI groups are currently in the process of establishing a memorandum of understanding (MOU) to work together, and hope to reach an agreement this autumn.

If the merger between CATS and MCCOI happens sooner than an MOU will be established between the MMCF and the new body (CATS and MCCOI).

All three organizations are concerned with supporting the interoperability of real-time information, except the MMCF group which alone covers video-on-demand. (Extracted from *Electronics Weekly*, 27 July 1994)

#### **One standard for all will smash barriers**

In what is being billed as the most ambitious standardization project ever, computer, telecommunications and broadcasting organizations are collaborating to produce a set of global standards which enable their products to work together.

The DAVIC (Digital Audio-Visual Council) initiative is being coordinated by key members of the team which ran the MPEG video compression standard program, probably the world's most successful standards initiative to date.

An organizing committee made up of individuals from 40 companies and organizations and 17 countries met in March to discuss the formation of DAVIC.

The purpose is "to promote the success of emerging digital applications and services by the timely availability of internationally agreed specifications of open interfaces and protocols that maximize interoperability".

The idea for DAVIC arose when it was realized that the existing structure of separate standards bodies for each discipline was inadequate to deal with new multi-media technology.

Wherever possible DAVIC will use existing protocols and standards. Where no suitable standard exists, the committee will develop proposals for submission to the suitable standards bodies.

The first target, agreed at a preliminary meeting in New Jersey, is to develop a set of specifications for video-on-demand services. Delivery is scheduled for 1 December 1995. (Extracted from *Electronics Weekly*, 11 May 1994)

#### **When ISO meets VLSI standards, metrology measurements become less uncertain**

Meeting ISO 9000 requirements just became a little bit easier when it comes to metrology and traceability back to national standards. Since 1 February, all metrology standards produced by VLSI Standards (Mountain View, CA), have certificates of calibration that are determined in accordance with ISO's "Guide to the Expression of Uncertainty in Measurement". Adoption of this methodology will enhance the world-wide uniformity and transferability of measurement standards.

Basically, the calibration standards remain the same, but there are differences in reported uncertainties on the company's certificates of calibration. In some cases, these differences are significant. The ISO guide describes a standardized manner for reporting these measurement uncertainties. In January 1993 this document was endorsed by the National Institute of Standards and Technology (NIST, Gaithersburg, MD).

The most apparent change brought about by the adoption of the ISO methodology can be found in Annex C of the ISO document: "The variance of the arithmetic mean or average of the observations, rather than the variance of the individual observations, is the proper measure of the uncertainty of the measurement result".

VLSI Standards helps customers interpret the extensive ISO document and its relevance to their procedures. The company provides customer support in proving the traceability paths of the standards that they provide.

VLSI's customers who bring their calibration wafers back to the company for periodic (most often annual) recertification will be given the new certificates whose specifications are expressed with ISO-compliant measurement uncertainties.

For more information, call VLSI Standards, (800) 228-8574. For copies of the ISO document ISO/TAG/WG 3, call American National Standards Institute, (212) 354-3300. For NIST's Technical Note, call (301)975-4000. (Extracted with permission from *Semiconductor International Magazine*, April 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

### **Easy ISO guidelines**

The Society of Manufacturing Engineers has a new ISO 9000 training programme for electronics manufacturers. It includes a 46 minute video tape and a 220 page handbook outlining a six-phase ISO 9000 implementation plan and a four-tier hierarchical approach for documenting procedures, processes and quality control. (Reprinted with permission from *Semiconductor International Magazine*, April 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

### **Industry readies analog hardware design language**

The electronics industry looks set to have a standard hardware design language (HDL) for analog circuits by the end of this year, thanks to a massive brain storming session early this year.

Engineers from the IEEE, the VHDL community and companies involved in the Analog VHDL Initiative (AVI) met to thrash out technical requirements and organizational structures. They intend to deliver a language specification for the analog extensions to VHDL by August. These extensions will realize a language, called VHDL-A, which is a superset of VHDL 1076-92.

This timetable raises the prospect of the language specification—called the Language Reference Manual (LRM) in IEEE parlance—being finalized at the end of this year if voting on the proposed extensions progresses smoothly.

A crucial objective of the meeting was to establish a wide-ranging consensus between three important groups: the IEEE SCC-30 standards coordinating committee which is developing a general set of requirements of an HDL for analog systems, the engineers involved in the VHDL-A work and AVI experts keen to see a standard developed quickly.

The consensus will prove vital over the coming months as the LRM for 1076.1 is being developed. The 1076.1 group would have been able to use these requirements as a basic set of specifications had a document been available by the end of 1993 as originally planned.

However, the SCC-30 group has recently been revitalized under the leadership of Professor Saleh of the University of Illinois, Urbana-Champaign. It now expects to have the document available during the summer. The requirements will address the needs of an analog HDL in 12 applications areas such as behavioural and mixed signal simulation, synthesis and electromagnetics.

Fortunately many of the engineers involved in the 1076.1 work are closely involved with SCC-30 providing for a crossflow of ideas. The 1076.1 LRM is being defined by a consortium of Analog, MTL Systems and CLSI under a \$700,000 contract awarded by the US Government through its Rome Laboratories. (Source: *Electronics Weekly*, 2 February 1994)

### **Video-on-CD standard**

A group of Japanese consumer electronics firms, led by Sony and Matsushita, are working on a standard for the next generation of video-on-CD technology which enables two hours of sound and video to be recorded on a single five inch disc.

Called Digital Video Disc, the standard is expected to result in hardware on the market by 1996.

Several techniques have been developed for increasing the density of data on a CD, but neither company would specify which were being considered for the new standard. (Source: *Electronics Weekly*, 27 July 1994)

## **Legislation**

### **Patent information on-line and on CD-ROM**

Patents have a reputation for being a difficult information medium, yet they represent a systematic accumulation of practical knowledge covering all branches of science and technology. A substantial proportion of the information which is published in patent specifications does not appear elsewhere in the literature, and for this reason alone it would be very unwise to ignore patents as a source of technical literature.

For subject-matter searching, Derwent's World Patent Index is often the on-line database of choice, since Derwent go to great lengths to provide annotated titles, informative abstracts and detailed classification and indexing. Most importantly, documents are grouped into families, each family consisting of a basic, first to publish patent, usually joined later by one or more equivalents filed in other countries.

In contrast, INPADOC applies little value-added processing to the data which it receives from the 56 contributing patent offices world-wide: names, titles and technical data are simply standardized. However, its strength lies in the accuracy and completeness of the names, dates, and technical data which it covers, and above all in the legal status information which complements the data for 13 major countries. The other on-line patent file worth mentioning is the EDOC file on Questel. This contains the internal search files of the European Patent Office, covering patent specifications from 14 countries and three regional authorities.

However, it is CD-ROMs which dominate patent document and image delivery. The simplest products, such as the EPO's ESPACE-Bulletin and MicroPatent's APS contain bibliographic data comparable with that found in on-line files. However, there are now a dozen or so CD-ROMs with images of patent specifications, either the front page alone, such as ESPACE FIRST, or the full text, as in the case of ESPACE EP-A and PatentView. (Extracted from *On-line and CD Notes*, July/August 1994)

### **Copyright (on the Internet) RIP?**

New technologies currently in development will destroy copyright as we know it. Once it is simple to send articles

anywhere in any form across a network, to one or many colleagues, people will begin doing it. No amount of litigation or intimidation will stop the practice since it facilitates the use of information in a productive way.

Copyrighted or not, once someone has electronic information it can be distributed to anyone on the plant who is connected to the Internet. Encryption methods will not prevent this. With the international nature of the Internet, such information would be available somewhere, stolen and repackaged by an unscrupulous entrepreneur no matter where it initially resided.

Since, in general, 10 per cent of the available information accounts for 90 per cent of the use, many information providers exist on the principle that you have to buy the whole database to get at that useful 10 per cent. This need no longer be so since you might now, from Internet groups have the 10 per cent or even 2 per cent filtered out and redistributed.

When information providers began to gear themselves to packaging their information in ways that added value, to sell information of greater utility to their users, they would be able to generate revenue without relying on copyright enforcement. This will be a healthy restructuring of the industry. (Extracted from *Online and CDROM Review*, 18(3), 1994)

#### **The management of intellectual property (US 1976 Copyright Law, and fileservers)**

Some of the issues arising out of the management and use of intellectual property may be illustrated by reference to three library scenarios. Each of these can then be examined to determine what is permissible under the (US) 1976 Copyright Law.

In the first scenario, a professor sends a graduate student to copy a journal article on her behalf. The questions arise as to whether the library is breaking the law in photocopying the article, or by scanning it and placing the resulting file on a server (in effect creating an electronic document delivery service). In the second scenario, the same staff member wishes twenty of her undergraduate students to read the article. Is it legal for the library to make twenty photocopies on request from each student, or as before, make a digitized version available on a file-server? In the third scenario, the library is asked to place a photocopy on reserve. What is the situation if one student re-copies the photocopy for distribution amongst the twenty? If the article is made available on a fileserver, what is the position if the fileserver and its contents can be accessed by anyone on the Internet?

Under sections 107 and 108 of the 1976 Copyright Law, copying (whether by photocopying or scanning) is legal provided it is done either by or at the behest of an individual: it is systematic copying (i.e. the production of multiple copies) which is illegal. Similarly, the library must transfer the copy to the individual concerned.

Faced with the need to provide copies of material, librarians can invoke the fair use provisions of the law to justify their electronic document delivery activities. In addition, however, they need to explore how the management of university-generated copyrights can be simplified. (Extracted from *Computers in Libraries*, 14(5), May 1994)

#### **The meaning of fair use (Copyright Clearance Center)**

The protection extended to intellectual property by copyright legislation has long been modified by the concept of *fair use*. The (US) 1976 Copyright Law defines fair use as copying for such purposes as "criticism, comment, news reporting, teaching (including multiple copies for classroom use), scholarship or research". Surprisingly, there is no reference to personal copying. It is generally accepted that information placed in the public domain enables other to build upon it. In an emerging electronic information environment, it is much easier to make and distribute copies, but this is not to say that the concept of fair use becomes invalid. Both concepts, copyright and fair use, are important in the development of arts and sciences.

Unfortunately, all types of copying are currently being challenged in the US courts, and users are being encouraged to make use of such facilities as the Copyright Clearance Center's (CCC's) Transactional Reporting Service regardless of whether it is actually necessary to do so. The cost of copyright clearance is high, and is increasing: at the University of Wisconsin, the cost of commercial document delivery service (including copyright clearance charges) has risen by more than 50 per cent in twelve months. Moreover, it has been suggested that the CCC and publishers may be imposing charges for copyrights that have not been assigned to them in writing, and are not therefore owned. Still more disturbing is the consideration that once the right to demand payment is acknowledged, so too is the right to refuse permission to use the work at all.

Librarians need to explain how fair use benefits society generally by permitting limited copying of copyright works and therefore supporting teaching, research and creativity. (Extracted from *Computers in Libraries*, 14(5), May 1994)

#### **Copyright in the electronic era**

Fair use has been most frequently described as the most nebulous concept in copyright law. The electronic era is bringing about four fundamental changes that will affect libraries and publishing in terms of authorship, auditing, ease of copying and responsibility for preservation. Fair use applies to electronically stored works as well as to traditional print publications, and both copyright and fair use will expand as necessary to embrace the electronic era. Factors governing fair use include the purpose and character of use; nature of the copyrighted work; amount and substantiality of the work used; and market effect. Under the current US Copyright Act, there is no real definition but a continuously evolving set of criteria. Section 108 of the Act is reviewed in terms of library conditions for copying covering number of copies, profit motives, and use of the copyright notice.

The electronic environment raises several copyright and legal protection issues including licence agreements for electronic journals in terms of downloading, printing, multiple copying, etc. Librarians need to be aggressive in seeking licence terms so that they can meet users' needs. A disturbing tendency is the attempt by some publishers to expand their rights to what might be regarded as copyright imperialism. It is concluded that it should be remembered that copyright exists to promote learning. Librarians need

to know their rights and the rights of the public that they serve. For years to come there will be a debate about whether copyright provides the best protection for works in the electronic era. (Extracted from *Serials Librarian*, 24(3/4), 1994)

### **Documentics: the electronic management of technical documents**

The purpose of any electronic management system for technical documents and publications is to meet the needs of industry. This it does by providing a means of preserving a company's memory; a source of reliable technical data; up-to-date documentation; and a standardized means of showing or listing technical data to avoid any material problems that may arise.

The elementary building blocks of technical data systems already exist today. Technical document filing and electronic management systems are currently being marketed in France by Bertin, Cell, Creativ' System, Dorotech, ID France, Lascom, Ressources Informatiques, Sete, Seafs, Telmat and others. They offer various functions, including indexing, consulting, annotating, updating, and visualizing multi-format documents, such as digitized drawings and CAD files.

In addition to these basic building blocks, there is a method for developing complete and coherent systems for managing documents, which involves four steps. First, information gathering: a description of objectives, needs and existing data, and an analysis of limitations. Second, analysis: highlighting scenarios in the existing system; a study of functional changes and their organizational impact. Third, a proposed plan of action: setting out the tools to be used, time periods and costs. Lastly, engineering the project. This involves drafting procedures and methods suited to the needs of the customer; integration of the system; training of operators; management facilities; and the setting up of operating teams. (Extracted from *The Electronic Library*, 12(3), June 1994)

### **The copyright law: how it works and new issues in electronic settings**

Copyright, the distribution system, and the role of libraries and publishers are being changed by the electronic environment as libraries move into a more complex networked and multimedia environment and more intellectual property tools are available. Other exclusive rights that arise with networked multimedia cover reproduction, public performance, adaptation and distribution. Meaningful contracts can be created on top of the copyright system which do not exist in the normal, traditional distribution chain. In the electronic environment, the publisher and the librarian perform the same function—providing access to information, and it becomes difficult to distinguish between the specific functions that are performed. The Harvard Information Infrastructure Project examined three specific problems to do with authorship, information publications, and derivative works. As the nature of research has changed, there is more collaboration between authors and institutions, and questions arise about ownership in terms of the individual author and the parent institution. It is suggested that, in such cases, authors' interests should be held jointly by the author and the institution, with joint owners having the ability to assign a non-exclusive licence.

In terms of informal publications in the network environment, questions arise concerning licences, the use

of automated public lists, and notification of ground rules to users. On derivative works, there is a problem if pre-publication work has its copyright assigned to a publisher so that material cannot be modified without the publisher's permission. Other general issues being studied by the Project are university involvement in knowledge management and the role of the university press in the electronic environment. Discussion following the paper covered electronic networking licences; university publishing and new copyright models; indexing and classifying electronic versions; and Aerial software. It is suggested that obsession with the Copyright Act should cease, and librarians should think about the kind of system that the research community wants—this is the strategic question that needs to be addressed. (Extracted from *Serials Librarian*, 24(3/4), 1994)

### **Authorship versus ownership (C-notices)**

A C-notice, usually on the title page verso of a publication, is required by international agreement: namely the Universal Copyright Convention. Although unnecessary for the UK market alone because their copyright is automatic, needing no registration in order to have the protection of copyright law, it is the agreed way of establishing copyright abroad in any countries which may still have non-automatic copyright.

The C-notice also services as a useful form of information. Publishers should find it helpful in establishing the start date of their own fixed-term rights in typographical layout, though it is quite unnecessary for a C-notice to show a publisher as well as a different owner of rights in the content. It should desirably become a permanent practice even if foreign legislative changes make it superfluous for claiming abroad.

Authors should ensure that the publisher offers a contract which makes their position as author or compiler or editor quite clear, especially on copyright ownership and royalty or fee payments, and indicates whether as part-author and editor they plan to employ any contributors to assist the task. A clause in the contract should specify the C-notice. This should normally show the author's name or, if they are writing with others jointly, the names of all authors.

However, the publisher may wish to own copyright in the content of the work, as well as that in the typographical layout. If the author agrees to this, a clause in the contract could show that they are assigning their copyright to the publisher in respect of the content when it appears in the published work concerned: leaving the author then free to use the material for other purposes at a later date. (Extracted from *Managing Information*, 11(6), June 1994)

### **Document delivery (copyright considerations, ILL guidelines)**

This article focuses on document delivery in non-profit libraries, where the institution is taking advantage of the "fair use" provisions of the US 1976 Copyright Revision Act.

Section 108 (d) of the Act allows the library to make a copy at the request of the user, provided certain requirements are satisfied, including the display of a warning notice at the library desk and the addition of a copyright notice to the copy itself. When requests are made by fax or Email, the warning notice should be displayed before the copy is supplied. Copying of a large proportion of a

copyright work is permitted provided the library makes a reasonable effort to determine that the work is not otherwise available at a fair price. The copy must become the property of the user making the request, and only a single copy can be made, so if the request is met by a fax transmission, the photocopy made for input into the fax machine must be destroyed after use. The library may supply electronic copies, but may not retain the scanned image in a database for subsequent re-use without obtaining the consent of the copyright owner. Subject to certain constraints, a library may make reserve copies for student use of works they own, although electronic reserve collections present certain legal difficulties.

Inter-library loan (ILL) is sometimes referred to as document delivery. Interlibrary Loan Guidelines have been negotiated by CONTU (Commission of the New Technological Uses of Copyrighted Works) which do not contravene the "aggregate quantities" prohibition contained in Section 108 of the Act. When a library establishes a true document delivery service on a commercial basis, however, it must negotiate royalty payments with copyright owners. (Extracted from *Computers in Libraries*, 14(5), May 1994)

## IX. RECENT PUBLICATIONS

### **Computer-aided design of catalysts**

From process simulation and accurate quantum chemistry to routine spreadsheet calculations and molecular sketching, the chemist is now surrounded by a diverse and rapidly expanding range of computational, chemically-aware tools. *Computer-aided design of catalysts* is a collection of detailed descriptions of the rationalization of catalytic phenomena and the optimization of catalyst systems using computational techniques. It provides an up-to-date account of the research field and an early glimpse of computational methods which may become standard techniques.

The component chapters span molecular orbital calculations of the extended Hückel variety, applied to the partial oxidation of methane over vanadia by Cardenas-Galindo *et al.*; the development of group additivity methods for evaluating rate parameters leading to insights into cracking catalyst performance by Allen and co-workers; and Klein and co-workers' development of accurate Monte Carlo based simulations of reaction kinetics.

The volume as a whole provides a useful background to the field, with an emphasis on applications rather than computational methodologies. Eds E. R. Becker & C. J. Pereira. New York: Marcel Dekker 1993. Pp1 + 621. \$150.00. ISBN 0 8247 9003 0. (Source: *Chemistry & Industry*, 7 March 1994)

### **Neural networks for chemists: an Introduction**

by J. Zupan and J. Gasteiger. Weinheim: VCH 1993. Ppvii + 305. DM68.00/£28.00 (softcover). ISBN 3 527 28603 9.

This is a well-crafted book with blocks of "learning objectives" at the start of each chapter and a summary with key equations at the end. It begins with the properties of neurons and their connection into one-layered networks and is illustrated by Hopfield networks, adaptive bidirectional associative memory and Kohonen networks. This is followed by multilayer networks, with discussion of

counter-propagation and the ubiquitous back propagation of the errors method.

Nowadays there seems to be no part of our lives that is not touched in some way by computers, but there are still a few areas that stubbornly resist their ingress. For example, if you had analytical data for eight fatty acids in 572 samples of olive oil taken from nine regions in Italy, could you predict the origin of a 573rd sample? A nice diversion for a year of wet Sunday afternoons! In principle it would be possible to devise a set of rules for distinguishing the samples and possibly encoding them using an expert system language (such as Prolog), but it would be extremely tedious.

A more efficient approach is to use the data itself to create a logical machine whose workings are determined by the data. Thus our olive oil discriminating machine has eight inputs (the fatty acids) and nine output values (the regions). The internal connections between the inputs and outputs are the neural network and the interactions between any pair of neurons are controlled by weights which are initially set to random numbers.

The data (known as the training set) propagates through the network to give an output which can be compared with the true answer. The interactions or weights between the neurons are then adjusted to improve, hopefully, the accuracy of prediction. Usually this is done by first modifying the last layer of neurons (that is those closest to the output), then the penultimate layer and so on back to the input layer (back propagation). The overall result is a multivariate equation embedded in the weights between the neurons of network.

The final half of the book gives sample applications which include predicting the reactivity of chemical bonds, the secondary structure of peptides (from the amino acid sequence) and the quantitative structure activity relationship of drugs.

This book is an excellent introduction to neural networks and will benefit the novice and expert alike. We strongly recommend it for library purchase and it will be a useful text for lecture courses. (Source: *Chemistry & Industry*, 7 March 1994)

### **Putting graphics back in books**

As every college student is only too well aware, textbook prices are climbing out of sight. Trade books, too, are feeling the economic pinch, with the result that excellent graphics of various types are routinely omitted from books for economy's sake.

Aware of these trends, and hoping to find a way of countering them, Edward J. Sylvester of the Walter Cronkite School of Journalism and Telecommunication at Arizona State University (ASU) is putting his book, *The Healing Blade: A Tale of Neurosurgery*, on the Internet, whence interested readers may download it at no cost. Published a year ago by Simon & Schuster, the book looks at the human brain through the eyes of neurosurgeons and their patients.

Right now, the prologue, opening chapter, and several graphics files are available, but the real purpose of the exercise, according to Sylvester, is to explore "... how graphics might be made available at little cost for future book buyers ...". He hopes to have a cross-section of interested parties attempt to download, view, and print personal copies of the graphics as he uploads them.



Readers who use Gopher simply need to locate the ASU Gopher within the Arizona gopher. Once there, they would go to Campus Wide Information Services, then to Journalism, then to Healing Blade. The README file gives information on downloading. Alternatively, access may be gained via Anonymous FTP from info.asu.edu/pub/cwis/journalism/healing\_blade.

Sylvester requests that people who have tried to download and read his files report their success (or problems) to him. Contact: Edward Sylvester, School of Journalism, Arizona State University, Box 871305, Tempe, AZ 85287-1305; America on Line, ESylvester; CompuServe, 71552.3620; Internet, Edward.Sylvester@ASU.Edu. (Source: *IEEE Spectrum*, March 1994)

### **Telecommunications services: negotiating structural and technological change**

by B. Bolton, E. M. Davis, Y. Landreau, S. O'Ceallaigh, N. Wada and P. Willman.

Telecommunications services have seen rapid transformation in the 1980s, including deregulation, privatization and far-reaching changes in technology. But how have the changes been managed? What has been the impact on employment? How far have the trade unions been involved? How has the difficult issue of disclosure of information been dealt with?

This highly topical book attempts to answer these questions by examining the evolution of telecommunication services from the standpoint of structural and technological change. Drawing on the experience of over 40 large companies in 22 industrialized countries, a comparative chapter summarizes the main themes and highlights the lessons learned. Six case studies (Australia, France, Ireland, Japan, the United Kingdom and the United States) illustrate the differing ways in which changes were introduced and negotiated, through either participatory debate or an imposed solution—or something between the two. The book, shows that, although the transformation has met with mixed success, the larger operators have been able to both expand services and to maintain employment levels, and that there are fewer transitional problems when the trade unions are fully involved.

*One paperback volume; pp. xi + 143; illustrations, diagrams. 16 x 24 cm. Published by International Labour Office, CH-1211 Genève 22 (Switzerland), 1993. Price: 22.50 Swiss francs. (Source: ITU Newsletter, 1/94)*

### **The Information society: a retrospective view**

by H. S. Dordick and G. Wang.

We are told that the industrial age is declining and the information age is emerging. In this new age our lives will be cleaner, greener, more pleasant, more intellectual, and perhaps even less manic because we will value ideas rather than things. In the cusp of this new era are we better off today than we were yesterday? Why has information, information technology, and the information economy and society become so visible and assumed so much importance in our daily lives? To answer these and other questions, this book examines 19 countries, which are categorized as high-, middle-, and low-income nations by their gross domestic product per capita, to define "informatization" along three primary dimensions: infrastructure, economic, and social.

The authors take a retrospective look at the information explosion of the past 20 years to see where we have been,

what have been the consequences, and where we are now, based on the forecasts and predictions made over the past two decades.

This in-depth study will be of special interest to students and scholars in communication studies, technology/information systems, political science, sociology, and management and organization studies. This volume will also be of value to development planners and decision makers.

*One paperback volume; pp. ix + 168; illustrations, diagrams. 16 x 24 cm. Published by SAGE Publications, Inc., 2455 Teller Road, Newbury Park, CA 91320 (United States), 1993. (Source: ITU Newsletter 1/94)*

## **X. SPECIAL ARTICLE**

### **IT Standardization and the Disparate User**

by Georges Ferné

Standardization in information technologies (IT) to introduce coherence among computer systems could have an enormous impact. A common bedrock of coherent systems, effectively interconnected and allowing communication from computer to computer with ease, is vital for the future of industrial and trade infrastructure. IT users ought to be freed from dependency on a single manufacturer so that they can use heterogeneous systems with hard- and software that will still be compatible even though it is supplied by different firms—IBM, DEC, Apple, and so on. And unless this development comes about, the world data-processing, transfer and access system will remain fragmented and will not allow new industries and services to evolve.

Standardization involves many different parties but also huge costs. For instance, the total cost of developing the Open System Interconnection (OSI) system of standards has been estimated at over \$4 billion over the past fifteen years. In 1984 the start-up budget for one of the bodies concerned (X-Open, a consortium of large firms) totalled some \$90 million.

#### **Manufacturers and users**

IT standardization involves two groups, whose interests occasionally clash. First, there are the computer manufacturers and distributors (hardware and software) and service firms working in product design, manufacturing and marketing. They have tended to follow monopolistic strategies and to divide the market into captive customer groups for specific systems (MS-DOS, Apple, and so on). Then there are the users, who are concerned by standardization only to the extent that it specifies the nature and precise characteristics of the products available, raises expectations of new applications and functions and diversifies their sources of supply.

Users have a tremendous hold over the industry, even though they might not be aware of it. Their choices can spell out life or death for a standard.<sup>1</sup> In IT, standards mostly concern networks, and the capacity of networks to attract customers depends on size. The more users who adopt a standard (VHS versus Betamax, for example), the more the standard will be attractive to other potential users (VHS, say, is favoured because more films will be avail-

able, because it will be easier to exchange and borrow cassettes, and so on).

In the event, IT standardization is hampered by the fact that its products (standards) do not match customer requirements (functions). Inevitably, there is a feeling that if producers and users consulted one another more often, many of these problems could be resolved or, at any rate, mitigated.

But this kind of consultation is especially difficult since IT users form a highly heterogeneous body of distinct groups which often change. They fall into four categories:

- Major user-groups (often multinational),<sup>2</sup> each representing market shares big enough to allow them to negotiate on an equal footing with equipment suppliers or service firms, sometimes even setting their own standards, as General Motors, Boeing, British Airways, Électricité de France, Reuters, and others have done;
- Public administrations, which can sway decisions in their capacity of IT users (some of the choices made by the Defense Department in the United States, for instance);
- Professional or trade associations (agro-food distributors in the United States, for example, who developed bar codes in distribution);
- Individuals using micro-computers, who can only influence standardization through their purchasing decisions.

In spite of these differences, users by and large share a common core of expectations of standardization. First, it should help avoid technological dead ends, where options trap users in a doomed technology. That has happened to people who purchased computers that were then cast aside by software designers (the failure of PS/2 launched by IBM in the late 1980s shows that even the biggest users can suffer this mishap), or who chose video recorders that met Betamax and not VHS standards. Next, standardization should promote universality by making it easy to communicate between all kinds of hardware and software of different sources.

#### Standardization where?

Producer-sellers and users lie either side of the market where standards compete and of an institutional system which in recent years has considerably branched out in IT. Rapid technological progress and increasing integration of IT and communications have spawned many official and non-official bodies, national, regional and international. In Europe, for instance (although similar bodies exist elsewhere), there is the European Workshop for Open Systems (EWOS) or the Open Systems Interconnection/Technical and Office Protocol (OSITOP) on the user side and, on the manufacturer side, the European Computer Manufacturers' Association (ECMA) and the Standards Promotion and Application Group (SPAG).<sup>3</sup> Various firms have joined together to defend specific interests or to move faster than the official channels: internationally, there is the International Standards Organization (ISO), the International Electrotechnical Committee (IEC) and the International Telecommunications Union (ITU); in Europe, there is the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standardization Institute (ETSI).

The many different roles of government in the standardization process muddy the picture even more. By

shaping the "profiles" of the technologies it wishes to acquire, and therefore by having a direct influence on the choices made by equipment manufacturers, the public sector can apply strong pressure over the adoption of standards in such high-tech activities as defence. An example is the European Procurement Handbook for Open Systems (EPHOS), and there are equivalents in other regions.

Public administrations have also become large users of IT in all areas and participate as such in the activities of the various standardization bodies without necessarily coordinating their positions. In many countries, government gives financial support to the standardization system, which therefore usually relies on public subsidies as well as on voluntary contributions by industry. The appropriate balance between the two modes of financing is the subject of much debate in most countries.

The public authorities have also occasionally been tempted to intervene in the standardization of IT by promoting a given standard either in the general interest (for open systems, for instance) or for the purpose of championing a national standard. This move has not always been successful. Moreover, the "perfectionism" of official systems clashes with the uncontrolled spontaneous changes occurring in the field in response to user demand. The official setting of X400 electronic mail standards is hampered in practice by the uncontrolled but extraordinarily rapid world-wide growth of the Internet network which diversifies to suit individual users.

The *ad hoc* combinations that come and go as all these public and private interests fluctuate make it more difficult to monitor standardization in IT so as to prevent overlapping and duplication of activities by the various bodies and introduce minimum coordination, to the dismay of all concerned. Producers complain about the huge costs and questionable efficiency of participating in these various bodies: in the case of a multinational, several hundred experts may be involved. Secretarial services and the chairmanship of many working parties have to be provided, participation fees must be paid to every consortium which aims at producing a family of standards, such as UNIX, which covers at least seven diverging variants. And users complain because they are acutely aware of the slow and inadequate progress of institutions which do not adequately meet their expectations for compatibility between different types of equipment, and because when they participate more directly in the discussions, they have to contend with institutional opacity, not to mention the considerable expenses entailed.

#### Ways of participating

Some users, of course, are highly organized and already participate in IT standardization, sometimes with considerable impact. Most of these users are so big that they can set their own standards and impose their requirements on producers to ensure the development of systems meeting general requirements while remaining specific. An example is the setting of standards for the exchange of data on financial transactions by banking groups or systems for booking tickets by air carriers.

Large firms are increasingly coming together in semi-official associations or working parties—EWOS, SPAG, OSITOP or X-OPEN. Their objective is to draw up unofficial standards quickly on a consensual basis which the parties concerned can introduce without waiting for the

approval of official institutions through cumbersome and protracted procedures.

The rapid evolution of IT favours this type of approach, especially to encourage the setting of application standards for open systems aimed at facilitating exchanges between different configurations—at considerable cost. The goal is to establish a system of standards for interfaces between computer systems and therefore applying both to equipment and to operating systems, and to communication protocols as well as to data access modes. The framework thus defined should therefore act as a reference for identifying more limited applications in response to actual requirements in the field.

The problem is that in a period of rapid technological growth, this kind of general framework is bound to be approximative and therefore leaves so much room for manoeuvre that the applications covered by the framework are not necessarily compatible with one another. Throughout the world there are many groups trying to raise the degree of compatibility between computers operating under UNIX or to develop the basis for computer-assisted transactions systems such as Electronic Data Interchange (EDI). But the final outcome of this work often generates new barriers to communication among families of standards that are supposed to be close to one another.

In the hope of overcoming these barriers, groups that are more specialized than ever before are being created without others ever being phased out, so that the overall standardization system is becoming more and more complex, opaque and poorly coordinated, resulting in an "institutional jungle".

Small users could indeed join forces, in the same way as large users do, so as to spread the costs of attending the many meetings of the legions of national and international bodies involved—in, say, the setting of EDI standards in transport or real estate, which are tending to acquire new network structures. But many users decide not to join in the knowledge that the benefits of any standardization will eventually be freely available to all.

Official institutions—in Europe, say, CEN-CENELEC (the European Standardisation Committee—European Electrotechnical Standardisation Committee) for information technologies or ETSI for telecommunications, or globally, the ISO, IEC and ITU—are full of good intentions and are prepared to accept the representatives of smaller users. But assuming they are willing to come forward, small users realize that the actual decisions are taken elsewhere and, here again, they have to face the costs.

Participation becomes difficult or not depending on the types of standard concerned:

- National or international—a small or medium-sized enterprise might sacrifice resources to take part in the proceedings of a national technical group working on a standard liable to bring specific benefits but will hesitate to become involved in regional or world-wide proceedings

Product or functional standards (for example, those governing teletex, videotex, mobile telephones, modems, and so on): here again, the more the potential benefits are limited to a specific product, the more direct participation of specific, well-identified users might be expected

- *Ex post, ex ante* or anticipatory standards—it can be easier to obtain a consensus for setting a standard for a product undergoing development as opposed to one that is already marketed; this is the path increasingly followed by standardization bodies (the GSM

standard on the new generation of mobile telephones has been drawn up in this way). The problem is that a product that is not yet in existence does not have any clearly identified users.

#### The impact of globalization

The current economic globalization process is making all users, whether large or small, more aware of what is at stake: small firms now feel involved in world markets. Although current standardization mechanisms generate multiple and complex fragmentation, as with EDI standards, advancing globalization means that these problems have to be overcome.

IT producers are not going to introduce a high degree of coherence and compatibility unprompted, since that would stimulate competition and they wish to retain their market shares under the protection of their own technologies. Only pressure from users can make them do so.

In 1991, the first signs appeared: a group of large firms that use IT (initially composed of American Airlines, Boeing, DuPont de Nemours, General Motors, Kodak, McDonnell Douglass and Merck) drew up a "menu" of requests, providing a kind of framework for future standardization work, for the intention of the IT industry.

More recently, a group of industrial experts on IT standardization has been set up by the OECD Committee for Information, Computer and Communications Policy to draw up a report on the mechanisms, procedures and products of standardization. Although very large multinational firms are being more overtly active at this stage, the movement is bound to spread, especially through the relations between these firms and their suppliers.

The public authorities are also trying to fill the present gaps in order to define and introduce measures stimulating and facilitating the participation of a wider range of users. Government intervention in standardization might take shape at different stages, from informing a wide range of users about the benefits of competitiveness to more active participation of government bodies in activities where collective interests are at stake, by way of efforts to improve the conditions of equal access to strategic information, transparency of procedures and the institutional economics.

There is no doubt that new technologies—today information technology, tomorrow materials and biotechnology—require new approaches to keep costs under control and avoid wasted technical progress. From their own viewpoints, users can bring a new dimension to standardization, closer to the concerns of competitiveness and efficiency prevailing throughout the fabric of industry.

(Georges Ferné is a specialist in information technology in the Science, Technology and Communications Policy Division of the OECD Directorate for Science, Technology and Industry. This article first appeared in *The OECD Observer*, No. 189, August/September 1994)

#### Notes

1. *Information Technology Standards: The Economic Dimension*, OECD Publications, Paris, 1991.
2. Computer equipment or service distributors that also happen to be users are not included here, since this category concerns buyers of IT products only.
3. Georges Ferné, *The Economic Stakes in Computer Standardization*, *The OECD Observer*, No. 164, June/July 1990.

### **Universality versus specificity**

Although in favour of standardization, and on good grounds, each group of users—if not each user—wishes to have access to technical systems as closely tailored to its own requirements as possible: the search for universality thus counteracts that for specificity. This is a vital point as it illustrates the frequent clash of interests between users and sellers. Sellers obviously prefer "captive" users (who have no other option than the hardware and software offered to them) to secure their market share or market lead. On the other hand, users have everything to gain from an open environment enabling them to turn to any supplier they wish for each component of their computer systems—and therefore derive full benefit of competitive advantages, which implies that each product should comply with a system of compatible standards.

Standardization is therefore the source of countless clashes between numerous organizations, with varying ambitions imposing the use of the standards they control, breaking into a monopoly to acquire a foothold, or escaping these constraints to obtain "customized" standards compatible with as many other standards as possible. These conflicts and contradictions are bound to flare up sooner or later. For instance, a dispute with considerable implications arose at the European Telecommunications Standardization Institute (ETSI) on the subject of intellectual property rights. A standard may include technological components

that are owned by a firm. Should the firm then be free to choose the size of the fees to be paid for the use of such a standard—say, the GSM mobile telephone standard, which (at least) can cover the whole of continental Europe—or should this right be limited?

Other obstacles may arise wherever users in various sectors decide to develop their own systems while official procedures are being laboriously followed to develop more general standards. Once users' own standards have been introduced, their diffusion is hampered in practice by the existence of many incompatible variants. Such is the case in Electronic Data Interchange (EDI), where the general standard, EDIFACT, now has rivals in the form of "customized" standards in road and air transport and various industrial and trade sectors.

Finally, users may be the victims of their own choices or of the mistakes made by manufacturers. When Wang missed the turn taken by office automation, many users found they had no other option than to convert to radically new systems at considerable cost.

The price to pay can be very high both for users and for suppliers when protracted and expensive standardization work is brought to a halt by such obstacles. Hence the idea of trying to achieve, in the early stages of standardization, consensual solutions through user participation, so that the use of new products can spread more easily. (Source: *The OECD Observer*, No. 189, August/September 1994)