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3 and 4/1998

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EMERGING TECHNOLOGY SERIES

INFORMATION TECHNOLOGY
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TO OUR READERS

Of special interest in this issue of *Emerging Technology Series: Information Technology* is the focus on a meeting that took place from 2nd to 4th November 1998, in Bangalore, India. The occasion was a meeting on "Information Technology in the Global Village". It concentrated on assessing the potential of information technology (IT) in the global village to improve the quality of life of human beings everywhere in the world and, in particular, those in developing countries. During the seminar, several dimensions of the impact of IT on developing countries and its potential in uplifting the quality of life for the weakest sections of society were explored by speakers from diverse disciplines: ranging from the analysis of the effect of English being the dominant language in the IT world to the potential advances in IT in the next century.

The final outcome of the meeting was the "Bangalore Declaration on Information Technology for Developing Countries in the Global Village", which recognizes the potential for IT as an historic window of opportunity for developing countries to create national wealth and break the cycle of poverty and dependence they have been caught in. It carefully warns, however, of the dangers of unbridled use of IT that could rapidly lead to further widening of the disparities between the haves and have-nots everywhere.

Two important papers presented at the conference are reproduced here. The first one by Vinay L. Deshpande, Chairman and CEO, Ncore Technology Pvt. Ltd., and Chairman, Processor Systems (India) Pvt. Ltd., discusses trends in information technology and their implications for developing countries. The second paper looks at the Global Village and led to the first draft of the Declaration. Its authors are Vijay Chandru, who is Professor of Computer Science and Automation, and Swami Manohar, who is associate Professor of Computer Science and Automation, both at the Indian Institute of Science, Bangalore.

The full text of the Bangalore Declaration is also included. The participants at the meeting urge that the Declaration be publicized as widely as possible. Please note that all the presentations made during the seminar have been made available on the website http://www.csa.iisc.ernet.in/bangit/.

Paul H. Makin
Scientific Editor

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A. SPECIAL ARTICLES

Expand your communications capacity—an overview of the major mobile telecommunications options

By Bruce Conradie; Satellite coverage—Mike Jensen

The benefits of mobile communications technologies are so significant, they deserve attention in their own right. Each technology warrants consideration for your company's technology armoury. Each of them either boosts productivity or makes possible the formerly impossible. Here is an overview of the major mobile options.

Cellular telephones

For those of you who have network coverage in your area, cellular will form the core of your mobile communications armoury.

If you are undecided about whether to issue your staff members with cellphones, try and broaden your thinking. Cellular telephony offers much more than just a quick way of phoning ahead to say you will be late for an appointment. Yes, cellular telephony is expensive, but the total package could be well worthwhile. GSM cellular offers a host of value-added services (GSM is a type of digital cellular network and is the technology used by most networks in Africa).

Core services that should be supported by your network include voice mail, call forwarding, and call waiting (alerting you to an incoming call while you are on another call). Short message service (SMS) is a technology that offers the equivalent of paging, but over the cellular can be useful for reaching cellphone carriers who are out of range or have their handsets turned off (especially if they do not have voice mail, it comes into its own, however, when group messaging is set up. Software that runs on a normal PC or on a network is available that allows a single message to be broadcast to groups of cellular subscribers. The cost of these messages depends on how you link up to the network's SMS server and on how the network charges for SMS, but it can be as cheap as e-mail.

Remember also that cellphone handsets boast their own features. An electronic phone book and automatic redial buttons are among the most common, but you will find many other features in today's mid- to high-end handsets: clocks, calculators, and electronic notepads, to name a few.

If value-added services and specific features are important to you, take care with your choice of network and of handset. Some features are provided by the network, for example, voice mail. Some, such as the phone book, are built into the handset. Some must be supported by both network and handset. An example of this is SMS. It is a network service. Nevertheless, the handset must support it. All GSM handsets on the market today support SMS receiving, that is they can receive and display SMS messages. However, only some handsets can send an SMS message (called SMS originating).

Another network-dependent service that is probably grossly underutilized is fax mail. In South Africa, both cellular networks (MTN and Vodacom) offer fax mail as part of an optional package of value-added services. Fax mail is the fax equivalent of voice mail. Sign up for the package and you are allocated a fax mail number, distinct from your normal cellphone number. People who want to send you a fax can use that number. Faxes are stored electronically in a mailbox. To retrieve faxes you dial up your mailbox, go through the voice prompts, and command the system to deliver the fax to the conventional fax machine of your choice.

So, what is the use of that? First, you have a fax machine that is never off-line and never runs out of paper. Second, you can receive faxes anywhere: at a client's premises; at a site office; at home. With a notebook you can take this to its ultimate and receive faxes via cellular directly onto your notebook (no fixed-line fax machine required). Third, fax mail requires no additional hardware, software, or technical skill.

Look out for the October '98 issue of *Business Computing* which features a comprehensive review of GSM handsets.

Personal digital assistants

Personal digital assistants (PDAs) may have an unfortunate name but at least it is unique (unlike the confusing term notebook). PDAs are small portable electronic devices that offer features such as a diary, calendar, and notepad. Most of them are hybrids, consisting of a computer plus cellphone. Data is inputted either with a micro-sized keyboard or with a stylus and touch-screen. The first PDA was the Apple Newton, now discontinued. Other

high-profile models are the Nokia 9000i and the 3Com PalmPilot.

PDAs are brilliant in concept. They marry computing and communications power. The result is an office squeezed into a package not much bigger than a paperback book. In practice, however, their usefulness is limited by physical and technical constraints. Data input is a problem. Manufacturers have opted either for a minuscule keyboard (forget touch-typing) or for a touch screen with handwriting or character recognition software.

Are PDAs the answer for you or for your company? They could meet specific or peculiar sets of needs. Consider them for mobile applications for which the critical buying factors are:

- Size (you can, practically, carry them everywhere)
- Weight (some are light enough for a jacket pocket)
- Ease of use (far easier than a notebook)
- Price (far cheaper than a notebook).

Notebook + cellular link

With a notebook computer you can take your office with you and work almost anywhere. Despite the huge gains in productivity that can be made from a standalone notebook, linking it to a cellular network notches productivity up to yet another level. Send last-minute e-mails from the waiting lounge of the airport before a flight. Fax an order from a client's premises. Fax an urgent quote to a client, from a parking lot. No need to be out of touch while attending that conference; just download your e-mails onto your notebook. You could even do it during a presentation and none of your fellow delegates will be any the wiser.

The traditional set up for doing this has been a notebook, a cellphone handset, and a PC card. PC cards used to be called PCMCIA cards (and still are, although the term is rapidly losing ground). The PC card fits into a port in the notebook and is in turn linked by a cable to the cellphone handset. It forms the interface between a notebook and either a cellphone, fixed-line telephone network, ISDN, or local area network (LAN).

Some products offer more than one type of connection, an example of which is Psion Dacom's Gold Card NetGlobal range. This is modular range with the potential to have 56kB modem, GSM, fax, ISDN, and Ethernet connectivity all on one card. Prices start at £200 for a 56 kB land-line connection, with optional connections going for around £100 each. According to press information, the Gold Card products include software that allows the user to specify which country they are in.

The software will then reconfigure the card for that country's land-line telephone system. CIA has not road-tested the Gold Card products but they sound like a good choice for frequent international travellers. Before you scoff at ISDN connectivity because your company does not have it, realize it may be available at overseas destinations.

In the case of cellular PC cards, be aware that these devices are proprietary, that is, you must have an Ericsson PC card for an Ericsson handset; Nokia card for Nokia handset, and so on.

Products have been appearing the last few months that do away with the PC card. In June, for example, Ericsson launched its SH888 handset, a high-end dual-band GSM handset. The SH888 has a built-in PC card and an infrared port. We road-tested the infrared capability using an IBM ThinkPad 770E, a heavy-duty notebook priced in the $6,000s with a feature set that puts most desktop systems to shame. The 770E boasts a high-resolution 14.1-inch screen, a 5 GB hard drive, and CD-ROM and diskette drives. A DVD drive is an option. The 770E is suitable as a desktop replacement

unit. Its large monitor and multimedia capabilities make it a good choice for the user who makes presentations.

Setting up the SH888 to work with a notebook is within the capabilities of a moderately skilled PC user. Coming standard with the SH888 is a CD-ROM with drivers (software programs that cause hardware to function) for the "modem" (technically it is not a modem, but it performs a similar function and we will use this inaccurate term here for the sake of clarity). Also on the disk are some comms utilities and well-written and comprehensive documentation.

Our experience showed that setting up the SH888 to act as a "modem" under Windows 95 was much like setting up a conventional modem, so much so that we experienced the obligatory technical hitch. After tweaking settings and a phone call to IBM for technical support, this was sorted out. In conclusion, setting up was no more difficult than for a conventional modem.

Once it is set up, connecting the ThinkPad to the cellular network involves simply activating the IR port on the SH888 (four keystrokes required) and placing the handset opposite an infrared port on the ThinkPad (you have two to choose from). From that point on, the SH888 behaves the same as any other modem under Windows 95. You can, for example, fax a document directly from a Win 95 program. You can also connect to your Internet service provider (ISP) in the same way you do with a land-line modem (although you are limited to a connection speed of 9,600 bps). Having no cables to connect up and not so much as a PC card to be inserted, was a real pleasure. Frequent travellers take note.

Another of the new technologies is still a PC card, but one that has a cellular data link built in. One of these devices in your PC card port is all you need to connect to the cellular network (no cellphone handset or cable needed). These devices save you the bother of tethering your notebook to your cellphone. However, to make cellular voice calls you will still need a separate handset.

The Nokia Card Phone does away with even this requirement because it makes it possible to make voice calls as well (it is a full cellular phone and PC card in one unit). You are unlikely to use the Card Phone on its own, however. The average user will still carry a separate handset for voice calls.

"An even bigger market", says Gavin Penkin, technical manager for Nokia in South Africa, "are vertical markets". Penkin cites as examples weather stations, traffic light control systems, and industrial applications. The sense of this becomes clear when you look at the numbers. First, using both the Card Phone and a separate cellphone handset would require two SIM cards and that means two cellular phone accounts. Second, the Card Phone is around $550. This is more than double the price of a conventional Nokia PC card which sells for around $260 (although a conventional PC card still needs a cellphone handset).

You may wish to opt for a palmtop rather than notebook computer. No fixed definitions exist, but a palmtop is essentially an even smaller notebook (one product manager from Hewlett-Packard classifies palmtops as a subcategory of PDAs).

Most palmtops use the Windows CE operating system. Examples include the HP 620LX, a sub-$1,000 model with a colour monitor and 16MB of RAM and the HP 360LX ($720). Others, such as the 3Com PalmPilots or the Nokia 9000, use proprietary operating systems.

Their place in the world is to provide full PC functionality out in the field. You would not, however, use them for data capture. You would create the annual budget on your desktop's spreadsheet and then download a copy to your palmtop to be used for reference out in the field. Yes,

you can make modifications and synchronize your files when you get back to your desk.

Another prime use for palmtops, according to HP, is for presentations. Make up a sales presentation in PowerPoint, download it to a palmtop, take it to the client, connect the palmtop to a projector or PC monitor, and present to the client.

Paging

Do not make the common mistake of getting so caught up in the wave of enthusiasm for cellphones that you regulate paging to the rubbish heap. Paging is not outdated technology. Used in the right applications, it offers an efficient and highly cost-effective means of communication. Before issuing your staff members with cellphones, consider carefully the benefits of paging.

Paging offers a number of advantages over cellular telephony. First, it is more reliable than cellular. Call a cellphone user and they may be on a call, out of range of the network coverage, or have their cellphone switched off. Send a message to a pager and it is almost certain the pager will receive the message.

Second, paging is cheaper. Third, paging is not open to abuse by staff members (unlike cellular, in which staff can easily run up horrendous phone bills). Fourth, pagers are about half the size of cellphones. It is possible to carry one on a belt and to be scarcely aware of it. Despite the drive to miniaturization cellphones are not quite there yet. Fifth, pagers are light on battery power. There is no need to recharge batteries and, more important, far less chance of being caught out in the field with a flat battery.

Some paging companies also offer broadcasting facilities, that is, you can send a message to multiple pagers.

Satellite telephones

Communications costs in remote areas are set to drop dramatically with the launch of a new satellite telephone system.

These systems offer the user the ultimate in mobile telephony. While cellular telephony gives great freedom of movement, coverage is still confined to urban centres and main roads. The new satellite network will have 100 per cent coverage of Africa. So you can be repairing a road in the middle of the Namib Desert, trucking through the Sahara, or climbing Kilimanjaro, and still keep in touch with head office via telephone.

To date Inmarsat has been the only player in the African portable satellite phone market, known as global mobile personal communications systems (GMPCS). Although its technology has steadily improved, the mobile handsets are expensive and bulky and call costs steep (around US$3 a minute). Now new entrant Iridium, a Motorola subsidiary, is set to open up the market. On 23 September 1998, at 9 a.m. EST, Iridium's network of 66 low Earth orbit (LEO) satellites will begin commercial operations.

Call costs will be as low as $1.60 a minute. Handsets will be almost indistinguishable from cellphones and will cost around $2,000. At the top end dual-mode models costing about $3,000 will be able to connect to both GMPCS and conventional cellular networks. These units will switch over to Iridium when the cellular network is unavailable.

How do these costs compare with those of Inmarsat? The handsets are not much cheaper than the new Inmarsat-M terminals (priced at around $3,500) and Inmarsat's call costs do go down to $2.40 a minute if more than 200 minutes a month are used. However Iridium breaks the psychologically

important $2 a minute barrier. This, combined with the greater portability of the handsets, is expected to expand the market.

The market will, of course, be made up largely of business travellers, wealthy tourists and international relief agencies, but some use by lower income rural populations is expected. Governments may provide isolated villages and remote public works projects with phones for use in emergencies. Iridium also has a social responsibility programme called NOMAD, which aims to provide free phones and free call time to governments and agencies involved in relief work and crisis management.

Iridium is working intensively with the public telecom operators in Africa to finalize tariffs and interconnection agreements. Calls made to destinations within a country may be cheaper than "international" calls, which may justify their use to a wider segment of the local business community. The issue is complex because only 12 satellite earthstation gateways are required to link the satellites back to the terrestrial network, so not every country will have its own local link. Someone in Mozambique making a call from an Iridium phone to the fixed-line network in the same country will have to cover the costs of bringing the call from the gateway to Mozambique.

Data comms available

The Iridium system does provide for data traffic, but at a maximum of 2,400 bps. This will be useful for e-mail and short file transfers, but browsing the Web at this speed will be painful and costly. Inmarsat can provide higher bandwidths (up to 64Kbps), but these will need more costly and bulky units, with corresponding increases in airtime costs. This situation is only expected to improve when the third generation satellite systems, such as Teledesic, go on air early in the new millennium.

Iridium and Inmarsat will not have the market to themselves for long, as a number of other companies are planning to launch services. Over 20 satellite projects are being planned for launch in the next 24 months, by which time bandwidth prices are expected to plummet, becoming a buyers market. It is unlikely that all of the projects will get to operational level and some may merge. However, Globalstar and ICO (Inmarsat's answer to Iridium) are well on their way and expected to launch in mid-1999.

Iridium is depending on the next 12 months to consolidate its position as the first of the low cost providers. While it may have to reduce its tariffs to match its competitors, no interoperability or standards for GMPCS telephones exist and so the company is hoping the $2,000-$3,000 investment in the phone will be a disincentive to switch providers.

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ICO—the vital stats	
SATELLITES	
Type	Medium Earth orbit (MEO)
Number	10 operational; 2 in-orbit spares
Orbiting altitude	10,400 km
Capacity	4,500 simultaneous calls
Coverage	Global
Bands	S-band and C-band
Name of network	ICONET
Space-to-earth interface	12 satellite access nodes (SAN)
Total cost	US$ 4.2 billion
Phone handsets	Dual-mode (cellular/satellite)
Commercial launch	Year 2000
Company	ICO Global Communications
Shareholders	Over 50% from developing countries; 11 from Africa
Web site	www.ico.com

Globalstar—the vital stats	
SATELLITES	
Type	Low Earth orbit
First launched	February 1998
Commercial launch	First half 1999
Developer	Loral Space & Communications and Qualcomm Inc. (USA)
Strategic partners (among others)	AirTouch Communications; Decom/Hyundai; France Telecom/Alcatel; Daimler-Benz; Vodafone

Iridium—the vital stats	
SATELLITES	
Type	Low Earth orbit
Number	66
Weight	700 kg
Orbiting altitude	780 km
Orbital period	100 minutes
First launched	May 1997
Lifetime	5-8 years
FREQUENCY BANDS	
Telephone and messaging service links	1,616-1,626.5 MHZ, L-Band
Intersatellite links	23.18-23.38 GHz, Ka-band
Ground segment, Downlinks	19.4-19.6 GHz, Ka-band
Ground segment, Uplinks	29.1-29.3 GHz, Ka-band
Services offered	Voice, Data, Fax, paging
Transmission rate	2400 bps
Commercial launch date	23 September 1998
Handset cost (estimated)	$2,000-3,000
Developer	Motorola, USA

(Reprinted from *CIA*, August 1998)

Trends in information technology and implications for developing economies

Bangalore Global Village Symposium

Over the last 50 years the information technology industry has grown from a few million dollars a year to a trillion dollar global business. During the same period this industry has created over 20 million new jobs that did not exist 50 years ago. Since the 1950s, many advances have occurred in this field that are, to paraphrase Arthur Clarke, "indistinguishable from magic", We have gone from mainframes to minis to PCS to laptops. We have gone from batch computers using punch cards to mini-computers using video terminals to interactive multimedia personal computers capable of seeing and hearing. Average power consumption for a computer has gone from 10 kilowatts to 10 watts. The cost of ownership has gone from millions of dollars to thousands of dollars. We have gone from large computer centres to desktop computers to computers on the body.

Over the next four years the computing power of entry level PCS is expected to go from 500 million operations to 2 billion operations per second, memory from 100 megabytes to 500 megabytes, and a dramatic drop in cost. Thus, within the next two years, we can reasonably expect that a GigaPC capable of billion operations per second with a billion bits of memory, and billion bit network bandwidth to be available for under $1,400. We should expect a 10 GigaPC by 2005 and barring the creation of a cartel, or some yet unforeseen technological barrier, we should see a TeraPC before 2015 and a PetaPC before 2030. What will the next 50 years bring? It appears that the exponential rate of change will continue for many years to come. Therefore, it is reasonable to assume that the next 50 years will be even more dramatic than the last hundred years. When you recall a hundred years ago, there were no cars and no highways, no electric utilities, no phone system, no radio or television, no airplanes, you can well imagine the magnitude of the change that awaits us.

There are three factors that are propelling this exponential growth. The size of the features on a chip have gone from 10 microns to 250 nanometres over the last 25 years and the fundamental limits of material science and physics are not expected to be reached for another 15 years. The size of the chips have gone from ½ cm square to 2 cm square. We are expected to reach larger die sizes of 10 cm square and beyond over the next 20 years. As a result, the number of components per chip are expected to exceed 100 billion by year 2020.

The question is what will we do with all this power? How will it affect the way we live and work? Many things will hardly change. Our social systems, the food we eat, the clothes we wear and our mating rituals will hardly be affected. Others,. such as the way we learn, the way we work and interact with each other, and the quality and delivery of health care should undergo profound changes.

Over the next 40 years, we can expect:

*   Computers that talk
    -   Televisions that hear and phones that show you pictures
    -   Costing a few hundred dollars
*   Pervasive invisible computers and intelligent agents
    -   Accessible to anyone anytime anywhere
    -   Permitting instantaneous access to movies, music and books
*   Embedded computers in appliances
    -   Consumable computers costing pennies
    -   Requiring milliwatts of power.

It is sometimes said that the last thing developing economies need is the most advanced technology created by the human race. I beg to disagree. I submit that the have-nots need the benefits of information technology more. Let us explore some ways information technology might have a dramatic impact on the poor, the sick and the illiterate and how this technology will be used to save lives, provide education and entertainment on a personalized basis, provide universal access to information, and improve the quality of life.

Universities without walls and lifelong learning

The three pillars of education are lectures, laboratories and libraries. Each can be transformed through innovative use of information technology. Face to face lectures can be replaced in some cases by distance learning tools such as transmitting live video of lectures using multimedia computers and digital transmission using high bandwidth data networks. Student/teacher interactions are facilitated through Internet chat rooms. These chat rooms will soon provide voice and video capabilities rather than just text. Thus, every district in a region can have a micro-university branch of the national university, for example, permitting local students to attend and participate in classroom activities on the main campus.

Virtual laboratories can be created through the use of computer simulation. This can be a low-cost equivalent for those who do not have the space, people or materials needed to maintain a real laboratory. Thus, many degrees that could not be offered within the Open University paper-based structure can now be offered through the computer networking medium, using simulated laboratories.

To fully realize the benefits of universities without walls, we need to create a high bandwidth data network capable of handling high-quality multimedia communications. With millions of students taking advantage of the system, countries will have to create multi-gigabit national backbones and make them available at affordable cost to sustain and nurture demand.

Universal digital libraries and universal access to information

Traditional access to information in libraries is being transformed by the creation of a universal digital library. This digital library can provide access to every book, newspaper, music, or movie to anyone, anywhere in the world instantaneously. The cost of accessing a book can be less than the price of a cup of coffee, with the cost of information access indexed to the standard of living of the country. The options enabled by the digital medium are endless. For example, using a universal information resource, you can read a digest of a book, watch the highlights of a cricket game or see a shortened version of a movie like "Gone With The Wind" in your local language. And do any of these tasks, in an hour, or less.

To make this dream a reality, national initiatives are needed to create digital libraries of local literature and creative works and become part of the global movement for creation of a universal digital library. We also need linguistic knowledge bases of all languages good enough for translingual translation.

Telemedicine

One area of major potential impact to our society is telemedicine. In countries like the US, telemedicine is being explored for uses for microrobotic surgery and other sophisticated procedures. In countries like India, the increased bandwidth and computational capabilities can be used to perform remote medical consultation, diagnosis and dispensation of drugs through the mediation of a local health

worker. The local assistant will be able to provide paramedical assistance, screening for infectious diseases, monitoring and advice for chronic ailments such as hypertension and diabetes, drug interaction assistance, and first aid assistance. Such a capability would go a long way to alleviate pain and suffering, and improve the quality of life for people located in remote areas.

To benefit from this option, we need to create and/or extend the high bandwidth low cost connectivity to rural areas using wireless and satellite communications where necessary.

Communication in a multilingual society

We are a polyglot world of billions of people, with many different languages and dialects. Imagine a future where the people from the South can read, write and understand people from the North, East and West without having to devote many years of effort in mastering their languages. It is not only possible to create such a translating telephone, it can be extended to the global stage permitting us to converse with anyone in the world in any language.

Commerce in a multilingual global economy

A national network connected to a global Next Generation Internet will eliminate barriers to communication and commerce and promote global trading with entrepreneurs.

Again networks and multilingual translation tools are essential for realizing this dream.

Conclusion

Exponential changes in information technology will lead to paradigm shifts impacting every aspect of human endeavour. The possibilities for effective use of information technology within national contexts appear to be limitless. As we approach the twenty-first century, we have the opportunity to transform our society:

- From nations of illiterate and semiliterate to nations with lifelong learning skills capable of accessing knowledge and know-how-on-demand from global databases;
- From nations suffering from malnutrition and poor hygiene to nations with universal affordable health care;
- From nations squabbling about how to overcome language barriers into nations which transcend the language barrier;
- From nations of clerks pushing paper to nations of productive problem solvers; and
- From nations who look to the government to provide jobs to nations of entrepreneurs who create jobs.

In the history of civilization, no work of science has so comprehensively impacted on the course of human development as information technology. Undoubtedly, information technology has been the greatest change agent of this century and promises to play this role even more dramatically in the coming decades. Information technology is changing every aspect of human life—communications, trade, manufacturing, services, culture, entertainment, education, research, national defence and global security. Information technology is breaking old barriers and building new interconnections in the emerging Global Village. Information technology has also become the chief determinant of the progress of nations, communities and individuals. (Adapted from the keynote address by Prof. Raj Reddy, Dean, Carnegie Mellon University, Pittsburgh, PA, USA, to the International Seminar on Information Technology in the Global Village, Bangalore, India, 2-4 November 1998)

Design for global competitiveness

International Seminar on "The Global Village"

In the recent past, knowledge and its technological applications have grown at ever steeper rates worldwide, in virtually all fields—food, medicine, materials, environment, services, manufacturing, etc., but especially in electronics, communications, information and services. For example:

- The cost-effectiveness of digital computing has almost doubled every two years, thus enabling individuals to now own computers and use networks that only the defence services could have afforded some years ago;
- User-friendly, over-the-counter software, which took whole divisions of IBM to produce in the 1980s, is now available for $25 to $50 a copy. Consequently, business managers worldwide now use computer and communication system capabilities to source and market internationally and to manage their complex tasks globally, despite their ignorance of the inner workings of the technologies;
- Several tens of millions of relatively young, sophisticated computer "communicators"—not programmers—worldwide have become relaxed and competent in using networks and complex programs. Their network interactions are now creating what Prof. James Brian Quinn, of Dartmouth College, calls "auto-catalytic growth, forcing economists and policy makers to rethink the very basics of education, trade policy, and economics".

Lester Thurow, who is Professor of Management and Economics at MIT, and is a former Dean of MIT's Sloan School of Management, remarks in rethinking the future:

"If you ask any industrialized country to list the industries in which they would most love to have some strong player(s) in that country, you will hear microelectronics, biotechnology, the new materials science industries, telecommunications, civil aviation, robotics, machine tools, and of course computer hardware and software."

Any country aspiring to a developed status must therefore have a technology vision centred around information technology.

The key element for national strategy in this knowledge, software, and services age is what could be variously described as design or innovation or technology. The concept of technology is as old as the science of economics. Both started to make themselves felt about two hundred years ago with the advent of the industrial revolution, which brought with it the widespread use of machinery and mass production in factories. For Adam Smith and his contemporaries, it was obvious that these innovations raised not only a country's output and wealth, but also the productivity of people engaged in the day-to-day production of the goods and services made available to consumers. We thus have to recognize that technology is the tool that brings faster economic growth.

The economic imperatives for acquiring technological strengths do not warrant repetition here. However, this connection has not become a part of the thinking of many in positions of leadership, whether in government, industry or elsewhere. A country aspiring to become a major economic player in terms of trade and increase in GDP cannot do it on the strength of turnkey projects designed and built abroad or only through large-scale imports of plant and machinery, equipment and know-how.

For example, for many Indian companies, the dependence on external know-how for design and technology

remains very high. This is perhaps so because we have focused too much and for too long on how to become low-cost producers. The incremental benefit of streamlining our processes, reducing our workforce, and decreasing our unit costs in most cases is limited. It is time to take some calculated risks and to view innovation as the bank of tomorrow. Make deposits into it today, and it will yield dividends in the future. It is time to stop focusing on the cost side of the business success equation and to turn to the demand side. Admittedly, stimulating demand is far more difficult than cutting costs. But it is also far more rewarding.

Innovation is the single best way to leapfrog competition, move ahead of the industry pack, and, most important, create new ways to bolster profit margins and fuel future earnings streams. What more could you possibly ask? If it is done right, innovation can be our most powerful competitive weapon. Successful new product managers will perceive innovation as a portfolio of different types of new products with varying degrees of risks, potential return upside, and strategic roles. Chief executive officers (CEOs) must stop obsessing about new product failures. The issue is whether or not the overall group of new products is yielding adequate financial return over time and satisfying strategic roles, all of which help the business to achieve its long-term goals.

Let us for a moment pause to look at the Indian information technology products scene. Domestic information technology production is now less than 0.1 per cent of global information technology production. In stark contrast, the Philippines exports almost $2 billion worth of information technology products per year, and over 40 per cent of Singapore's exports in 1997 were from information technology products. Or look at the Taiwanese success story: barely eight years ago, nobody would have imagined that by 1997, Taiwan would emerge as the second largest producer of notebook PCS in the world, just slightly behind Japan, by producing about 4.5 million notebooks valued at over US$ 6.5 billion. How did they reach this stage? By a systematic progression from low-cost manufacturing (aided by consciously building up the appropriate infrastructure) to value-addition through innovation. The rapid pace of industrialization and exports in the newly industrialized countries would not have been possible, had they not shown an ability to adopt, transform and develop industrial technologies in many sectors.

There is therefore an overwhelming need for governments of developing countries to stimulate their development capabilities in information technology. Neglecting to encourage such capabilities could rapidly diminish each nation's economic, military, and life-quality standards. In fact, R & D in India has survived only because of the efforts of a few visionary scientists and leaders. But for them, the nation would have been satisfied with making small items, surrendering to business interests that would use all means to convert India into a perpetual "buying nation".

Although the heterogeneity of both the information technology sector and the developing countries precludes generalizations about strategies to a large extent, it is reasonable to state that every developing country needs an information technology industry that can stand on its own, rather than be dependent solely on import of technology from abroad. For example, simply because the developed world is moving towards DTH satellites and corresponding receivers for consumers, does every developing country need to ape them with a similar system that entails expensive consumer hardware which even most of their middle class might not be able to afford? There could be lower-cost alternatives possible, that may be appropriate for their needs, and would not sacrifice quality, but each country would need to take initiatives to encourage development of uniquely local solutions for uniquely local needs. A very significant benefit of developing such alternative solutions would be that such solutions could then be supplied also to other third world countries whose needs are more likely to be similar but who are also today reconciled to using solutions foisted on them by the developed world, owing to non-availability of viable alternatives.

CHOIS (Cable-based Home and Office Interactive System) technology, developed by a Bangalore-based company, is a case in point. It facilitates a whole series of interactive infotainment services using the existing Indian cable television infrastructure, including video-on-request, interactive shopping, information on a variety of topics, interactive advertising, etc., at a very low cost to the Indian cable viewer. It is an excellent example of a uniquely local solution for uniquely local needs, created through innovation.

It is such innovation that must be encouraged and nurtured. For without innovation, economic growth is limited by physical resources available and (in an excess-capacity world) implicitly to marginal returns on capital invested. As physical product margins drop, the best way for any nation to break out of these marginal returns is to make better use of resources through innovation. Consider, for instance, the case of the electronic typewriters that a Mumbai-based company has started supplying to their German collaborator, by cutting down the manufacturing cost by over 20 per cent, simply through design innovation.

A few more examples of innovation and product development by Indian information technology firms will highlight the importance of encouraging and nurturing indigenous R & D and innovation in information technology products:

- Yantra, the smallest and lightest multimedia notebook PC in the world, was developed two years ago, and exported to Japan, by a Bangalore-based company;
- During the last financial year, the entire profit made by a Bangalore-based peripherals manufacturer, on a total revenue of Rs. 1 billion, was generated out of sales of printers that were indigenized and improvised through local design and innovation;
- An independent manufacturing EOU in Cochin, has exported advanced networking products worth Rs. 1.6 billion over the last four years—all the products were developed by yet another Bangalore-based company;
- A Bangalore-based manufacturer of terminals has exported over 69,200 monochrome and colour terminals over the past three years, worth $12.67 million. All the products were designed in-house;
- Of the five original "starters" in printers manufacturing in the country, only two survive today—and both have employed indigenization and improvization through local design and innovation;
- Computers have increased efficiency and service in certain previously chronically deficient services; the computerization of ticketing on Indian railways, or in State bus-transport undertakings, being notable examples. These have given rise to the London underground or Sydney metropolitan transport services being computerized by Indian companies;
- India today can proudly claim to have started licensing intellectual property in the area of DSP-based modems, speech coders, PC BIOS, PCMCIA card manager software, etc.

In contrast to the above successes, consider the following non-successes:

- Of the six original "starters" in computer monitors manufacturing in the country, only one survives today, but even that unit is struggling to survive. None of them has invested in any local design or innovation.
- Similarly, despite a few "starters" in FDD manufacturing, virtually no unit survives today, as most of the units had simply resorted to kit-based manufacturing.

Let us look at some non-information technology examples, if only to emphasize the importance of technology and innovation further:

- A Bangalore-based group of mechanical engineers designed and produces the ACE CNC lathe, which is priced substantially below the others in the market, which gives them a competitive edge. Since ACE machines are based on indigenous designs, and no collaborations are involved, the problems and costs of royalty payments, CKD imports, and so on, are avoided. As a result, ACE CNC lathes are typically priced 30 to 40 per cent below others. A combination of indigenous design and low overheads has helped keep the price low;
- India's Prithvi Missile is comparable to any world class missile system, and probably is the best of its class in payload capability, yet completely developed in India;
- Work has been completed for the state-of-the-art submarine sonar, Panchendriya, by the Naval Physical and Oceanography Laboratory (NPOL).

The above examples clearly demonstrate the importance of promoting design and innovation.

In that context, let us now look at India's software industry. Currently at a size of about $2 billion, the targets for India's software export are projected as $10 billion by 2002 and approximately $38 billion by 2008. Even these projected levels of achievement can be greatly surpassed by encouraging entrepreneurship. In the long term, though, there is one element which should make us feel concerned. Can this boom of software export and application last for decades, merely based on software developed in other advanced countries which is operated by our people, as application support personnel, data analysts and market developers, or as programmers who simply code under someone else's direction?

There is a definite need for India not only to derive benefits from the present software boom and demands, but also to prepare itself for the higher end of the market. India should dream of becoming a software business bidder in a decade.

India has the intellectual power for higher levels of software. High-level software provides a challenge for our best minds and at the same time it is a wealth generator. This should be focused upon as a mission area in information technology. It is India's experience that when visionaries set a mission, results are achieved.

Despite some undoubted flaws, no system has worked as well to promote innovation and to generate wealth as has the constructive interaction of democratic governments and private producing enterprises, working in a market economy, along with carefully constructed social and economic regulation. Active government intervention and support actually create large positive increments of innovation and totally new markets.

Government actions can (and often do) create entirely new public markets that generate large growth opportunities for the nation and for private companies. The framers of the American Constitution and early US laws, in fact, specifically supported only invention and discovery as key growth ingredients for the nation. Virtually every major industry in which the US is world-dominant today has been generated or nurtured due to US Government policy.

In cases where probabilities of individual project success are too low, the need for interacting disciplines is too high, and times to payoff are too long from private companies to sponsor the needed development efforts, government can improve potential payoff-to-cost ratios by supporting a wider range of options, by extending benefits to a larger population, and in some cases by coordinating the various programmes to lower total programme costs. And the public benefits the government can capture for the whole country legitimately justify investments that private companies would be unwise to undertake. When successful, such endeavours create whole new industries that otherwise would not exist. The question, therefore, is not whether government has a role in fostering innovation and wealth-creation, but where and how it can participate more effectively.

For example, no private individual or group of producers could probably have justified the risks, costs, and difficulties DARPA undertook in establishing the Internet because it would have been so difficult to get the institutional cooperation needed and to capture the benefits produced. Nevertheless, the potential benefits of the Internet to the public—improved education, research, knowledge sharing, faster interactions, low-cost services access, and many billions of dollars in new market opportunities—clearly exceed the development costs by a massive margin. The "net" is now a whole self-sustaining virtual economy, with at least 30 million Internet connections in 140 countries, which is expected to grow to 150 to 200 million by the early years of the new century. During the 1960s and 1970s, a vast majority (90 per cent) of US federal funds went into the DoD, AEC, NASA, etc. Government R & D expenditures exploded during this era (to several tens of billions of dollars). Industrial technology was presumed to "fall out" from these efforts, and there were some increased tax incentives to perform private R & D. In fact, high-profile S&T programmes—space, medicine, military and energy development—became tools for individual members of Congress to achieve further patronage, prestige, power and headlines.

Examples and modes of US Government support and current market size

Industry	Examples and modes of government support	Current market size ($ billion)
1. Software	Basic maths research, military R & D, encryption, language standardization, military purchases of systems, IP rights, interface standards	>100
2. Computers	Basic research, large-scale development, first purchase, software support, component development, mass-market development through education	>150
3. Semiconductor	Materials research, first quantity purchase, military research, Sematech, advanced system development, large-scale system deployments	>90

These industries, and many others, would not be operating at today's scale, complexity, or efficiency if they had not enjoyed significant government support.

Let us take another example—the robotics industry. The US dominated this industry in the 1950s and 1960s. By the mid-1980s, however, the Japanese produced over 50 per cent of the world's robots, and were the largest exporters in the world, reaching sales close to US$ 500 million by 1987. How did this happen? Due to the powerful linkage between business and government, a system in which the Ministry of International Trade and Industry (MITI) was giving "administrative guidance, and steering companies into the most productive lines of activity, and stimulating demand for robotics products".

The Japanese Ministry for International Trade and Industry (MITI) has financed numerous initiatives in the automation sector. Basic research in automation (1976-1983: $190 million) and FMS (1977-1983: $60 million). The Japan Development Bank has provided credit on easy terms, and special depreciation rates apply to machinery "Made in Japan".

Governments in other developed countries have helped to foster innovation, subsidizing R & D and making finance available on easy terms. The erstwhile West German Government subsidized 40 per cent of the R & D personnel costs of small companies and 50 per cent of the costs of companies participating in special R & D projects. Between 1934 and 1988, funding to the tune of DM 530 million was made available at special interest rates. In Sweden, the Government identified and financed six "leading-edge companies" for their high-risk pilot projects.

In a very much similar fashion, closer to home, the opening up of the STD/ISD public call booths in India created a huge market for the STD/ISD metering-cum-billing equipment, which is another uniquely local solution for uniquely local needs.

Creation of such "public markets" is not a national cost to be abhorred any more than environmental, health-care, police protection and legal systems costs are.

Government can support many classes of value-creating innovation that private markets cannot.

For example, recommending adoption of the Smart Card for a variety of applications (including voter identity cards, passports, medical records and electronic wallets, etc.), and sponsoring cross-industry collaboration (among hardware and application-software developers) will result in a huge opportunity for indigenous companies.

In structuring its policies to stimulate innovation in such early markets, government should use the same concepts (of competing designs, interactive testing, performance figures of merit, problem-solving incentives, and R & D production continuity) that characterize innovative private marketplaces. It should consciously exploit the companies' own interests in subsequent commercialization. In doing so it must recognize the importance of vigorous competition. Competition forces firms to streamline operations, cut costs, and search for new products and new markets. There has to be endogenous technological capability, which most governments of the newly industrialized countries had been encouraging over a period of two decades. However, such capabilities cannot be developed, and subsequently enhanced, unless firms are forced to compete. In fact, there is no rational reason why the Government's practices could not parallel industry's "core competency with outsourcing" strategies. Such approaches avoid the barriers to further development and exploitation that government self-production or in-house development so often create. Major benefits would accrue if such strategies were more visibly used across government agencies. Due

recognition must be given, however, for the intellectual property of the developer firm. Unless intellectual property is perceived correctly, the country will not be able to deal rationally and well with many of the technological and growth challenges of the future.

It may be interesting to note here again the experience of the US Government. For years, various US government agencies, like the NSF, NIH, and DoA insisted that the technologies created under their funding be available free to all comers, and few private companies were willing to undertake the investments and risks of exploitation. Yet, when private patents were finally allowed, innovation and exploitation finally blossomed.

In fact, government must truly assume the role of a servant. The role of a servant means exactly that—to serve others involved in innovation by providing them with the funding, people resources, and rewards structure to be able to handle the new products properly. If a new startup has to "tin cup" and panhandle its way through corporate corridors begging for resources and capital, this will not foster innovation. Companies should be financially rewarded, not penalized, for investment in innovation.

Create a department/ministry of innovation: This new cabinet position would be responsible for developing programmes and initiatives to stimulate a resurgence in innovation. Defence and space research, which has continued at an accelerated speed, should be converted to commercial application. This source of new technology and innovation for business is yet untapped.

Establish national innovation awards: Such awards would recognize innovation superiority and create innovation benchmarks that companies could use to monitor the effectiveness of their own innovation efforts. This might be similar in nature to the national Malcolm Baldridge Award for quality.

Capital and tax policy support to intellectual property

Most corporate accounting and national data practices now contain biases against capitalizing expenses incurred towards development of information technology products. Tax policies encourage companies to disguise or expend such costs. Although such practices increase the tax shields from current investments in product development, they lower apparent profits and result in a significant understatement of the enormous asset value of product intellectual property. Financial institutions and banks must therefore be encouraged to recognize intellectual property (including product development expenses) as capital assets.

Yet it is not enough to have the brainpower to create new products, because those who can manufacture those products more cheaply can take them away from their inventors. A lot of people, in many countries, however, believe that it is simply impossible for them to compete (in manufacturing) with the advanced countries, where massive automation has offset the low-labour-cost advantage of the developing countries. We must stop thinking about local manufacturing as purely a low-labour-cost proposition, and start focusing on value-addition through R & D. In fact, to a large extent, modern manufacturing is simply a series of service activities (R & D, product design, process design, logistics, etc.), linked together to create customer value in the form of a product output, and therefore should not be viewed as involving mere assembly. Consequently, such intellectually-based service activities should be viewed as the nation's growth vector for the future. Technology innovation,

entrepreneurship, and diffusion must be the critical leverage factors in the growth equation from now on.

One of the starting points for future competition will be having the skilled labour to master low-cost, high-tech processes. In fact, both high-tech and low-tech products in future will be made with high-tech processes. Therefore, ultimately, product innovation will not do any country much good if they do not have the processes to become the cheapest producer. As we are entering an era of "brainpower" industries, there are two things which every developing country must focus on:

- Building the skillls base (everything from Ph.D.s to skilled production workers); and
- Making the right investment in R & D.

Let us now move to the topic of finance, which presents the classic problem to many an entrepreneur or start-up company—the bank never gives you money when you need it, and you do not need the bank when you have got the money. Further, if an entrepreneur has been lucky enough to get bank finance but unluckily suffers a setback in the market, the bank worries more about when it would receive its money back, rather than how it could help the entrepreneur to recover from the setback, so that the bank finance may be repaid. Venture capital is thought to be the solution to this problem. For example, in Silicon Valley, start-up founders can raise as much as, say, $10 million without any of their capital, and still retain substantial equity up to 25 per cent. In most developing countries, venture capital firms are not so aggressive, yet. And almost all financial institutions require bank guarantees or enormous collateral security, for start-up funding. This prevents smaller companies from growing or continuing with, or even initiating their R & D. With so many other obstacles to overcome (infrastructure, customs, cargo, etc.), the entrepreneur would therefore rather take the easy way out by staying in familiar territory—trading. Without private investors to boost development, government therefore has a big role to play. Perhaps government should set an example by setting up a large venture capital fund specifically to promote development of information technology products (both hardware and software) in each country. Taiwan is a notable success in this area—Singapore is another. Both have very supportive Governments investing in industry. Which is why companies such as Creative Labs (who are today the de facto standard for PC sound cards, with revenues exceeding a billion dollars), have emerged out of this region.

In developing countries, we need innovative financial support in the form of research/development grants for local firms to undertake R & D in advanced information technology products. Further, banks should release collateral-free loans to information technology product developers.

During the late 1970s and 1980s, average capital costs in Japan were one third to one fifth of those in the US. Simply expressed, if managers invested $1 million at a capital cost of 5 per cent (Japan's rate in the 1980s), they could rationally wait 14.2 years to get their money back; but they could wait only 5.4 years if capital cost was 15 per cent (the US rate at that time). Further, they can wait only 2.6 years if accepted corporate IRR is 30 per cent (as it is currently in many US companies).

During the 1980s, the Japanese Government and banks made favourable financing available through special arrangements to targeted industries at a cost varying between 0 and 6 per cent. As a consequence of these financial arrangements, many Japanese companies were able to invest in projects that would not have been rational for many US companies. In the late 1980s, seeing Japan's example, other Pacific rim countries began similar low-cost capital policies to support their companies.

The distribution model in the US and other western markets requires stocking of retail shelves on credit, with payments being made only after sale, and then too after enjoying a credit period (ranging from 90 to 180 days). Also, any unsold goods are returned to the manufacturer/marketer. Import/export and foreign exchange regulations in most developing countries are incompatible with the distribution model, and need to be appropriately modified to facilitate export to distributors.

Also, financial institutions should make easy finance available for such credit-based export, against the sole security of the exported goods, after verifying the antecedents of the foreign distributors.

Infrastructure is another aspect that needs attention. The sparser the infrastructure, the higher the entry barriers for start-up companies, and the higher the initial funding requirement. Smoothly functioning infrastructure is a must for high technology. For instance, in Silicon Valley, and now even in Taiwan, a new product, for example, a network interface card, could be conceived one day, and the design provided to a layout bureau the next day. A week later, a contract manufacturer may be lined up, to whom materials can be supplied by distribution firms. Within a month, a rep organization is located, and the marketing and PR activities are outsourced. Bay Networks or Cisco, for example, do not operate their own factories. They outsource manufacturing after having decided that it is not core to their overall operation. Not only does this conserve capital for the highest ROI activities, it also provides management of the bandwidth to be fully focused on their core business. Such a management philosophy is practically non-existent (in the information technology sector) in India, for instance, as the infrastructure is not so well developed or complete. Government must encourage development of such an infrastructure in the country, so that everyone gains by the better utilization of capital investment.

Next is the issue of encouraging indigenous information technology product development through fiscal and tax incentives. Why not exempt all products that incorporate indigenous R & D from taxes such as excise, sales tax, customs duty, octroi, etc., on a graded structure according to the value addition?

Preparing for other "sunrise" technologies

A few other initiatives will additionally prepare us for the coming age of intellectual property.

By now, most of us know Moore's Law, propounded by Gordon Moore in 1965, by heart: "Transistor densities on a single chip such as a CPU double every 18 months". It has remained remarkably accurate so far. However, no one has dared to predict that the number of chip designers would grow at the same rate. Gate counts are up, but the number of chip designers is not keeping pace. In the coming system-on-a-chip era, EDA software and reusable intellectual property will play an increasingly important role in IC design. Silicon designers of tomorrow will be like the board designers of yesteryear, putting together off-the-shelf reusable intellectual property (chip "cores") into the desired system designs. Policy initiatives must therefore strengthen the country's VLSI design training programmes to prepare designers for this scenario. Also, private sector companies should be encouraged to undertake development of intellectual property cores.

Any developing country can have a thriving domestic information technology industry, provided all of us in industry and government recognize the potential and power

of intellectual property by exploiting the synergy between R & D (design/innovation) and manufacturing to not only re-engineer current products (for cost optimization), but also to create new markets by thinking radically differently. They may win in some areas and lose in some others, but as long as they treat each other as partners, not adversaries—as facilitators and implementers, they will definitely help progress towards becoming a developed country. (*Source*: Paper by Vinay L. Deshpande, Chairman & CEO, Ncore Technology Pvt. Ltd., and Chairman, Processor Systems (India) Pvt. Ltd.)

The global village—aspirations and opportunities for developing economies
By V. Chandru and S. Manohar

The role of various agents of change in integrating developing economies with the global village

The global village
The ideal village is a compact community where everyone is easily accessible (connected); all the necessities of comfortable living are produced and consumed locally (move electrons not atoms); in short, a self-contained community of happy and prosperous people. The global village is an Utopian vision of a future in which every citizen of our planet experiences life—personal, professional, cultural and social—as a member of a virtual village.

Over the past decade the international information superhighway, or the Internet, has been cited by many as the means by which this vision of the global village will be realized. The analogy of a highway applied to the Internet, though a cliché, is appropriate. We will explore the implications of this analogy in this discussion paper.

Build roads
In the road maps of the global village, developing countries are huge impassable jungles with a minuscule number of two-lane highways. In India, for example, Ernet, NICnet, VSNL's VSAT links etc. are accessible to an elite few, and several mud roads (VSNL dial-up links, in India) connecting a few major cities and towns. As a result, developing nations play an insignificant role in the global village.

What are the steps to be taken to break away from this sorry state to become a vigorous and vital part of the global village? We attempt to suggest some possible paths. (We mix metaphors throughout this note with the intent of provoking the imagination of the readers.)

One major refrain heard from several quarters—software industry, economists, government planners—is that software exports from developing nations in general, and the software industry at large, is constrained by the lack of trained manpower. Several initiatives, both private and public, are under way to address this major problem. However, if we step back and look at the larger issue of integration with the global village, it will become obvious that what is more serious is the lack of roads. Software professionals come in various hues, just like vehicle drivers come in various modes: cyclists, four-wheel drivers, truck drivers, bullock-cart drivers and even pedestrians. To be concerned exclusively with producing a large number of drivers is to put the cart before the ox, if we can mix metaphors further.

If we look back in history, every great king built roads. We need to pause and consider why this was done:

obviously, for the army to move quickly to reach the borders, for people to travel easily between parts of the kingdom so that trade and commerce and culture could flourish. At a higher level, building, maintaining and operating the roads was a significant economic activity: it gave continued employment to people in times of peace, generated revenue for the king directly in terms of the tolls collected and indirectly, and more significantly, in terms of increased economic activity engendered by the roads. No wonder kings built roads.

Build roads and the irrepressible human nature will ensure that people invent, modify, improve and learn to drive a multitude of vehicles and engage in countless activities—economic, social and cultural—that depend on the existence of the roads, and the feasibility of travel.

We need to build roads of all kinds:

* Conventional: gigabit networks, megabit networks, 64 Kb dedicated lines, modem-based telephone networks;
* Unconventional: power-line networks, cable television networks, railway signalling networks, wireless networks. These roads should reach every nook and corner of the country—even a mud road connecting to the nearest one-lane tarred road means connectivity for an isolated village.

Another statistic quoted extensively is that the number of households with PCS in developing countries is very small. We believe that this attests to the native wisdom of the population: buying a PC without access to a network is like buying a car without a road to drive it on. Only the rich, the foolhardy and the status-conscious will do so.

Build roads and we will see people scrambling to buy or rent vehicles of all kinds. Resource-constrained societies are famed for their ability to reuse goods, seemingly without end. A healthy market in used computers and accessories of all kinds is inevitable. And novel homespun ways of utilizing the available computers to the fullest extent will emerge.

Who will build the roads?
Building a nationwide network from the ground up is an enterprise so vast that no modern king can afford to tackle. However, his ancestors hardly ever had to convert a jungle into a road. Instead, footpaths, cattle-grazing trails, tank bunds and dried river beds were converted into roads. Such pre-roads exist for the information superhighway:

* Existing computer networks (such as Ernet, NICnet, etc. in India);
* Telephone network;
* Cable television network;
* Power lines;
* Railway network;
* Wireless network (satellite and ground-based).

This task of converting these networks to form part of the Internet can be cooperatively and competitively managed by the public and the private sector. The commercial potential of building and operating these roads is enormous. The bottom line is that there is plenty of money to be made in road building.

The vehicles
Vehicles with which to surf the superhighway must be affordable and accessible to the general populace. We foresee numerous possibilities of how this will be accomplished:

- The Government supplies vehicles for all its functionaries, at all levels, but no more. However, it facilitates creation of affordable access points.

Consider the ISD/STD booths that have mushroomed all over India, providing telephone access at a scale that was in the realm of the impossible, even a decade ago. The presence of these STD booths, and the Indian twist of providing the call-receive facility at a price, means that the often stated statistic of x number of phones per thousand people does not truly reflect the real scale of telephone access. With these booths, neither the caller nor the called party need to own a telephone but can reliably communicate. One proposal by the Karnataka Government seeks to upgrade these STD booths to cyber-booths that provide Internet access. With the roads and the cyber-booths in place, a similar multitude of people can surf the Internet without owning vehicles of any sort. The loose sense of ownership and the acceptance of borrowing everyday articles are cultural factors that will act as access multipliers. For instance, it is well known that a single VSNL dial-up account is usually shared by half a dozen family members;

- Network computers (NCs with Linux, etc.);
- Set-top boxes for cable television (WebTV);
- Private ISPs with information kiosks;
- Schools/colleges/libraries and other public facilities.

Providing access points is also a source of considerable commercial potential. Unlike the road-building efforts, this activity can be taken up by small businesses and individuals.

Access points are not just computer hardware. The front end should be accessible: for instance, it should be in the local language. Reliance on English at the front end is an obstacle to widespread access. This is also an opportunity for the creation of indigenous products that target multiple languages.

Highway commerce

People use roads for a wide variety of reasons: selling their produce, buying goods from the retailer or in bulk from the point of manufacture, going to school, going to the movies, visiting relatives and friends, attending social/cultural/religious events, meeting government officials of all kinds, going to the banks or to the local money lender, to the hospital and so on and so forth.

The neighbourhoods of the information highway need to be rich and diverse before people can be expected to surf the highways in droves. Thus, a whole range of applications must be available on the network. It is not suggested that applications be created to lure people to the information highway. Rather, there must be significant benefits (social, economic and democratic) in migrating to the information highway, as opposed to the physical roads.

For instance, access to banking is limited to cities and towns. It may be possible to make banking accessible more economically (in the long run) over the Internet than by means of actual bank branches in the remote locations. Education, both traditional and continuing, is another example. We list below some applications which will enrich the landscape of the information highway.

- Information: several sources of information, for the gathering of which people currently have to travel, could be brought on-line. General digital libraries as well as specialized digital collections (land records, judicial case histories and stock market information are some examples) could be created;
- Transactions: several transactions could be conducted on-line. Technologies for banking and trading in the stock market as well as for ordering books and software

over the network are already available in the developed countries. Cyber-cash or digital cash is already a reality, though not yet in widespread use.

However, movie theatre tickets are already being reserved over the network in India. The computerization of railway ticket reservation is a remarkable success story and it can be followed up by on-line reservation. Electronic commerce oriented to agriculture should be facilitated. For example, the procurement agent credits the farmer's bank account;

- Entertainment: movies on demand, networked video games, multi-player computer games, chat groups, multicast of major cultural and social events are a small sample of the potential of entertainment over the network. We believe that this segment needs no special encouragement from any source, but will catch on just like television;
- Work: several avenues, some already well tested and some novel, for replacing physical commuting by telecommuting exist;
- Access to bureaucrats/political leaders and others: a responsive electronic presence of these officials would empower their constituents.

Digital assets

The creation of digital content is a major issue to be addressed. For instance, all land records must be completely computerized before a title search can be conducted digitally. Technologies for digital libraries are increasing in sophistication. However, without significant and relevant local content, the technology is irrelevant. And local content implies that content should be predominantly in the local language. To demand literacy in English as a passport to the information highway is as impractical as it is unjust. Thus, the language issue has to be faced.

One can despair at the number of local languages that dot the Indian landscape and be paralyzed into inaction. Or one can seize the opportunity to create new markets. Consider cable television. Numerous private channels in regional languages are prospering today, where none existed barely four years ago. Software for all these channels is being produced and there is an insatiable need for such software. These channels play an important role in the creation of the global village—the same regional language programme could be watched by people in Gujarat or Kerala, or even Malaysia or Muscat.

Content creation and application development could potentially be stifled by software piracy. With a proliferation of computers, the problem of piracy could multiply. However, every major problem is also a major opportunity. Technical solutions to reduce piracy have been making rapid strides: digital signatures, cryptography and authentication, site certification, and user certification are some examples. In addition, innovative ways to eliminate the compulsion for piracy could become lucrative products. A naive scenario is as follows: with widespread and reliable network access, it is possible to create software package servers on the Internet that host a range of widely-used software. Users can connect to the server (using a network computer), invoke the software after proper authentication, use the software and then be charged an amount commensurate with the resources utilized. Thus, instead of paying for expensive packages as well as maintaining and upgrading them at great cost, individual users can use the software legally and pay for the usage. It is a well-established social fact that for every situation there is a threshold below which it is not worthwhile to break the law. Technical solutions that are needed to realize such software servers can become lucrative products. In addition, there is

considerable commercial potential in running such software servers.

Consider the economy edition text books. Without these, rampant copying of the original textbook (at the numerous photocopying shops that have appeared in recent times and which most of the times co-exist with STD booths) was an economic necessity. With the economy edition, though it may cost more than a photocopy, students routinely buy the former.

Transportation science and engineering

Networking the far corners of the country, making computers available for all, computerization of various aspects of daily life with the aim of increasing the quality of life are all laudable goals. However, it is not enough to approach them at the micro level without efforts to build up competence in perceiving and managing the big picture. Developing nations should aim to create, develop and master the science and engineering of information technology. Currently, these nations import hardware, software and systems from developed economies and where possible retrofit them to suit local needs. This will not only result in continued dependence on developed countries but also complete the vicious cycle by fuelling the growth of the developed economies by squeezing the scarce resources of already impoverished economies to meet the ever-increasing demands of information technology.

Governments of developing countries should vigorously support the creation and sustenance of local information technology industries that can stand on their own, rather than be dependent on imported technology from the developed world. Instead of blindly adopting imported technologies, efforts must be made to evolve lower-cost alternatives that are appropriate for local needs. The goal must be to encourage development of unique solutions for the unique needs of developing economies.

In India, the goal of mass computerization, and access to computers in every secondary school and hospital are worthwhile goals. However, without the development and deployment of indigenous hardware, software and systems products, this exercise will drain the economy. Access to computers in every school is not merely one of buying a few computers per school. Even assuming that the networking to connect all the schools together and to the Internet (another massive enterprise) is already in place, the computers in each school must have necessary software and infrastructure for the productive use of these machines.

A "back of the envelope" calculation, assuming about 50,000 secondary schools in the country and an investment of $23,600 per school shows that close to $1.7 billion is required. At the current rate of obsolescence of information technology products, at least $230 million will be needed every three years for maintenance and upgrade. If the current practice of importing all hardware and software is to be followed then the outflow of foreign exchange will be enormous and unsustainable. The only beneficiaries on the Indian side will be the traders who do the importing of these systems. Even if PCS are assembled in India, the bulk of the profits go overseas. This picture is unlikely to change even if costs go down due to the enormous volumes. This is why the Indian Government should frame long-term policies for encouraging local design, development, and manufacturing capabilities in information technology.

Such capabilities for innovation and product development already exist in India (thanks to Vinay Deshpande of Ncore Technology, Bangalore, for the information).

- Yantra, the smallest and lightest multimedia notebook PC in the world, was developed in 1996, and exported to Japan, by Ncore Technology of Bangalore;
- Godrej have started supplying Adler of Germany with electronic typewriters, by cutting down the manufacturing cost by 20 per cent, simply through design innovation;
- Innomedia Technologies, a Bangalore-based company, has developed the CHOIS (Cable-based Home and Office Interactive System) technology that facilitates a range of interactive services using the existing Indian cable television infrastructure;
- During 1997, the entire profit of Wipro Peripherals, on a total revenue of $23,255,800, was generated out of sales of printers that were indigenized and improvized through local design and innovation;
- Sun Fibreoptics, an independent manufacturing EOU in Cochin, has exported advanced networking products worth $37,674,396 over the last four years—all the products were developed by Processor Systems (India) Pvt. Ltd., Bangalore;
- VXL Instruments, Bangalore, have exported over 69,200 monochrome and colour terminals over the past three years, worth $12.67 million. All the products were designed in-house.

Socio-politics of mobility

In addition to intellectual property issues associated with information technology-based commerce, there are a number of legal issues that will keep our lawyers and judges busy. These relate to authentication, veracity of information, security and controls on the networks. The legal perspectives have to build on careful sociological and political analyses.

The profound effect that the information highways will have on education is already being felt in societies all over the world. Trade schools and polytechnic institutes have sprung up everywhere and are providing manpower for local and global information technology industries. Fortunate teachers and students who have access to the Internet are quick to use the vast electronic library that already exists. While affluent societies plan for one computer per child, we must seek our own solutions that build on our social ethos. Digital libraries containing lesson plans can be created in local languages and distributed to remote corners. Inexpensive and innovative access points must be conceived, designed and fabricated. There is no reason why a network computer should cost much more than an electronic toy. The fact that our urban educational systems seem to have succeeded in training minds that can absorb the incredible complexity of software engineering tasks is a phenomenon that cognitive scientists and education theorists should pay closer attention to. We should build on our strengths.

Information technology has the ability to automate various labour-intensive jobs that provide employment to many individuals today. In this role, the impact of information technology is no different from all the automation technologies that have invaded our work culture and patterns since the industrial revolution. What is perhaps special about the information revolution is that it also monitors and informs us about activities, events and objects. Some sociologists have predicted radical changes to societies as information technology alters the intrinsic character of work as experienced by millions of people in their daily lives on the job. However, the magnetism of the past and the forces of inertia also have the ability to dull the impact of change and it is likely that the radical changes will be noticeable only in very elite organizations, at least in the near future. One very positive effect of information highways will

be to support economic empowerment of women through their easier participation in various information technology-related activities which may not require hard choices between family/home and work.

Access to information and easy communication suggest that the impact of the global village will be to hasten the dismantling of unnatural social orders. Easy polling on a variety of issues has the potential to empower democratic structures in society. However, by the same token, existing political structures and cultural norms strongly influence the adoption of technologies that may require re-engineering. For example, it has been observed that effective use of groupware only happens in organizations where hierarchical barriers are surmountable (it is acceptable to flame your boss or senior colleague).

Since information is power, issues of equity in information access will become important for sociologists to track.

In the 1970s when energy audits were carried out in India there was a clear disparity in per capita energy consumption and the strong correlation between energy usage and prosperity. Information, like energy, is an essential input for the process of economic empowerment and surplus generation. We will need the same level of involvement of sociologists, economists and technologists in information technology planning as we have had in energy planning and technology. Indigenous and appropriate information technologies will follow.

Potholes and other hazards

The benefits of the information highway, if properly harnessed, can certainly be a boon to developing countries. However, powerful technologies and tools are double-edged swords. In this section, we highlight various issues that developing nations should consider carefully before connecting to the global highway. We also point out other dangers that can befall the community of highway travellers.

- Homogenization
  Satellite television's global audience has influenced content creators to gravitate to portraying a homogenized culture and values. In addition, this vast audience has become a fertile ground for the marketing of consumer products with global brand names. The global information highway will provide a much larger momentum to this process of homogenization that will result in the loss of diversity.
  - The English language could extend its present dominant role on the Internet to the emerging global network, displacing numerous other languages and associated cultures;
  - Cultural and political values of the developed world will become world standards, steamrolling alternates. For instance, laws on pornography, free speech, personal choices, etc., are already influencing the technologies and the ground rules of the Internet. This is natural since the Internet originated in the United States. However, it is up to developing nations to determine if they want to be subsumed by this "global culture".
- Side effects of technology
  The impact of the information superhighway on the societies of developed countries is as yet unclear. To embrace new technologies with the hope of breaking away from the clutches of poverty and under-development without a profound analysis of the technology and its suitability to the local conditions is to invite disaster in the long run.
  Examples of short-sighted transplant of technology are:

- The Green Revolution, that has proved to be unsustainable and which has resulted in Indian farmers' heavy dependence on subsidized and imported fertilizers, as well as reduced yield and environmental degradation;
- Import of a water cannon for riot control by the Bangalore police and its maintenance at huge expense, even though it has never been used.

Developing nations do not need to spend billions of dollars (that they can ill afford) on fixing the year 2000 problem precisely because the level of computerization is minuscule. The lesson to be learned is not that computerization is a bad idea, but rather, adoption of new technologies in core areas of the economy has to be done with extreme caution.

- Loss of sovereignty
  It is easier for developed nations to extol the advantages of a borderless world since they own or control all the technologies and content on the information highway. Developing countries have to be cautious in assessing the impact of a borderless world on their populations, especially the vulnerable sections. Effects of sanctions and embargoes imposed for political reasons on a society heavily dependent on the information highway need to be studied.
- Security
  Well-laid roads also mean that the enemy can march swiftly into your capital. The problem is especially severe in developing countries where the infrastructure and the resources needed to secure the highways will be at a premium. There is potential for the loss of considerable native knowledge bases and raw data through the network. For instance, valuable germ plasm has been illegally removed from developing countries before and after the Biodiversity Convention, precisely because of such vulnerability. The scenario where external agencies steal valuable information stored on networked machines and using them for profit is not farfetched. For example, local communities may present traditional medical treatments for local ailments on-line. A well-endowed drug company can systematically gather such information, convert native wisdom into patentable products without benefiting the community that created the knowledge.
  Disruption of the economy due to accidental or intentional damage caused to key installations on the highway can cause immense economic damage, as illustrated by a recent failure of a single router in the north-eastern United States. In developing nations, such disruptions will be much more frequent and serious;
- Amplification of social inequities
  The globalization of the world economy has resulted in the increased gap between the haves and the have nots. The benefits of such globalization tend to accrue more to the developed nations and whatever is left with the developing nations is often cornered by the affluent in that country. The globalization of the information economy has the same built-in biases. Only if the developing nations create their own unique ways of integrating with the global information economy can they hope to reap the benefits of information technology.

Agenda for the agents of change

To realize the aspirations and avoid hazards, several agents that are unique to each developing nation have to play significant but diverse roles. In the following we outline

the agenda for the agents of change from the Indian perspective.

- **Central Government**
  - Eliminate the monopoly of VSNL and encourage private and public ISPs;
  - Introduce legislation to open up network infrastructure creation (similar to the opening up of basic telephone services);
  - Invest in nationwide high-bandwidth backbones;
  - Invest in comprehensive support structures for public domain software like Linux and Gnu;
  - Invest in semiconductor (processor chips, communication chips) industry oriented towards meeting the mass requirements of access points;
  - The Indian Government can give a real kick-start to the Indian information technology industry by encouraging development of indigenous products for the 600,000 Info-kiosks, or the set-top boxes, Internet access devices, and computers for SMART schools proposed by the Information Technology Task Force, to usher in Information Technology-for-All-by-2008. These proposals should be backed up with adequate funding for development and "first procurement" offers;
  - Government can support many classes of value-creating innovation that private markets cannot. For example, recommending adoption of smart cards for a variety of applications (voter identity cards, passports, medical records etc.), and sponsoring cross-industry collaboration (among hardware and application-software developers) will result in a huge opportunity for indigenous companies.
  - Defence laboratories and public-sector companies that get new products developed for their special needs by private companies should also commit the production order to them instead of transferring the production to a government or public-sector agency. In doing so, due recognition should be given to the intellectual property of the developer firm.
  - A very serious anomaly exists in our income-tax structure, namely, while export revenue from software services is exempted from income tax, royalty revenue from licensing of intellectual property is taxed. Such anomalies must be corrected and concrete incentives for encouraging creation of intellectual property should be taken;
  - Indian information technology-product companies should be encouraged in aiming for export markets, by simplifying or eliminating many of the anachronistic provisions of FERA, RBI and Enforcement Directorate regulations;
  - Set up a large venture capital fund specifically to promote development of information technology products in the country.
- **State Government**
  - Invest in State-wide backbone networks;
  - Support private and public ISPs;
  - Invest in regional language access technologies, software and content;
  - Explore novel networking schemes that are suitable for local conditions.
- **Industry**
  The scenario presented above will throw open a myriad of business opportunities, both for established information technology industries and for entrepreneurs. The new markets will belong to those, indigenous or otherwise, that are agile in seizing such opportunities. We list below a few possibilities:

  - Build conventional networks in the BOO (build-own-operate) mode or BOOT (build-own-operate-transfer) mode;
  - Internet service providers
    Prepare to become ISPs when the monopoly of VSNL ceases and the networks fall into place;
    Develop technologies and build unconventional networks;
  - Industry for network computers (manufacture, maintain and upgrade);
    Create diverse digital content and specialized applications for accessing such content;
    Create the software tools and the hardware for operating a franchise of cyber-booths;
  - Software servers: develop technologies and methodologies for software servers;
    Creation of regional language front-ends and applications, including voice-recognition and speech synthesis for interfacing with illiterates;
    Explore implications of ubiquitous networking and plan for the future. For instance, a vast semi-skilled information technology labour market can be tapped for tasks like data entry;
    Solutions for electronic commerce, smart cards, etc.
- **Banking and financial institutions**
  - Should take steps to recognize intellectual property (including product development expenses) as capital assets;
  - Make easy finance available for credit-based export, against the sole security of the exported goods, after verifying the antecedents of the foreign distributors.
- **Academia**
  - Encourage innovation and problem-solving skills;
  - Set up mechanisms for commercialization of research;
  - Create leaders for managing all aspects of the emerging global village;
  - Contribute high-quality public domain software.
- **NGOs**
  - Ensure that the investments in information technology are socially just;
  - Act as watchdogs to ensure that the pitfalls and hazards indicated above are avoided.

This is an evolving document and will benefit greatly by your valuable feedback. Readers are encouraged to send their views on this document to the authors V. Chandru and S. Manohar. The most recent version of this document can be found at http://www.csa.iisc.ernet.in/~manohar/BIT.html

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The Bangalore Declaration on Information Technology for Developing Countries in the Global Village
4 November 1998

INFORMATION TECHNOLOGY PRESENTS DEVELOPING COUNTRIES WITH A HISTORIC WINDOW OF OPPORTUNITY THAT ENABLES THEM TO CREATE NATIONAL WEALTH AND BREAK THE CYCLE OF POVERTY AND DEPENDENCE THEY HAVE BEEN CAUGHT IN AND LEVERAGE THEIR WEALTH OF HUMAN RESOURCES FINALLY TO SECURE A RIGHTFUL PLACE FOR THEMSELVES IN THE GLOBAL VILLAGE.

THE DELEGATES OF THE MEETING ON IT IN THE GLOBAL VILLAGE (AN INTERNATIONAL SEMINAR)

ORGANISED by the Government of Karnataka, India, under the auspices of the United Nations Industrial Development Organization,

HAVING MET in Bangalore from 2 to 4 November 1998, with the aim of assessing the potential of Information Technology (IT) in the Global Village to improve the quality of life of human beings everywhere in the world and, in particular, those in developing countries, and

RECOGNISING

- that food, security, shelter, access to quality health care and to education and knowledge are the cornerstones of development,

- that the developing countries possess an untapped wealth of human resources,

- that the empowerment of women and the protection of the young, hold the key to population stabilization, healthy families and collective prosperity,

- that the majority of people everywhere express themselves effectively and creatively in their own language,

- that prevailing concepts of community and sharing among many indigenous cultures are in conflict with the present regime of monetised intellectual property rights,

- that in the next millennium, intellectual property will be the yardstick for assessing the wealth of nations,

- that the nurturing of open societies and the elimination of existing gross inequalities in wealth, power and status are essential for the long-term stability of human civilization,

- that the ability to assimilate any new technology is not uniform across, and even within, cultures,

- that elites everywhere are the first to access any new technology,

- that developing countries are caught in a cycle of poverty and dependence which they can break with imaginative use of IT,

- that IT is a potent instrument for bringing about radical social and economic transformation on a scale, and at a pace, that has no precedent in human history, and

- that unbridled IT will unleash forces that could rapidly lead to further widening of the disparities between the haves and have-nots everywhere,

PROCLAIM that the proponents of information technology worldwide should strive to abide by the following principles:

IMPACT OF INFORMATION TECHNOLOGY

1. IT is only a means to the improvement of the lot of everyone in society, and in particular, of the weakest sections. It is not merely an end in itself. Further, excessive focus on IT at the cost of other means of development should be avoided.

2. IT holds a unique promise for women in developing countries to empower them to move beyond their traditionally assigned roles, and to help them to take their rightful place in society by active participation in all areas of the economy.

3. Timely access to appropriate information and knowledge is the key to development, for both the individual and society.

4. IT must be used to strengthen the role of the media in making democratic structures more participatory and transparent.

5. The priority application of IT should be the following three broad areas, namely, information access, communication and economic transactions, a few examples of which are given below:

   a. agriculture on a priority basis,

   b. improved access to primary and reproductive health care,

   c. access to reliable data for effective planning and administration at all levels, and

   d. low-cost communication to enable cooperation between people everywhere.

6. Applications of IT in such areas as entertainment and electronic shopping, are critical components of the information economy where market forces have a leading role to play, but within the framework of a fair and equitable society.

7. The latent intellectual talents in a developing country should be harnessed to create monetised intellectual property in IT, as this can lead to the rapid generation of national wealth.

Global Imbalances

WE CALL UPON IT PROPONENTS IN DEVELOPING COUNTRIES TO

8. Recognise the current reality of their almost complete dependence on developed nations for all IT products, which, combined with the thrust for rapid spread of IT, can result in large-scale flow wealth away from developing countries, thus perpetuating current inequalities;

9. Avoid an exclusive focus on exporting software services which is detrimental and unsustainable in the long run. Further, the significance of such earnings may be far less if the indirect costs of the IT infrastructure that creates such manpower are factored in;

10. Encourage the creation of intellectual property in IT which is owned by individuals or companies in developing countries.

Promoting Information Technology

WE THEREFORE CALL UPON DEVELOPING COUNTRIES TO

11. Facilitate the rapid and equitable development of infrastructure for IT, and in the process,

a. strive to provide IT for all citizens rather than simply responding to pressures from vested interests,

b. facilitate the rapid creation of a backbone for national networking (by upgrading existing facilities and establishing appropriate new infrastructure) and expedite low-cost connectivity to the national backbone by resorting to innovative means such as cable-TV networks, wireless-local-loop technologies, railway signalling networks and power grids, and

c. facilitate the availability of a range of computers, including cable-TV, modified telephone instruments, and rugged, low-cost, hand-held devices, along with traditional computers, for purposes such as information gathering, communication and transaction processing;

12. Give priority to education, without which the human resources of the populace will not be developed. Governments should therefore

a. invest massively in basic education to ensure the success of the goal of universal IT,

b. facilitate higher education, training and re-training in IT to generate the requisite manpower for IT services,

c. nurture advanced engineering and technology education geared to the creation of intellectual property in IT, and

d. initiate programmes to develop expertise in the legal, financial and marketing aspects of global trade;

13. Realize that the role of Governments in supporting R&D is critical, and hence governments should

a. fund basic and long-term research, especially since such research is unlikely to be supported by private industry in developing countries,

b. support the development of select IT products by various means such as grants, low-interest loans, marketing support, tax incentives, and lay strong emphasis on the availability of genuine venture capital,

c. protect indigenous products from unfair international trading practices, and

d. provide incentives to industry to develop in-house R&D;

14. Jettison the antiquated laws which may relate to IT that many developing countries have, and formulate new ones that regulate without stifling innovation. A responsive judicial system is necessary to promote a vigorous information economy.

15. Monopolies of all kinds, whether governmental, multinational, or domestic, need to be eliminated to facilitate the fast growth of IT;

16. Ensure access to IT for every citizen irrespective of gender, language, physical handicap, geographical location, caste or creed, in the same manner as they have access to telephones, and indeed provide access to IT even for illiterates;

17. Use IT as a vehicle to attain transparency in administration at all levels and enact freedom of information acts to make necessary information available to citizens;

18. Use IT to empower all citizens through mobilisation of their choices, facilitate simple polling on contentious social and political issues, and offer access to political representatives and administrators.

19. Encourage a vibrant hardware industry which meets their diverse and specialised IT needs;

20. Avoid blind transplants of IT solutions, proven in other infrastructural and cultural contexts, and instead, nurture local expertise that can adapt IT solutions to meet local requirements;

21. Devise measures to crate thriving markets for local language content and applications;

22. Utilise the many sophisticated packages and systems tools that are available today, as free and public domain software, to create unique solutions using such software and thus contribute to the global enterprise in free software;

23. Devise new measures to reward innovators, and protect intellectual property rights to empower local design and innovation in IT.

NOTES OF CAUTION

WE URGE DEVELOPING COUNTRIES TO BE AWARE OF THE FOLLOWING PITFALLS.

24. They are likely to fall into a grave debt trap, if they make heavy investments in IT infrastructure without simultaneously making long-term plans for generating substantial surpluses using IT;

25. Rapid and widespread induction of IT into all aspects of society bring with its risks of unforeseen situations, such as the Year-2000 problem, causing massive disruption;

26. IT is likely to lead to the loss of diversity by bringing in homogenisation in several spheres:

   a. The rapid spread of global television networks has led to the spread of a homogenised consumer culture dominated by the preferences of the primary content creators. The spread of IT could have a similar or even more pervasive impact on cultural diversity across the globe.

   b. Even within countries the dominance of the English-speaking urban elite, is already marginalising indigenous cultures. IT will worsen this situation since it is the same elite has historically enjoyed disproportionate benefits from any new technology, to the disadvantage of the weaker sections of society.

   c. The fact that English is the primary language for software development leads to certain implicit cultural assumptions in software packages which further alienate indigenous cultures.

27. The goal of providing universal access to IT may bring with it several risks including the loss of privacy. These risks are especially serious since the checks and balances which are essential to maintain rights have yet to be put in place, even in developed countries.

28. Appropriate security mechanisms do not as yet exist, and will require legislation, to prevent the

   a. theft of accumulated and valuable indigenous knowledge in various domains, such as agriculture and medicine, and hence the loss of invaluable intellectual property,

   b. disruption of the economy by malicious or accidental damage inflicted on IT infrastructure, and

   c. misuse of IT to abet oppression and exploitation.

In enacting legislation, care must be taken to ensure that such laws are based on public referendum and do not themselves become tools of oppression.

ROLE OF THE GLOBAL COMMUNITY

WE DEMAND THAT

29. Developed countries play a supportive role in realising the global potential of IT;

30. Existing international bodies, as well as emerging IT-specific international organizations, contribute by

   a. facilitating international cooperation, particularly among developing countries, to share technologies and experiences in the use of IT as an instrument for development,

   b. promoting standardisation, which is critical to the rapid spread of any new technology, through the adoption of new standards relevant to IT in local languages, and establishing responsive and inclusive processes for international standardisation in IT, and by

   c. strengthening cultural diversity, and thereby reversing current homogenising influences through appropriate international action.

FROM ALL PERSPECTIVES—HUMANITARIAN, MORAL, ECOLOGICAL, ECONOMIC AND SOCIAL—INFORMATION TECHNOLOGY HAS THE POTENTIAL TO ELEVATE THE QUALITY OF HUMAN LIFE EVERYWHERE. IT IS IMPERATIVE THAT WE, THE CITIZENS OF THIS GLOBAL VILLAGE, SEIZE THIS HISTORIC OPPORTUNITY.

Further details from: Department of Computer Science and Automation, Indian Institute of Science, Bangalore 560 012, India. Tel.: 091-80-3092368; e-mail: office@csa.iisc.ernet.in; Internet address: http://www.csa.iisc.ernet.in (Source: *Meeting results*, 4 November 1998)

B. NEWS AND EVENTS

Knowledge management

Knowledge management involves the identification and analysis of available and required knowledge and the subsequent planning and control of actions to develop knowledge assets so as to fulfil organizational objectives. Knowledge assets consist of information pertaining to markets, products, technologies, resources, skills and systems that a business owns or controls and which enable it to achieve its objectives.

In businesses defined by the delivery of knowledge and solutions rather than conventional products, the return achieved on knowledge acquisition costs is a key financial indicator and the efficient management of those acquisition costs is increasingly important. The effective use of knowledge brings business and competitive advantages. Increasingly companies are marketing their track record in problem solving to their clients, as well as using the same knowledge base to sustain internal business innovation.

The knowledge manager and knowledge worker are becoming recognized roles within organizations. Companies are expressly recruiting knowledge managers including those at board level or assigning senior staff to the task. New jobs are being created to carry this role. Often with a research, IT or mainstream business background, such people usually have hybrid skills which have enabled them to make the transition.

It is likely that as intranet technology develops, internal and external knowledge analysis and provision will be integrated. However information service professionals may still be hampered by the perception that their role is to acquire information, not to analyse and contextualize it. It is at the point when information is sifted and has context and meaning applied to it that it takes on the characteristics of knowledge. (Source: *Library Association Record*, 100(4) April 1998)

Information ethics: a contemporary challenge for professionals and the community

It can be argued that information today is more freely available than ever before as telecommunications and communication technologies allow access to information from around the world. However, information is not freely available to everyone as there are many information-poor cultures who are being either left behind or left out of the competitive information race. There has always been a moral dimension to information in terms of accuracy; people who should receive it; whether or not to charge; and questions of copyright infringement. In addition, there are issues of confidentiality and commercial secrecy. Professional work should be characterized by knowledge, training, honesty and competence, and librarians are aware that taking a position on a professional matter is very much an ethical concern. In the information and library area, in addition to the issues already mentioned, professionals need also to be concerned with those of censorship, which can be very complex. Of great concern in recent years have been information liability and negligence, and confidentiality.

It is concluded that information professionals face a range of ethical challenges in the modern world. The nature of the product—information, leads to ambivalent perceptions of work which is both open and freely accountable, and at the same time, secret and commercially and politically sensitive. Large cultural and social issues such as intellectual freedom and access arise, often associated with economic and commercial factors. In addition, the information sector is made up of various organizational cultural ethics, and some of these are more entrepreneurial and competitively secretive than others. Ethical professional conduct starts with effective and honest ethical self-examination with a hard-developed integrity that requires testing in the workplace and in personal reflection. (Source: *Library Review*, 47(2) 1998)

Forged e-mails

Forged e-mails can have huge and damaging implications for businesses and individuals, including companies that deliver goods on e-mailed orders and anyone who acts on e-mailed requests for confidential information such as security passwords or private files.

Forging e-mail, termed spoofing, can work no matter what e-mail service you use. All of them give subscribers an address which is usually so that anyone can send a message to the owner. If mail is sent from a PC using the service's own proprietary software, it should automatically add a header to the message with the sender's personal address. However mail can also be sent over the Internet from a Web browser or some other e-mailing software.

Most people assume that they have to enter their own, authentic data for the mailer to work. In reality there is nothing to stop them entering false data. Once this has been done, a false address will appear in the header of any message they send. The true owner of the address has no way

of knowing it is being misused. The recipient of the mail has no reason to doubt that the message is genuine.

The only answer is for Internet service providers to use certification. This gives each subscriber a unique and unforgeable digital signature that is automatically added to every message they send. The signature provides the proof that a message really has been sent by the person named in the header. As yet no service provider uses certification for e-mail despite the fact that a formula has been agreed by the Internet's standards bodies. (Source, *New Scientist*, 2127 28 March 1998)

The European Environment Agency Web site

The European Environment Agency is a relatively new organization. Established by the Council of Environment Ministers of the European Union in 1993 the EEA exists to provide Member States with objective, reliable, and comparable information that can be put to strategic use for the protection and improvement of Europe's environment. Headquartered in Copenhagen, Denmark, 1996 was the Agency's first full year in operation.

Its Web site now receives in excess of 100,000 visits per month. The EEA has established a network, EIONET, which links a wide range of environmental agencies and should be fully operational in each member state by the end of 1998. The EEA Web site has English as its predominant language, although a few documents have been translated into a selection of European languages.

Although the EEA Web site gives the impression of not yet being fully completed, it already contains much valuable background documentation, research results, and statistical data. It is not flashy and, with a few exceptions, not graphics-intensive. There are separate sections for news stories, projects, links to other useful sites, databases, a calendar of global environmental events and a facility to search an index of keywords. A link to EIONET will be operational shortly.

The background documentation section contains the 1991 Dobris Assessment described as the most detailed and comprehensive review available of the state of the environment in 46 European countries. Usefully, this is sub-divided into a series of chapters that can be downloaded as PDF files. One of EEA's future projects, scheduled for early 1998, is an update to the Assessment. The Search/ Index section allows readers to search an index of key issues either as literal text or using Boolean. (Source: *Database*, 21(2) April/May 1998)

Chip makers warned over "Bug shutdown"

Chip fabrication plants could be brought to a standstill due to the Millennium Bug.

This is the warning of the US research and development consortium Sematech, which believes that chipmakers face the nightmare problem of identifying Year 2000 bugs in their production systems. If these are not all located and fixed in time, billion dollar chip fabs, among the most complex industrial production systems ever built, could grind to a halt.

With the chip industry struggling with a glut of chips, interrupting production could be viewed as good news for some sectors especially DRAMs, but if companies cannot get their fabs back on line, it could have disastrous effects on electronics companies and markets worldwide.

Sematech is acting as a rallying point for Year 2000 issues, and it has compiled a list of 8,200 tools from nearly 1,400 suppliers and is telling them that they should have fixes available by the year end.

Intel, which is the world's largest chip manufacturer, said it is well aware of the problem and is working on it but has no information on progress in dealing with the issue.

Sematech estimates that a paltry 880 fab tools on its list of 8,200 have Year 2000 fixes available, nowhere near enough to ensure the smooth operation of fabs. (Source: *Electronics Weekly*, 29 July 1998)

Warning, a killer mistake in business: don't let technology drive your requirements

While the right information strategy can turn failing businesses into success stories, an ill-planned approach can create havoc. The first step to avoiding costly mistakes begins by identifying the actual requirements of your organization's information needs. Companies trapped in yesterday's technology or too timid to advance with bold, fresh ideas, risk sailing a course to failure. Determining the optimum mixture of information tools for the organization begins with a sober understanding of the organization's internal processes, resources, and information requirements. Even the most experienced leaders in business struggle to avoid these common mistakes.

Until recently, most companies were starved for information. That situation is now reversing in dramatic ways. Information on a global scale is now available electronically to most people and businesses, despite obstacles of time and distance. This new found ease of sharing information is shrinking traditional barriers to communication and understanding. The amount of information available can be staggering, leaving the user with the overwhelming task of sifting for a few strands of meaningful information.

The transformation of information into knowledge is the challenge of today's top computer scientists. The integration of facts and the wisdom of human thought will soon be processed by knowledge hubs. They will be capable of providing businesses with keen situation awareness, leading to better problem solving and decision making. The knowledge hub will act as a central processor for information: organizing, sorting and recombining. The heart of the knowledge hub will be the personal computer which will provide instructions, open communications and direct the flow of information traffic. (Source: *Information Outlook*, 2(6) June 1998)

Myth-ing links: power and community on the information highway

There is a view in the news media that today computer communication is bringing about an information revolution that links people and places around the world in instantaneous communication and makes the production of information and entertainment a central economic and political force. According to its supporters, no society can resist the powerful impact of the computer, particularly when linked to advanced telecommunications and video systems. However, the author argues that one cannot understand the place of computer communication technology without taking account of some of the central myths about the rise of global computer communication systems, particularly those identified with the Internet, cyberspace and the information highway.

The information highway presents a powerful myth because it is a story about how ever smaller, faster, cheaper and better computer and communication technologies help to realize with little effort seemingly impossible dreams of democracy and community with practically no pressure on the natural environment. According to this view, the information highway empowers people largely by realizing the perennial dream of philosophers and librarians: to make possible instant access to the world's store of information without requiring the time, energy, and money to physically go where information is stored. Moreover, computer networks like the Internet provide relatively inexpensive

access with tools necessary for empowerment equally available to all.

This compelling vision is increasingly the subject of critical accounts that debunk the myth, with the information highway increasingly in the hands of corporate giants whose base in television, telephony, Hollywood, publishing and computer hardware and software gives them the resources to control pricing and products on the highway. (Source: *The Information Society*, 14(1) January-March 1998)

Taming the information flood

Controlling and managing the information streaming onto the corporate desktop is becoming ever more of a problem. Conventional sources such as fax, voice-mail and e-mail have now been joined by Web-based push technologies and smart messaging services running on mobile phone networks. Fortunately, standards for messaging systems are now becoming established, which enables guidelines as to how they should be structured to be laid down.

More and more, the front-end for unified messaging services is likely to be Web-based, as the applications are cheaper to deploy and maintain. Such an interface can also be given an attractive appearance to make a basic service more pleasant to use. An example is the nationwide public directory mounted by the Swedish postal service on its server.

There is also a requirement for a common management interface, giving access to the various servers and connectors, as well as to the user details held in the enterprise directory. Directories underpin the entire messaging system, and the addressing formats employed vary considerably from system to system. If a unified messaging connector is attempting to link (say) an e-mail and a fax system, it must be able to access both sets of addressing information. An enterprise-wide directory, therefore, needs to be developed using open standards, with connectors to the various address books.

Ideally, this meta directory should provide a single view of all data held in a number of otherwise incompatible sources, and support management of this information from a single point. Although construction of the meta directory is by no means a trivial task, once completed it supports any number of new service opportunities, from the provision of White/Yellow Pages facilities to running a cluster of servers as a single virtual service. (Source: *Communicate*, June 1998)

The soaring cost of e-commerce

Launching a commercial Web site is relatively inexpensive, making it—apparently—an attractive way of doing business. It is unlikely to attract much custom, however, unless a deal is struck with the portals which dominate Internet traffic, such as AOL, Yahoo! or Excite.

Such arrangements are by no means cheap: in June, three brokerage houses agreed to pay AOL $25 million each over two years for coverage in AOL's finance section. Only if a retailer brings content which helps to differentiate a portal from its competitors is it likely to be able to negotiate less eye-watering charges. Some portals have also entered into revenue-sharing agreements with their customers.

When determining how much it should be willing to pay for a high-profile distribution channel, the would-be outline retailer must predict the cashflow arising out of the new business which will be generated. Calculating this, however, is much easier to describe than to perform. Even when the calculations have been completed, the retailer may discover that the cost of acquiring new customers will exceed the profits that can realistically be expected from them.

Despite this, some companies have decided to pay the charges demanded, on the basis that they need to establish a position in the marketplace now, whatever the cost. This long-term strategy demands access to considerable amounts of capital.

Some rules of thumb can be applied. Do the calculations. Consider alternative approaches using other media. If it is decided to pursue the online route, choose the right partner. Focus on branding and differentiated services. Nobody, however, would claim that the decisions are easy to make—with the possible exception of the portal suppliers. (Source: *Fortune*, 3 August 1998)

Global delivery of education via the Internet

In the early 1990s, advances in telecommunications technology meant that the concept of real-time tele-education became a reality, although initially it was very expensive. By the late 1990s, educators began to experience the cyber-campus with global access being available at a relatively negligible cost. The issues that have to be considered with respect to Internet-delivered education are academic; technical; administrative; instructional; and behavioural. A major academic institution has to decide which courses should be offered in the tele-education mode and their timetable and format. The most challenging issues that have to be faced are technology mastering; faculty training; and course restructuring. A prototype course has been designed to form a simple cyber course shell which can be used for the subsequent production of cyber courses. This prototype shell provides for easy entry of educational material and presentation parameters.

In the prototype, educational material is presented as a sequence of HTML pages which may include embedded files that are audio or video, and images and animation. To provide users with a feeling of security and for design simplicity, the course has a consistent appearance. There are three options for accessing the material and these are illustrated. It is concluded that the Internet, as a network, coupled with streamlined audio technology, provides the necessary infrastructure for global course delivery. Today there is a need for course development tools which can be learnt and used with a minimum of skill, time, and effort on the part of the educator. Given time, education via the Internet will mean that no person is deprived of education because of time, inconvenience or location. (Source: *Internet Research: Electronic Networking Applications and Policy*, 8(3) 1998)

Cordless Internet service hits the airwaves

RF Internet service is speeding downloads in Detroit and Phoenix. The Internet provider, called SpeedChoice, beams Web pages over 2.5-GHz signals that give a faster throughput than traditional phone lines or satellites. Users of the service make Internet connections through a roof-mounted antenna and phone connections simultaneously. Web page or data download requests go to SpeedChoice via phone lines. Servers there retrieve the requested Web pages over an Internet backbone, then beam them from a transmission tower to the user, who can be as much as 35 miles away. A receiver at the user site feeds data to a special modem.

Downloading a 10-Mbyte file with SpeedChoice takes 1.33 minutes compared to 23.82 minutes with a 56k modem. Uploads and Web page requests over dial-up or switched phone lines take place at up to 10 Mbytes per second, and phone-line prices are claimed to be lower than for ISDN or

T-1 connections. The service will soon be available in Chicago. (Source: *Machine Design*, 6 August 1998)

A security framework for on-line distance learning and training

The provision of distance education and training facilities means broadening access to knowledge to people who would not otherwise be able to have access. Recently the widespread use of IT and the popularization of the Internet/World Wide Web has provided opportunities to develop distance learning activity in a more advanced on-line environment. The key elements of such a programme are the provision of learning materials; providing facilities for practical work; allowing for questions and discussion between students and lecturers; assessment procedures; and provision of student support services. A learning resources provider (LRP) supplies the necessary materials and services over the public multimedia network to a remote student. A generic reference model for on-line distance learning is proposed built around a life cycle module which covers enrolment; study; completion; termination; and suspension.

The communication requirements in the on-line distance learning scenario involve a number of communication flows between the LRP and the remote student and each of these will have different security requirements. There are three levels of confidentiality that have to be considered—generally available public information; information restricted to enrolled students; and information that is private between the LRP and the individual student. The security areas that demand attention in the on-line distance learning scenario are remote student authentication and accountability; access control; intrusion detection; protection of network communications; non-repudiation issues; and LRP housekeeping issues. These security issues are being addressed in the SDLearn Project which is a collaborative project between researchers at the University of Plymouth and the Fachhochschule Darmstadt in Germany. The project aims to develop new standards for secure distance learning and their implementation. (Source: *Internet Research: Electronic Networking Applications and Policy*, 8(3) 1998)

Next Generation Internet

In the US, the Clinton administration recently requested $110 million for the 1999 fiscal year, to fund development of the Next Generation Internet (NGI). This compares with an appropriation of $85 million for the current year. While many members of Congress support the concept of the NGI, agreement on funding is likely to be delayed until various issues have been resolved. These include the appropriate roles of the private and federal sectors, the avoidance of duplication in the federal efforts, and the inclusiveness of the NGI planning process.

The National Coordinating Office (NCO) published the NGI Concept Paper in June 1997, and the second version of the NGI Implementation Plan in February 1998. These note that traffic on the existing Internet has been increasing at 400 per cent p.a. in recent years, and predict that by the year 2000 more than 50 per cent of the population will have access to it. To accommodate this growth, a more powerful system is urgently required. The Implementation Plan covers the undertaking of research into advanced network technologies, the development of systems giving speeds and capacities at least one hundred times higher than those available at present, and the development of innovative applications.

Both papers state that it is not the intention to replace private sector development of the Internet, or to make the federal government a provider of commercial network services.

Nonetheless, reservations expressed by members of both houses have resulted in Congress providing only part of the NGI funding requested for 1998, and will at the very least delay approvals for expenditure in 1999. (Source: *Journal of Academic Librarianship*, 24(3) May 1998)

Round the clock, round the world

Only digital data has the flexibility to satisfy future needs. You can merge it, move it, reformat it, even print it. With the Web growing by leaps and bounds, the infrastructure is under development to reach every potential user, and that is everyone on the planet, ultimately. Efficiency, cost constraints, and our professional duty and responsibility require today's information professionals to aim their best efforts towards creating the very best information services we can build or find on the very best delivery medium the world has ever seen. Print will not die, but it will become an adjunct, a secondary medium. As more and more information goes digital and more and more people become comfortable with using digital data, the standard of round-the-clock service becomes a basic quality measure for any information service.

Most information industry firms want predictable revenue, if only to offset their highly predictable costs. At best, they want their money up front, pre-committed for the longest possible time span, as in multi year subscription contracts. That means selling to people who know the value of information. In turn, that usually means dealing with librarians or information professionals who can measure and assess the value and relevance of specific content sources for specific end-user communities. However, when you deal with information professionals, you basically deal with experts hired by consumers to look after consumer interests. They will compare shop until they get the best deal.

The content on traditional services may have the depth and breadth that professionals admire, but it usually lacks the polish and targeted, linked honing to the interests of users that Web sources have. Ultimately, information professionals report to people who are not information professionals. As those people grow more comfortable with searching the Web directly themselves, they put constant pressure on their house experts to come up with better data at a better price, preferably free. (Source: *Information Today*, 15(6) June 1998)

Investext brings valuable business and industry intelligence to the Web

The Investext Group offers Investext, MarkIntel, and the newest, Industry Insider. Their flagship product is Investext, which has full-text company and industry reports from investment and brokerage firms. Investext is found on DIALOG, Dow Jones, FT Profile, LEXIS, STN, and I/PLUS Direct, Investext's own dial-in service. In March, Investext took the Web plunge with Research Bank Web, a brand new service that has all three databases.

Industry Insider follows the Investext pattern of identifying valuable but underexploited print business information and bringing it online. Industry Insider's new territory is research from industry trade associations. Many of the larger national and international trade associations conduct extensive data gathering and analysis. Their reports and studies, typically, are available only to members, often at a stiff surcharge. As with the Investext database, this information was previously unavailable online. The database contains reports from nearly 150 industry trade associations.

With the Research Bank Web (RBW), Investext makes a cautious entrance onto the Web. In RBW all documents are in Adobe Portable Document Format (PDF), which retains original page layout, including tables and charts. Besides the value of facsimile output, this means that you have access to more reports than are available on third-party hosts. The RBW interface uses formatted screens to construct queries according to several criteria, including company, ticker symbol, industry sector, geographic region, date, report title, report author, publisher, report type, and report number. Several of these have pull-down menus to assist in selecting search values. Search criteria can be combined to produce very broad to fairly narrow search results. (Source: *Information Today*, 15(5) May 1998)

On-line information and Eastern Europe

On-line hosts have been selling into Eastern Europe for many years, generally with a mixed response. When the old regime collapsed, the situation actually deteriorated rather than improved. Before 1990, much of the on-line usage was through large government-controlled central bodies, but during the 1990s the role that these central bodies played has largely disappeared. In the short term this actually meant that on-line usage dropped in many countries.

Previously, large industries had their research departments. They had budgets, and they used information services, including on-line hosts. Today most of these companies have gone. Those who used to ask for on-line services are scattered to small firms and self-employment. The information market, therefore, will need some time to revitalize itself. The impact of decentralization, however, is just one of a number of hurdles confronting providers hoping to sell into Eastern Europe. Due to the economic situation, as well as technical problems associated with telecommunications and a lack of hard currency, conditions remain rather difficult in Eastern Europe.

Petrochemicals and pharmaceutical companies have accounted for a large proportion of East European on-line revenue up until now, and sci-tech remains the largest chunk of on-line usage in Eastern Europe. But the need for business information is growing rapidly, as companies look to expand their markets beyond their own borders. Like everywhere else, there has also been an explosion in the use of the Internet in Eastern Europe, a development that has inspired a new generation of regional on-line services. The Estonian-based Baltic News Service (BNS), for instance, provides local political, social and economic news both directly over the Web, as well as via all the major on-line hosts. (Source: *Information Today*, 15(5) May 1998)

Forces that will shape the Internet

The bulk of Internet traffic growth will come from transactions between computers unmediated by any human. Devices such as boxes atop the television set, palm computers, pagers, cellphones, and perhaps even wearable computers will depend on data automatically transmitted via the Net. In the next five years, governments will have to decide who has jurisdiction over borderless cyberspace, who can tax whom for transactions there, who is responsible when something goes wrong. Corporations will have to decide whether and how to use the Net in manufacturing, distributing, advertising, and recruiting.

Even so, network bandwidth will always be a scarce commodity. A familiar vicious circle applies: New highways built to relieve urban congestion encourage more driving and in turn become choked; so it goes with the Internet. Every time the size of the pipeline is increased, the growth in traffic

blows the forecast, not in a matter of years but in weeks or months. At the end of 1997, about 41 million American adults used the Web, according to Cyber Dialogue, a New York research firm. That figure is up from 14 million only two years before. By 2002, the projection is for at least 92 million users.

In the home, a host of consumer-electronics devices will be wired to the Net, starting with the TV itself. Microsoft's WebTV is a stand-alone box that plugs into the phone line and delivers Web pages to the set, while WorldGate Communications, will do the same using software in cable-TV set-top boxes. Digital cameras will download data to a film processor via the Net, and prints arrive a day or two later in the mail. Baby monitors hooked to the Web will let parents see their children's bedrooms via remote camera. (Source: *Fortune*, 6 July 1998)

Internet2: new computing infrastructure

Conceived by a coalition of universities, government institutions, and high tech businesses, the goals of Internet2 (I2) are to take today's Internet to the next level and give I2 members a new, powerful way to communicate and share information. To that end, I2 members, which number 100 universities and several high tech businesses, are working on developing the technology required to implement and maintain I2. Corporate partners include Ameritech, MCI, Cisco, Sprint, DEC, Sun Microsystems, and IBM.

The infrastructure and tools required to achieve the technological feat of I2 are now being developed, one example being the University of Minnesota which is pursuing a number of I2 projects. These include videoconferencing, remote video instruction, and new intranets. One of the things I2 hopes to achieve is bandwidth so enormous that the video you now view in your VCR will be available in digital libraries. The University of Minnesota is an I2 charter member and has participated in envisioning the project since its origins.

From an academic point of view, I2 could be very popular for two basic reasons: enhanced communication between research institutions and a new distribution system for academic instruction. Colleges and universities have long recognized the potential of the Internet and hope to begin realizing it with I2. One of the powerful aspects of the Internet is that it is one huge, public, low cost, and ubiquitous wide area network, available to every household with a connection and the right software to use it. I2 embraces and extends that vision. (Source: *Information Today*, 15(5) May 1998)

E-commerce: hit or hype?

E-commerce has traditionally been associated with access through a PC at the place of work or at home. The rate of growth of access to the Internet via the PC continues at a fast pace. Meanwhile new technologies are waiting in the wings to further boost consumer access to on-line services, such as WebTV which gives the consumer access to Internet stores via the home TV. Companies who prefer to wait until this channel to market is truly popular are likely to find themselves well behind those who do not.

For those who have access to the medium already, the Internet is playing an increasing role in the buying process. Consumers are beginning to recognize the Internet as a source of information that can assist in the selection of products, but usually still resort to traditional channels to complete purchase transactions. Adding the capability to complete the transaction via the Internet is a natural progression that, once in place, would actually be more convenient for the consumer and could predominate in the long term.

Research shows that the consumer is worried about security, which raises the question of whether on-line purchasing mechanisms would be used if provided. This is being addressed with the emergence of the Secure Electronic Transaction (SET) protocol, an industry standard for the use of bank credit and debit cards on open networks such as the Internet. SET is currently being tested in small pilots around the world and has the backing of Visa International and MasterCard. (Source: *Document World*, 3(3) June/July 1998)

Virtual private networks

IP-based virtual private networks (VPNs) are attracting considerable interest at present. By aggregating the traffic generated by multiple users, they provide a network service which behaves as though it were a private (voice or data) network. The client company is relieved of any need to manage a private network on its own account.

The US-based Equant has recently launched its @equant range of IP products, including offerings for managed intranets, global Internet access and a multi-protocol LAN access product which enables users to dial into their corporate network from anywhere in the world. The company claims that demand is buoyant. Another company, Cable & Wireless is making similar claims, although continuing with a three-pronged approach to the market, with different services for IP, proprietary data networking protocols and voice.

Racal's managed IP networking division, Quza, reports that Times 1000 companies, which last year were concentrating on establishing their Intranets, are now intent on converting them to extranets capable of trading with customers and suppliers. Applications likely to appear on IP networks early on are seen as fax and voice.

Traditionally, the VPN finishes at the user's network interface, but today the distinction between a VPN and a managed network service (i.e. with the supplier managing the equipment on the customer's premises) is more apparent than real. Companies such as Racal are keen to offer VPNs now, in the hope that this will be converted into a full managed service at a later date.

Although some observers have questioned whether native ATM might prove more reliable than IP, considerable investment in IP by many players suggests that they do not doubt that IP is the way to go. (Source: *Communicate*, June 1998)

Factors and issues in creating an Internet strategy

Any given organization can make use of the Internet in a variety of different ways, from simple e-mail to video-conferencing, from advertising to on-line ordering and invoicing systems. It might not want to use all the facilities available, but select those most appropriate to its needs. This, however, implies a clearly-expressed set of objectives, and a strategy intended to realize those objectives.

In formulating such a strategy, the organization must determine not only which material (if any) is currently being provided via the Web, but also that which is not. A review of the former will probably indicate that existing Web-based material can be categorized under five broad headings—public relations, publications, working/professional material, educational and practical—although further sub-groups can also be identified.

The review should be guided by the organization's communications objectives: what is it trying to say? These objectives, in turn, should take account of the user's needs and requirements, which are likely to vary considerably, depending on the audience being addressed. One overriding objective, however, should be to establish a corporate identity, as opposed to a mere corporate presence. This can be created by the use of common designs (perhaps via a template) for Web pages and adherence to "house rules" regarding their content. Unnecessary duplication of material should be avoided, and the material updated on a regular and timely basis. This, in turn, suggests the need for some form of central function to oversee the operation of the Web site.

Other aspects—such as access control and security generally—mean that reference must also be made to overall company information systems policy. (Source: *The Electronic Library*, 16(3) June 1998)

Electronic commerce and privacy

Although electronic commerce via the Web is on the increase, some commentators believe more rapid growth has been inhibited by governmental indecision regarding cryptography. Secure and private systems are seen as essential if user confidence is to be gained, yet governments around the world have feared not being able to examine encrypted documents and discouraged the use of encryption.

Late in April this year, however, the UK Government finally released its Secure Electronic Commerce statement, which indicates an intention to license the provision of cryptographic services. The precise manner in which this will come about has yet to emerge, but the intention is to create government-regulated certification authorities and trusted third parties to administer organizations' public keys. The systems are likely to employ a mixture of symmetric and asymmetric ciphers, so as to give fast transmission combined with the security associated with public keys. (Source: *Electronic Times*, (904) 1 June 1998)

Internet fraud

Internet fraud can be divided into two distinct categories. The first is fraud aimed at companies and commercial organizations, the second those committed against individuals. According to Sun Microsystems, many companies in an attempt to improve productivity unwittingly increase the vulnerability of their computer networks by adding a Web site and FTP server to allow customers to retrieve product information and software fixes from anywhere in the world at any time.

A number of frauds affect only those within the Internet industry itself. One such is the setting up of a Web site with low value content but which has hidden links to another site with high-value content. Callers have no idea that their call is being passed until they get their monthly bills. When a content provider is defrauded in this way bona fide traffic is slowed down as the additional demand is catered for. Furthermore, depending on the payment regime agreed with the outsourcer, the additional cost to the bona fide content provider can be considerable. The service provider may also be paying for bandwidth whilst receiving no revenue for the services it actually provides.

There are also a large number of frauds aimed at the individual users of communication technologies. One fraud involves the mass mailing of advertisements inviting the gullible to forward small amounts of money to start up or participate in a business opportunity. Another involves the direct solicitation of credit card data by inviting users to fill in a proforma electronic document. Armed with this, fraudsters are able to make any number of purchases. (Source: *Communications International*, June 1998)

ADSL this year for Web access

High-speed Internet access, based on asymmetric digital subscriber line technology (ADSL), will start to roll out this year, claims SGS-Thomson Microelectronics (STM).

Telecoms firms in several countries, including the US and Denmark, have committed to using the technology which gives Internet access at up to 6 Mbit/s.

DSL expects up to 400,000 lines to be connected this year, increasing to three million by the year 2000.

Although originally developed for the TV industry, particularly video-on-demand, ADSL has more recently been championed by Internet users.

Because of the switch from video-on-demand to Internet, a lower speed version called ADSL Lite has been specified by Intel, Microsoft and Compaq. It has a 1.5 Mbit/s downstream speed and 384 kbit/s upstream.

The system uses all existing wiring and phone sockets. The lower data rate also enables longer runs of standard copper wiring up to several miles.

Unfortunately, opposition to ADSL may come from the telcos themselves. The Lite specification states that the line must always be switched on, indicating a flat fee type of billing. Telcos do not like this, preferring to charge by the second for time connected. (Source: *Electronics Weekly*, 20 May 1998)

Year 2000 survival guide

The Year 2000 problem is larger than most people think. First of all, it is not just mainframe software that is affected. Hardware also suffers from Y2K consequences as do embedded systems for monitoring and controlling places as diverse as power stations, water plants, phone switches and burglar alarms. One commonly cited problem is associated with systems that monitor periodic maintenance. Our interdependent world guarantees that each initial failure will have a ripple effect.

Y2K fixing is now, however, a seasoned field. Software is tested and effective; consultants have a proven track record; and there are standard methods for handling each situation. The first principle of getting through Y2K successfully is that your enterprise must survive. This might involve outsourcing some or all of the enterprise's processing and using manual and paper-based systems.

The second principle is that you must accustom yourself to reality. You need to do real planning with real numbers and real information. It might turn out that you cannot be ready in time, even after spending a reasonable amount of money and devoting a reasonable amount of effort to the project. If so, you need to know that and start looking to Plan B from the start.

In a retail business, for example, this might include putting pads of receipts, sales tax lookup tables, and printing calculators at each register, plus providing a brush-up course on simple maths for the cashiers. Each department should estimate how many human beings it will take to do what computers do now and extra shifts might be necessary. (Source: *Byte*, July 1998)

Decaff makes a strong solution for Silicon Valley

The technique used to make decaffeinated coffee beans could be used to clean up the microchip manufacturing industry. Researchers at the Los Alamos National Laboratory in New Mexico are working on ways to use supercritical carbon dioxide—which is used to extract caffeine from coffee beans—instead of corrosive chemicals to etch circuits on silicon chips.

Chips are made up of successive layers of components, such as transistors and charge-storing capacitors, which are created using masks. When light is shone on a mask, it causes a chemical change in a "photo-resist" coating, which makes it soluble in certain areas that are dictated by the mask. Next, sulphuric acid or hydrogen peroxide eats away the unwanted material. The problem is that if these chemicals leak they can pollute local ground water supplies.

Leisa Davenhall and her colleagues at Los Alamos are putting the finishing touches to an environmentally friendly etching process using supercritical CO_2. When CO_2 is heated to more than $31°$ C and subjected to pressures over 8 megapascals, it turns into supercritical CO_2—a substance that behaves like both a gas and a liquid.

These dual properties mean that it rapidly fills any container right down to the smallest pore, but because it also behaves like a liquid, other chemicals can be dissolved in it.

The Los Alamos techniques mixes the supercritical CO_2 with a small percentage of an environmentally benign solvent, propylene carbonate. This mixture can then be used to strip photo-resist twice as fast as organic solvents or acids, without the danger of a toxic spill when accidents occur. (Source: *New Scientist*, 11 July 1998)

Almost unparalleled

A distributed computer built from 68 PCS has been found to be one of the 500 fastest computers in the world. The Avalon computer at the Los Alamos National Laboratory cost just $150,000 to build and can handle more than 20 billion operations per second. The key to its success is a rugged parallel operating system called Linux, say the researchers. (Source: *New Scientist*, 11 July 1998)

Electronic purse to get global appeal

A common global specification for the electronic purse which will allow purchases to be made in various currencies will be published later this year.

The specification is the result of a partnership between Visa International and two of the world's largest operators of domestic electronic purse programmes, ZKA in Germany and SERMEPA in Spain. The agreement means that the 50 million electronic purse cards issued by the members of these associations will become interoperable.

The specification will use public key technology. Each electronic purse will be able to hold multiple currencies, so the user can store their home country's currency, the euro and other foreign currency all on the one card. (Source: *Electronics Weekly*, 1 July 1998)

Internet telephony set to dominate by 2000

The use of the Internet for making telephone calls will overtake fixed network traffic by 2000, according to a report by industry research company Analysys.

As Internet telephone calls become cheaper and easier to make, the service will begin to threaten the established operators, says the report.

However, the major European companies will not be introducing their own Internet telephony technology until they are forced to.

Price differences will disappear in the next three to five years but for the moment international calls are cheaper on the Internet. Other long-term technological advantages will ensure the rise of the Internet call over fixed networks.

Efficiency gains offered by the use of packet networks, the low cost of deploying gateways and the potential for computer telephony integration are all set to drive long term growth of Internet telephony.

Providers of Internet telephony already offer their services to people without PCS by use of a code that connects the user to a local Internet service. (Source: *Electronics Weekly*, 24 June 1998)

Counting down

One in seven organizations in Europe and the US will not be able to complete their preparations for the year 2000 date change problem in time, according to a recent survey. The second Millennium Index from computer services company Cap Gemini covering the first quarter of this year, however, also showed that levels of preparedness and the projected investments involved vary widely from country to country.*

Nearly three quarters of organizations in Germany (74 per cent), for instance, indicate that they will not complete the work on time, simply because they started too late. But this may also be due to the extremely high level of spending planned in that country, which at $87.7 billion is more than five times the anticipated expenditure in France.

The Index, which is intended to monitor supply and demand for IT resources for dealing with the year 2000 problem, has been constructed from several sources. For the UK a survey of some 300 organizations has been used as the basis for an extrapolation of the total spend of 70,000 organizations with a turnover of more than £2 million, which account for 76 per cent of UK IT expenditure.

So what is the size of the problem? According to the Index the cost of fixing the year 2000 bug will be a staggering $717 billion in the US and Europe, with the US accounting for $520 billion of this total or over 70 per cent. But so far only $199 billion, or 28 per cent of the final projected outlay, has been spent. Other countries' millennium budgets vary not merely in the absolute amounts involved but, arguably more interestingly, in the proportion of normal IT expenditures they represent.

Moreover not only are different countries spending markedly different amounts on tackling the problem but they are also at quite different stages in their millennium campaigns.

Though the Index does provide confirmation that intensive work to counter the millennium bug is underway it also indicates that with less than two years to go before the ultimate deadline, and maybe even less before other effects begin to kick in, there are still areas of uncertainty. For a start the estimated cost of fixing the problem is still rising.

The embedded systems issue has also yet to gain the attention it requires. Almost half (49 per cent) of UK organizations have still to allocate a budget to the problem, whilst another 25 per cent appear to have no idea of what to do at all. Nevertheless within the UK the private sector is pushing out well ahead of the government in its preparations for the millennium issue.

Similar comparative figures also illustrate that the private sector has got a head-start on the public arena in actual hands-on "code renovation" work. Only 16 per cent of public sector organizations have started such detailed work, while 30 per cent of those in essential utilities have done so. The corresponding figure for manufacturing is 35 per cent, whilst in the finance sector the proportion of those getting into the electronic entrails of their systems is 60 per cent. (Extracted from *Engineering*, May 1998)

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*For more information contact Cap Gemini Sogeti, Tel.: 0171 434 2171.

Ericsson crosses Atlantic with multi-standard mobile

Mobile phone company Ericsson is introducing a "World Phone" which is capable of working on both sides of the Atlantic.

However, "World Phone" is a slight misnomer as it will not work in Japan.

The cellphone combines the circuitry necessary for GSM at 800 and 1,800 or 1,900 MHZ, D-AMPS at 800 and 1,900 MHZ and analogue AMPS networks. Ericsson says this covers 175 million subscribers and 80 per cent of the wireless market.

This is the industry's first true multi-standard phone, and is a milestone in the development of mobile handsets.

The increased integration required to implement multiple standards has therefore not affected size or weight. The phone is similar to the company's existing GF788 range, weighing 135 grams. Ericsson is aiming the phone at the business community. (Source: *Electronics Weekly*, 8 July 1998)

Encryption export ban relaxed in US

The US Government has lifted restrictions on the export of encryption products for financial institutions operating in 45 countries.

The move is seen as a gradual liberalization of strict US export controls on encryption technologies which are treated as munitions. The US Department of Commerce will allow financial institutions to use 128-bit encryption products abroad, instead of restricting them to 40 bits, provided that they apply for a one-time licence.

US computer and software firms have recently stepped up pressure on the US Government to lift all restrictions on strong encryption technologies. (Source: *Electronics Weekly*, 15 July 1998)

Gearing up for the "African Renaissance"

Internet penetration into Africa is set to receive a shot in the arm. That is if the promises of Africa's biggest ever telecoms exhibition, Africa Telecom 98, held in South Africa in May, are brought to fruition. The exposition provided a platform for the launch of a host of efforts to improve the continent's abysmal telecommunications infrastructure.

The International Telecommunication Union's (ITU) annual Telecom exposition and symposium, which moves from continent to continent each year, attracted over 20,000 participants and 400 exhibitors to the 4-day jamboree in Johannesburg.

Huge line deficit

To help address the huge deficit in phone lines, South African president Nelson Mandela called for the establishment of an African Telecommunications Development Fund. This was endorsed by many other leaders at the event and South Africa's Minister of Posts, Telecommunications and Broadcasting, Jay Naidoo, has been spearheading a caucus of African telecommunications ministers to develop a new agenda for telecommunications infrastructure development.

Building on the process started by the 1995 Abidjan Telecommunications Green Paper, which was endorsed by all of the telecommunication ministers, this has culminated in the release at the expo of their strategy document called The African Connection. This document is seen by the ministers as an indigenously developed response to the plethora of initiatives and directives coming from international and multilateral agencies such as the World Bank and the IMF.

With the massive capital requirements to meet the ministers' goal of adding 50 million phone lines over the next five years, the essence of the strategy is to create the necessary policy and regulatory frameworks to make Africa an attractive destination for the investment needed, but on African terms rather than those of the multinationals and developed countries.

New products for African market

Many international telecoms companies used the event to promote the launch of products aimed at the African market.

Reflecting the vast distances and thinly distributed population centres in Africa, satellite systems were much in evidence at the expo. These ranged from WorldSpace's digital radio system, which will broadcast 100 channels of CD quality audio anywhere on the continent via a specially built African satellite to be launched next year, to Lockheed's announcement of a partnership with Russia's Intersputnik to launch a new telecom satellite with an African footprint.

When these and existing projects are taken into account it is clear that the supply of satellite bandwidth will be changing dramatically in the next few years, promising much cheaper access to the global network. Nevertheless there was less optimism over the relevance of the much-trumpeted hand-held global mobile phone (GMPCS) systems, such as Iridium which starts operating in September. While these will clearly be attractive to business travellers, there was much scepticism over their value for the general populace because of their high usage costs relative to the continent's very low incomes.

There was however one more promising GMPCS system announced at the expo—ECCO. It will provide both fixed and mobile services, but will focus only on the tropical regions of the world, thus bringing costs down to about 35 US cents a minute for fixed links.

Internet for the masses

Public access Internet systems were also popular at Africa Telecom 98. The South African Post Office showcased its Public Internet Terminal (PIT) which provides a touch screen and smart card reader based around a Microsoft NT workstation. After further trials, PITs will be placed in every Post Office in the country, allowing users to send and receive e-mail, browse the web, access government information and carry out government transactions such as driving licence renewals.

In a different approach, France Telecom demonstrated its newly released I-Card, a smart card-based access control system for cybercafes, telecentres and other public access Internet points. A smart card is issued to each user and is charged with the credits they buy. A simple $200 smart card reader is plugged into the serial port on each PC, allowing the telecentre operator to forget about controlling and billing for access.

The I-Card administration software allows the cards to be re-charged with credits at the rate defined by the telecentre operator and also controls which applications the user can access. The smart card is also more convenient for the user as it contains their login and password, web browser bookmarks and other personalized application information. Contact ITU-Telecom, Tel.: +41 22 730 6161; Fax +41 22 730 6444; e-mail telecominf@itu.int or africa-telecom@itu.int; Website www.itu.int/telecom (Source: *CIA*, June 1998)

The challenge for traditional retailers in an on-line world

The on-line bookselling market has been exploited more vigorously, at least in the initial stages, by newcomers such as Amazon, who have stolen a march on the more slowly starting megabrands such as Barnes & Noble. It is predicted that as much as 10 per cent of all book sales will occur online with the next five years, so that much market share will be lost by the once powerful chains to new start-up companies. Such changes have not been confined to the book retailing market—digital media have also impacted e.g. music, automobile, travel, new media, entertainment, computing, transport and personal finance industries. Steps that will help the traditional retailer frame and understand the potential impact of the Internet are set out under six headings.

(1) Do not ignore the Internet: by the year 2001 Internet commerce is forecast to be worth 220 billion dollars, or nearly 1 per cent of the world's economic output. (2) Analyse the impact of the Internet on your industry: for booksellers there are the added advantages of convenience, inventory range, customer support and information details—but the Internet is not so advantageous for selling goods that have to be tried out, or where the target market is not overly computer literate. (3) Be prepared to pour significant resources into this new type of marketing, especially in building new brand names or preserving established ones. (4) Understand your strengths and weaknesses, e.g. Blackwell's Online Bookshop has chosen to focus its limited resources on those markets where its brand affinity is strongest. (5) Decide which of the following strategies is most appropriate for you—aggression, testing the water, proceeding with caution or opting out altogether. (6) The Internet does not really change the basis of one's overall marketing strategy, but the biggest opportunity it provides is to segment one's market down to a one-to-one level. (Source: *Online and CD Notes*, 11(4) May 1998)

Is it curtains for old Windows?

Software released by Microsoft only four years ago will not cope with the date change from 1999 to 2000, the company says. Microsoft is still testing some of its products to discover the effect of the millennium bug, but many older programs will never be tested.

Older versions of Windows 3.1 and Windows 95 cannot cope with the date change. Microsoft has posted some software fixes on the Internet, but the company is still investigating the full extent of the problem. Version 2 of the popular Access database program, released in April 1994, will read the two-digit date "00" as "1900".

People with DOS-based software may suffer most. These programs are still widely used in both homes and offices. Version 5 of the DOS word processor Word has serious problems. Documents dated 2000 or later may corrupt when saved. The computer then freezes and refuses to work until shut down, and valuable data may be lost. Microsoft suggests that users upgrade their software. Microsoft says it has no idea how many people are still using problem software. (Source: *New Scientist*, 2 May 1998)

Agreement reached to achieve global roaming for 3rd generation mobile systems

At the initiative of the Chairman of ITU-T Study Group 11, Dr. Sadahiko Kano, senior representatives of the world's telecommunications standards organizations from Europe (ETSI), Japan (TTC), Korea (TTA) and North America (T1, T1A) discussed collaboration in the area of networking for 3rd generation mobile systems. The participants met together in Geneva, 18-19 May, as an Ad Hoc Group of the Global Standards Collaboration (GSC²) Meeting.

They agreed to join forces towards the goal of achieving global roaming for users anywhere—anytime within the

framework of ITU standards. The International Mobile Telecommunication 2000 or IMT-2000 is an initiative of the International Telecommunication Union (ITU) which aims to integrate the various satellite, terrestrial, fixed and mobile systems currently being deployed and developed under an "umbrella standard" or concept of "family of systems". This concept which was endorsed by all the participating standards bodies aims at facilitating the evolution from today's regional 2nd generation systems that are incompatible with one another towards 3rd generation systems that will provide users with genuine global service capabilities and interoperability soon after the year 2000.

Under the 3rd generation systems, users will not only be able to roam among countries which currently use different technologies but will also be capable of seamlessly moving between multiple networks—fixed and mobile, cordless and cellular. As a result, product life cycle for core network and transmission components should be longer and network operators, service providers and manufacturers should benefit from increased flexibility and cost effectiveness. A definite boon for the industry, the global approach embedded in IMT-2000 whether technical, operational or functional, should also prove particularly attractive to developing countries. But perhaps more important, users who currently cannot use their handsets when they travel to areas where other systems are in use, would greatly benefit in terms of cheaper terminals through economies of scale, reduced tariffs through increased competition, and greater functionality, operability and choice of services and equipment. While the path of evolution as well as their speed will be governed by the market needs, appropriate global standards as well as the harmonized assignment of suitable spectrum by the various national and regional authorities within the framework of the internationally agreed spectrum allocations in the ITU Radio Regulations will be the determining factors for a successful implementation of IMT-2000.

IMT-2000 is being developed in recognition of the fact that future wireless access systems will need to provide users with the same high quality and broadband characteristics offered by fixed networks. As wireless becomes a major part of global telecommunications, common network components need to be developed which can provide virtually any desired future service combination between wired or wireless access links. This is all the more important in a competitive, multi-operator environment.

The agreement is significant because of the commitment of all key regional standards organizations to promote IMT-2000 as a backbone for tomorrow's mobile systems unhampered by differing national or regional implementations. (Source: *News Release*, 21 May 1998)

ITU and Brazil sign cooperation agreement

An agreement was signed between the International Telecommunication Union and Brazil's recently created national regulatory body—Agência Nacional de Telecomunicações (ANATEL) to provide advice on the structure and operations of ANATEL with a view to enhance its efficiency.

The agreement contains 18 projects most of which focus on priority regulatory issues that should be implemented urgently. These include numbering and interconnection issues in a competitive environment, service and network quality obligations and open access and universal service issues in the emerging Global Information Infrastructure. The projects also cover the development of regulatory competencies through training and the study of the micro and macroeconomic impact of the transition to an open and competitive telecoms environment on the country's economy.

The objective is to enable ANATEL to create a stable regulatory environment that will ensure fair competition among the various players that are and will operate in Brazil's telecommunications market.

The project, which amounts to US$ 22,145,000 is financed entirely by the Brazilian government. It is expected to be completed by the end of 1999. (Source: *News Release*, 1 April 1998)

Patent award for recycling of PFCs

Air Products and Chemicals has been awarded a US patent (5,730,779) for a system developed for recycling perfluorinated compounds (PFC) from semiconductor manufacturing effluent streams.

The patent covers the system's membrane-based gas separation technology which separates the PFCs—such as carbon tetrafluoride and hexafluoroethane—from the large amounts of nitrogen present in the exhaust. The concentrated stream of PFCs is then returned for purification and recycling.

PFCs are used for etching and cleaning operations in the fabrication of various electronic devices, including the construction of integrated circuits for computer applications. (Source: *European Chemical News*, 6-12 April 1998)

Information management and challenges for development in Africa

The development challenges that face Africa at the turn of the new century are no different from those of fifty years ago. Instead, they have become more complicated as the world order changes. Africa is still struggling to meet basic needs of food; shelter; education; health; and security. There is also the increasing debt burden; spread of pandemic diseases; and retrogression in controllable diseases while natural disasters and war have taken a heavy toll. Against this grim background, information management can play an important role if it is geared to contribute to the development process. Development is defined as improvement in standards and quality of life. However, the development that has been practiced has been geared to Western value system needs, productivity, and the use of natural resources. The gap between rich and poor is widening and the need for information is much greater than ever at a time when public resources to expand information management are dwindling.

Whatever strategy is used it has to contribute towards meeting basic human needs, be self-sustainable and not propped by exogenous forces. It has to be intertwined with the socio-cultural context of the participants and beneficiaries. The strategy used has to be one which empowers people to define their situation and transform undesirable elements and have access to the resources needed. Information management has not escaped some of the pitfalls of recent initiatives. Record keeping and information storage and transformation has benefited from advances in electronic and print media. However, there is not yet an effective delivery strategy that reaches ordinary people. Factors to be considered are information management for effective development; generation of information and analysis; information storage and distribution; and information assimilation in the development process. Lessons to be learnt from past mistakes are that development agents should play a catalytic role to ensure sustainability and continuity of development initiatives. It is concluded that a more co-ordinated approach to information management with the aim of bringing effective development through alternative strategies is probably the answer to the so far elusive dream of effective development. (Source: *Records Management Bulletin*, No. 85, April 1998)

Second network for speed demons

Scientists who need superfast computing networks now have a new way to get their fix, which should make it easier for scientists to do everything from operating a telescope remotely to hitching together far-flung computers.

Right now, most scientists who need fast data transmission turn to the National Science Foundation's very high performance Backbone Network Service run by MCI, which moves data at up to 622 megabits per second (Mbps). The new network, called Abilene, will be four times faster—2.4 giga-bps, which can transmit the *Encyclopedia Britannica* in 1 second. Universities will decide whether to link to an Abilene node.

Developing the network is the University Corporation for Advanced Internet Development, a group of over 120 research universities which runs Inernet2, a project helping to create the federal Next Generation Internet. Abilene's infrastructure, however, is a gift: It will start operating this year on 26,000 kilometres of fibre-optic lines, a service worth an estimated $500 million donated by Qwest, a Denver company that wants to show off its network to potential business customers. Cisco Systems and Nortel are chipping in other equipment. (Source: www.sciencemag.org, *Science*, vol. 280, 24 April 1998)

Membrane unit recovers PFCs from exhaust

Air Products and Chemicals has received US patent No. 5 730 779 for its perfluoro compounds (PFCs) recovery and recycle system, which will enable semiconductor manufacturers to reduce PFC emissions from their processes.

The system employs membrane-based technology which separates the PFCs, such as carbon tetrachloride and hexafluoroethane, from large amounts of nitrogen present in the exhaust of semiconductor fabrication facilities. The product, a highly concentrated mixture of PFCs, can be returned to Air Products for purification and recycling. (Source: *European Chemical News*, 30 March-5 April 1998)

New engineering body to represent 40,000

Three engineering institutes have been merged to form the 40,000-member Institute of Incorporated Engineers (IIE).

The three, the Institution of Electronics and Electrical Incorporated Engineers (IEEIE), the Institution of Mechanical Incorporated Engineers (IMechIE) and the Institute of Engineers and Technicians, have pooled their resources with the aim of producing engineers more suited to industry's needs.

The IIE believes industry requires engineers with a broader knowledge, rather than the more specialized chartered engineers catered for by the IEE.

The IIE plans to lobby universities to provide suitable degrees, give training relevant to employers and strengthen the regional and overseas networks to aid personal and career development. (Source: *Electronics Weekly*, 8 April 1998)

Chips for cheap PCs

Intel has announced the first product in a series of processors aimed at low cost PCs.

Celelon, previously codenamed Covington, is a new brand of processors based on the Pentium II/Deschutes core, but with fewer features. The processor is aimed at the sub-$1,000 PC market, and will replace the Pentium with MMX from April.

Later this year, Intel will announce the second Celeron processor, codenamed Mendocino. This will reintroduce 256 kbyte of cache, but integrated on-chip, and running at the full processor speed. The performance boost will be significant.

For high end machines, such as multi-processor servers, the Deschutes processor will move to a new package, called Slot 2. This will have a full speed level two cache, and will run at up to 450 MHz this year. (Source: *Electronics Weekly*, 11 March 1998)

Ultracomputer will model global environment

The Japanese computer company NEC has announced that it will develop a 32 Tflops (10^{12} floating point operations per second) parallel computer for the study of global environmental problems. Described as an "ultracomputer" by NEC, the system will play a central role in the Earth Simulator Programme of the Japanese Science and Technology Agency.

The system will expand on NEC's current SX-4 supercomputer technology and is scheduled to come on line in 2005. The ultracomputer will consist of thousands of vector processors connected in parallel and will have more than 4 Tbyte of memory.

The ultracomputer will be used to perform virtual Earth simulations that will use data from Earth observation satellites to initiate, refine and validate the calculations. According to NEC, the system will open up new possibilities in computer simulation such as predicting climate change on a global scale. (Source: *Scientific Computing World*, March 1998)

Consortium will study interfaces

A consortium of European universities and research institutes has been awarded an ECU 1.3 million grant from the European Union to create systems for the continuous interaction between humans and computers.

The Theory of Continuous Interaction Techniques (TACIT) project will focus on interfaces that involve image and speech recognition and virtual reality visualization. The project is coordinated by the Italian Consiglio Nazionale delle Ricerche (CNUCE).

TACIT researchers will investigate the design of systems that allow multiple users access to complex information through continuously changing computer interfaces. TACIT plans to accomplish this by integrating ideas from computer science, cognitive psychology and semiotics into models for interaction. Computer architectures to implement these models will also be developed. (Source: *Scientific Computing World*, March 1998)

Strategic alliance proposed to speed up the advent of digital radio

In a move to provide a single forum for all players to act cooperatively, broadcasters, network operators, transmitter and receiver manufacturers, other hardware and software industries and standards and regulatory bodies have set up a non-profit consortium coined Digital Radio Mondiale.

The aim of DRM is to produce a system for short-wave, medium-wave and long-wave broadcasting that would be the single, tested, open non-proprietary, consumer-oriented digital broadcasting world standard.

The consortium, which adopted a Memorandum of Understanding, has suggested that the ITU be the depository of this MoU. The partnership would make DRM a technical resource for the ITU in developing the specifications for the system. The single worldwide standard is considered necessary to keep costs down and reach a mass market required to encourage broadcasters to move away from analogue systems currently used.

The ITU has already approved two basic recommendations that define the overall system requirements needed to

carry out future evaluation of proposed new systems on a common basis and has established a lead group to deal with the rapid development of a single worldwide standard.

This action has been taken in response to the 1997 World Radiocommunication Conference which decided to give a green light to the adoption of spectrum-efficient techniques such as digital modulation techniques. WRC-97 took this decision given the imperative need to make room in the highly congested HF bands.

Broadcasters have a vital interest in adopting digital techniques. Most public broadcasters are operating large AM transmitter networks in short-ave, medium-wave and long-wave frequency bands which required huge investments but are facing a steady decrease of their audience due to the better quality offered by other delivery mechanisms. The introduction of digital techniques for broadcasting in these frequency bands could revitalize the service and the networks could continue to be usefully exploited.

Implementation of digital radio for broadcasting is expected to allow operators to provide services which could compete successfully with current and future high-quality audio services. Digital broadcasting AM represent a net improvement over conventional analogue radio in that it will provide higher reliability, superior stereo audio quality comparable to that of FM, better protection against interference, greater area coverage with less power and easy-to-tune receivers.

The system would also have to be compatible with any digital and conventional analogue system either through dual-system receivers or a simulcast approach that would enable a smooth transition from analogue to digital. It would also have to take account of the different planning environment where the channel spacing differs among regions and frequency bands. (Source: *News Release*, 24 March 1998)

ITU announces partnership agreement with Canada to increase developing countries' access to information and knowledge

The International Telecommunication Union has announced that it had agreed to establish a strategic partnership agreement with Canada to help developing countries participate actively in the global information society.

Partnership arrangements are one of the most promising potential strategies for telecommunications development and the ITU Telecommunication Development Sector strives to promote partnerships which benefit all partners, avoiding purely commercial approaches and concentrating on long-term benefits as opposed to short-term gains. Together, the partners each bring elements necessary to the success of the venture. It is by making use of all these resources that "inhibited" potential markets in the developing world can be made to flourish, thus creating a truly universal global information infrastructure.

The partnership agreement is expected to cover Canada's cooperation with the ITU and in particular:

- Pursuing universal access
- Executive training
- Capacity-building
- Joint pilot projects to encourage rural communications and applications in social, education and health services, especially in Least Developed Countries (LDCs)
- Regional seminars on best practices and
- Promotion of private sector, government and ITU partnerships.

Canadian government participants including CIDA, the International Development Research Centre and Industry Canada will work with private Canadian companies.

Canada's participation in this new partnership is the latest in a series of programmes undertaken by Canadian institutions to work with private companies, international agencies and financial institutions and non-governmental organizations to broaden access to knowledge technologies towards strengthening the global information society. (Source: *News Release*, 30 March 1998)

Latest internet hacker threat ...

A new technique used by hackers to vandalize corporate networks and Web sites has security experts scrambling for solutions, reports the *Wall Street Journal*. Called smurfing, this latest version of a denial-of-service attack does not allow access to sensitive information but rather lets almost any Internet user harness hundreds of computers on a network to flood unwitting victims with data, crippling their network connections and degrading the speed of neighbouring Internet connections. Smurfing works like this: Hackers exploit a common Internet feature known as pinging, a function that allows network administrators to query remote machines to see if they are operating correctly. A smurf programme used to direct as many as several hundred remote responses to an intended victim's computer at once triggers a digital deluge. Security experts liken the prank to sending dozens of pizzas to someone who never ordered them. (Source: *Communications of the ACM*, March 1998, vol. 41, No. 3)

SEMATECH forms international SEMATECH

The globalization of SEMATECH took a step forward with the official formation of International SEMATECH, which will take over the work of the US semiconductor manufacturing technology R&D consortium's International 300 mm Initiative (I300I) subsidiary, while adding responsibility for lithography infrastructure, semiconductor industry standards and environmental, safety and health (ESH) issues.

There are 15 companies participating in International SEMATECH, which will officially begin operation on 2 April at the SEMATECH facility in Austin, Texas. The international participants, who were previously involved in I300I, are Hyundai Electronics Industries of South Korea, Philips Semiconductors of the Netherlands, SGS-Thomson Microelectronics of France and Italy, Siemens of Germany and Taiwan Semiconductor Manufacturing Co. (TSMC) of the Republic of China.

The American participants are the ten members of SEMATECH: Advanced Micro Devices, Digital Equipment, Hewlett-Packard, Intel, IBM, Lucent Technologies, Motorola, National Semiconductor, Rockwell and Texas Instruments.

Semiconductor Equipment & Materials International (SEMI), the industry group representing suppliers of capital equipment and chipmaking materials, recently endorsed the formation of International SEMATECH. Although US companies dominate the SEMI membership rolls, there are dozens of companies from Europe and Asia that belong to the trade group, which maintains offices in Brussels, Belgium; Hsinchu, Taiwan; Seoul, South Korea; and Moscow, Tokyo and Singapore, in addition to its four US offices.

SEMATECH said International SEMATECH will have its own board of directors. The 10 members of the SEMATECH board of directors will also serve on the International SEMATECH board, along with the five representatives of Hyundai, Philips, SGS-Thomson, Siemens and

TSMC. SEMATECH's annual operating budget will increase from $125 million to $160 million, all funded by dues paid by the members of the two organizations. SEMATECH originally received funding from the US Government through the Department of Defense and the Defense Advanced Research Projects Agency (DARPA), but that funding ended last year, at SEMATECH's request. The members of SEMATECH increased their corporate dues on the first of this year to help make up the difference in the annual budget; SEMATECH is now a smaller organization, down more than 100 employees from two years ago. (Reprinted with permission from *Semiconductor International Magazine*, March 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Mobile phone makers see recycling threat

The threat of the EU imposing a tax for the recycling of mobile phones is spurring the industry to come up with its own recycling schemes.

To prevent the tax from slowing the adoption of mobile phones, handset makers, mobile phone operators and retailers are joining forces to develop their own inexpensive schemes for recycling. The objective is to enable each store that issues a mobile phone to take it back for recycling. The majority of funding for the scheme will come from the industry itself, but some cost may trickle down to the user.

A six-month trial in the UK and Sweden, dubbed Takeback and launched by Motorola, Nokia, Ericsson, Panasonic, Alcatel and BT Mobile, has found that only four per cent of handsets were returned for recycling.

Its other findings include the typical lifespan of handsets are between two and four years, and that the attitude regarding recycling varies according to the country.

While obstacles for the recycling scheme remain, the industry is confident that the objective of economically recycling mobile phones through local suppliers is achievable. (Source: *Electronics World*, February 1998)

EU evaluates role of HPC

A new European Union (EU)-funded programme for high-performance computing (HPC) technology will evaluate the role of new computer technology in research and industry. The Development of an Interdisciplinary Round-Table for Emerging Computing Technology (DIRECT) includes 14 member scientific institutes from European Union (EU) countries.

DIRECT consists of three Enterprise Groups. The Visualization and Emerging Computing Techniques group will bring together researchers in fields at the forefront of visualization such as computational fluid dynamics. The Data Storage and Management group will provide the EU HPC community with a forum to discuss data-related problems. The Data Inter-operability group will evaluate the current state of data standardization, representation, transfer and mediation with the aim of improving data mobility and inter-operability. (Source: *Scientific Computing World*, February 1998)

EECA presents fresh PCB focus

The European Electronic Component Manufacturers Association (EECA) has relaunched its PCB activities.

The EECA PCB committee is the long-awaited response to the establishment of the European Federation of Inter-connection and Packaging (EFIP). EFIP was set up a year ago in response to several PCB manufacturers in the UK and the rest of Europe being dissatisfied about their represen-tation with regard to the rest of the world.

The committee aims to identify trends in the PCB and interconnection industry to enable members develop appropriate strategies in response. (Source: *Electronics Weekly*, 14 January 1998)

Satellite will eclipse DTT

Digital satellite television will for a short while eclipse digital terrestrial television (DTT), forecasts analysts Datamonitor.

Even though there will be up to 1.4 million European households with DTT by the year 2002, the satellite broadcasters will have control of the digital market with a 65 per cent share and 13 million digital subscribers. (Source: *Electronics Weekly*, 14 January 1998)

Bookselling on the Internet: a future that works

The coming of the book superstore in the US had already substantially changed the climate of retail bookselling before the Internet came on the scene. Bookbuyers were presented with wider choices and more amenities. The Web-based bookseller Amazon has extended this evolution, copying some of the superstores' techniques, but building on the unique strengths and novelties of the electronic medium. For example it allows the bookbuyer to search for books, browse subjects, find out about bestsellers, and have books recommended based on their interests. The customer can see the book covers, read the blurbs, and in some cases download a short excerpt. What it cannot do is provide human contact and physical ambience.

When it comes to special orders for titles not stocked in bookstores, Amazon probably has the edge. Special orders can be a valuable service in a bookstore if the customer can be assured that the book is in print and available, if the order is executed promptly, and if the customer is notified as soon as the book arrives. Amazon reduces the uncertainty in the ordering process, thereby gaining customer satisfaction and competitive advantage. Unlike stores, Amazon also allows customers to do their own look-ups and using the service's search engine is like dealing with a superbly well-informed bookseller. In addition, for almost all books, Amazon's price is 30 per cent off for hardcover titles and 20 per cent off for paperbacks. This compares with superstore discounts of 30 per cent on hardcover bestsellers and discounts of 10 to 20 per cent on other hardcovers. (Source: *Logos*, 9 (1) 1998)

IT-related training opportunities

The Institute for Development Policy and Management (IDPM) at the University of Manchester provides an annual cycle of IT-related training programmes for those who want to manage, create and implement effective information systems.

All programmes incorporate a contextual understanding of developing and transitional economies, and of the public and NGO sectors.

For 1999/2000, the following programmes are available:
- Masters degree in "Management and Information" October 1999 for one year
  The programme is aimed at managers and IT professionals who wish to update their skills and knowledge in three areas: information systems, management, and information technology. The programme aims to create the "hybrid professionals" who will be essential to organizational change in the 21st century.
- Training for Computer Trainers January 2000 for twelve weeks
  This programme is aimed at computing personnel who need to disseminate computing skills to other staff in their organization, and at trainers who need to include

computer training in their portfolio. It covers training analysis, design, delivery and evaluation as core components.

- Postgraduate Diploma in "Management Services and Information Systems"

    April 2000 for one year (including nine months by distance learning)

    This innovative programme for "agents of change" combines three months of study in the UK with distance learning components. It trains participants in two key aspects of the organizational change process: new staffing arrangements and new computerized information systems.

- Effective Microcomputer Information Systems

    June 2000 for six weeks

    This is a practice-based programme aimed at IT professionals and managers who want to derive maximum benefit from the computers being introduced into their organizations. It provides participants with the skills and confidence to understand organizational information problems, and to design and implement computerized information systems.

Full details plus application forms can be obtained from the IDPM Web site: http://www.man.ac.uk/idpm/

The Web site also includes:

- Details of potential sponsors
- On-line reports on public sector and development informatics
- Links to other informatics sites.

Alternatively, details and application forms can be obtained from:

Dr. Richard Heeks, Senior Lecturer,
Information Systems and Development
Institute for Development Policy
  and Management
University of Manchester
Precinct Centre
Manchester M13 9GH
UK
Tel.: +44-161-275-2870; Fax: +44-161-273-8829;
e-mail: richard.heeks@man.ac.uk

(Source: *IDPM Personal Communication*)

C. NEW DEVELOPMENTS

Liquid logic

Chemicals that function like electronic circuits on a silicon chip can now compute responses to up to three separate inputs. These molecular logic gates respond to the presence or absence of the inputs by emitting coloured light.

Some of these chemical switches are made up of molecules that light up when they grab a molecule from the surrounding solution. Others turn off when certain molecules are present. Already, such simple YES and NO logic gates are being used as sensors that monitor acidity levels or the concentration of sugar in blood.

A few years ago, A. P. de Silva and his colleagues at Queen's University of Belfast designed a chemical AND logic gate—a molecule that lights up only if it detects two different ions at once. Now he has pushed molecular logic a step further, with a NOR gate and an INHIBIT gate.

The NOR molecule lights up only if neither mercury ions nor protons are present in solution. INHIBIT lights up when it senses both calcium ions and organic molecules called cyclodextrins—but the presence of oxygen turns the light signal off. (Source: *New Scientists*, 12 September 1998)

A new angle for flash cards

Flash is a solid-state, non-volatile memory for storing data in electronics gear when power is off. A new type of flash memory card from Hitachi Semiconductor, Brisbane, Calif., can hold up to 300 Mbytes of data, four times more than conventional cards. The development making this possible is a new method of packaging the memory chips in the card. Instead of mounting the chips flat, the new card has its ICs mounted standing up on an angle. With this angled configuration, up to forty 64-Mbit memory chips can be crammed into one PCMCIA card. Conventional cards can only hold ten. Contact Hitachi by fax, (303) 2997-0477, or stop by their Website: www.hitachi.com/semiconductor (Source: *Machine Design*, 6 August 1998)

Hydrogen-powered laptops and TVs

A new fuel cell uses hydrogen and air to create electricity for laptop computers, lanterns, small TVs, and other portable devices that usually rely on batteries. Developed by engineers at Dais Corp. working with Rensselaer Polytechnic Institute's New York State Center for Polymer Studies, the fuel cell and a $2 tank of hydrogen

(roughly the size of a quart of milk) will provide enough electricity to light a fluorescent lamp for more than 40 hours,the equivalent of 80 D-cell batteries. In its smallest size, about as big as a half gallon of ice cream, the quiet, air-cooled unit can power several devices needing up to 30 W. When in commercial production, the device would cost about $200 and last 4,000 hours, according to Dais. The company is working on a 2,500-W fuel cell as well as pellets that will generate hydrogen fuel when dissolved in water. (Source: *Machine Design*, 23 July 1998)

Flower power

Researchers at Los Alamos National Laboratory are working on solar cells that use a process like photosynthesis in plants. "We ultimately hope to develop a more efficient means of grabbing solar energy and converting it into electrical power", says Greg Van Patten of the Bioscience and Biotechnology Group. The cells consist of a glass substrate dipped in a chlorophyll-like dye called porphyrin. The glass is coated with multiple dye layers of different colours to absorb more energy from the sunlight. When a photon strikes a porphyrin molecule, one of its electrons is bumped to a higher energy state. This molecule then passes its energy to a neighbour in bucket-brigade fashion generating electrical current. The molecules must be lined up in an orderly way on the substrate for the energy to transfer. That remains a technical challenge. If the research is successful, however, these low-cost, low-tech solar cells could eventually supplant conventional solar cells. In another application, energy-transferring films could use energy from sunlight to render toxic substances harmless. For more information, contact James E. Rickman. Tel.: (505) 665-9203. (Source: *Machine Design*, 23 July 1998)

Bus instruction set computer

Y. Yamashita and his research team at the Department of International Development Engineering, Faculty of Engineering, Tokyo Institute of Technology, have devised and established the logical design of a new type of processor, the Bus Instruction Set Computer (BISC), featuring high-speed processing with easily added functions.

The architectures of microprocessors in ordinary use today are the CISC, RISC and VLIW versions. The working speeds of these architectures are being increased by

pipelines, superscalers, branching estimation and instruction reordering. However, introducing these functions makes the processors increasingly complicated, so it is actually difficult to make additional changes in processor functions in response to needs. The BISC architecture was devised to cope with this situation, and a BISC-1 processor is being fabricated based on this design.

In the architecture to issue instructions, when the leading single bit is 1, this indicates that a series of instructions have been completed and will be followed by branching. When the next single bit is 1, this indicates that the next word is not an instruction but an immediate data. After that, the register numbers of the sender and the receiver are aligned in a pair.

For the execution of instructions, the sender register is read out, and when the receiver register can read in, this is achieved by data transfer. For arithmetic or logical processing, a bit of data is transmitted to the register to indicate the type of arithmetic processing to be achieved by the arithmetic logic unit (ALU). In this case, the number of bits necessary for indicating the arithmetic processing is few, so it is possible to indicate several batches of arithmetic processing with a single word. Arithmetic processing is commenced as soon as the necessary volume of data for the ALU input register is transmitted, and the results are read out with the output register.

Regarding branching, a register to set the branching destination address and a register to indicate whether the branching is conditional or non-conditional are prepared (with BISC-1, the register surplus bits other than those used to indicate the type of arithmetic processing are used). The conditions for conditional branching are provided in the same manner as for indicating the type of arithmetic processing to the ALU. The information regarding the establishment or non-establishment of the conditions is transmitted to the branching control unit, and branching performed after carrying out the instructions of the leading bit. Based on this branching function, there may be cases in which the branching destination is determined beforehand (as with a looped message), so branching can be achieved efficiently.

This architecture does not require instruction set changing with respect to the additional changing of functions, so various types of functions can be added with ease. In addition, the time for executing an instruction can be shortened to the extent it will be impossible to shorten the time further, so the resources inside the processor can be utilized most efficiently. Further, since the range in which operations must be performed with the same clock frequency is rather narrow, the issue of clock skewing is alleviated. At present, the logical design of BISC-1 with duplicated internal bus has almost been completed, and performance evaluation is presently in progress.

Further details from: Tokyo Institute of Technology, Department of International Development Engineering, Faculty of Engineering, 2-12-1, Ookayama, Meguro-ku, Tokyo 152-8552. Tel.: +81-3-5734-3497; Fax: +81-3-5734-3497. E-mail: yamasita@ide.titech.ac.jp (Source: *JETRO*, June 1998)

Long electrolytically polished coiled tube

Kuze Bellows Kogyosho Co., Ltd. has developed an electrolytically polished (EP) coiled tube that is 100 m long for use in the special gas feeding lines for the manufacture of semiconductors, to cope with the size enlargement of semiconductor factories. The longest coiled tube in use previously had been 60 m, so this new 100 m coiled tube is the longest available. The new coiled tube is safe and there is no hazard of leakage of gases.

Using the new extra-long coiled tube decreases the number of welding points and shortens the welding time considerably, so that the overall cost is decreased by 10-20 per cent. In addition, since the tube inner surface roughness is suppressed to less than 0.7 μm, and since there is no metallic contamination inside the tube arising from welding, the coiled tube can now be used to handle a wide range of highly pure fluids such as ultrapure water and high-purity medical drugs in extra-clean production plants. When shipping these tubes, thorough cleaning with high-temperature ultrahigh-purity water and high-temperature baking are performed to remove impurities such as oil particles, effused ions, moisture and other foreign substances.

The company plans further research to develop a 100 m coiled tube of smaller calibre with an outside diameter of 6.35 mm as well as a coiled tube that is 120 m long. Further details from Kuze Bellows Kogyosho Co., Ltd. 74-1, Minamichujo, Tsubata-cho, Kahoku-gun, Ishikawa Pref. 929-0343. Tel.: +81-762-89-4740; Fax: +81-762-89-2136. (Source: *JETRO*, July 1998)

IC chip integrating lithium ion battery charging and abnormality correction functions

Mitsumi Electric Co., Ltd. has developed an IC chip MM 1433 that integrates in a single chip the functions for lithium ion battery charging and abnormality correction.

Conventional types of ICs with the battery charging function only incorporate the functions necessary for constant voltage (CV) and constant current (CC) charging and not the other functions necessary for battery charging. Users therefore had to devise circuitry by assembling a microcomputer or discrete component featuring the functions for preliminary charging, recharging as well as for abnormality correction, correcting overvoltages and overcurrents. The company has succeeded in developing an analog IC monochip that integrates all these functions for preliminary charging, recharging and abnormality correction.

The new IC chip incorporates all the functions necessary for lithium ion battery charging, or the preliminary charging and recharging functions including a highly accurate constant-voltage and constant-current charging function that constitutes a basic charging requirement (the constant-current charging function is determined by an external AC adaptor rated output current). In addition, the charging unit is structured with only a few ancillary components but incorporates a function to turn the timer off to prevent over-voltage and over-current at time of charging, as well as a function to correct abnormalities whenever some irregularity occurs with the AC adaptor.

The main uses of this IC charging chip are the charging of portable telephones, PHSs, PDAs and movie units as well as their ancillary devices. It is also usable for charging mobile devices such as portable telephone units of which miniaturization and weight reduction are in progress. Further details from Mitsumi Electric Co., Ltd., 8-8-2, Kokuryo-cho, Chofu City, Tokyo 182-8557. Tel.: +81-3-3489-5333; Fax: +81-3-3480-5582. (Source: *JETRO*, July 1998)

Largest, most powerful laser

The National Ignition Facility (NIF) is a stadium-sized laser complex under construction at Lawrence Livermore National Laboratories, Albuquerque, NM. When completed, the NIF will be the largest, most powerful laser on the planet. It will be able to simulate, on a small scale, the temperatures and pressures developed during the explosion of nuclear weapons. In one experiment, beams from 192 powerful lasers are focused onto a BB-sized capsule containing deuterium and tritium. This is expected to produce ignition and

self-sustained fusion burn of the target, similar to what happens at the core of stars.

It is befitting that the world's largest laser employs the world's largest single crystal. The huge pyramid-shaped KDP (potassium dihydrogen phosphate) crystal weighs over 500 lb and measures 22 in. across its base. Using a fast-growth method pioneered in Russia, scientists at the lab were able to grow the leviathan from a thumbnail-sized seed crystal in only six weeks, as opposed to two years using conventional methods. Moreover, the quality is much better. The crystal is a key component of the laser, but not in bulk form. It must first be sliced into plates 1 cm thick. The plates convert light from the laser into a shorter wavelength. About 700 of the plates are required.

Technology developed for NIF should lead to advances in such areas as electro-optics, high-speed instrumentation, and advanced imaging. The $1.2 billion facility goes on-line in 2001. To find out more about NIF, browse the Lab's website: www.llnl.gov (Source: *Machine Design*, 6 August 1998)

Clever pipework takes the heat out of chips

Chips with a built-in cooling system have been developed by researchers at Sandia National Laboratories in Albuquerque, New Mexico. Fluid evaporating in pipes in the substrate of the chips ensures that they do not overheat.

Standard chips have long relied on heat spreaders, which conduct heat from the chip to metal fins that transfer energy to fan-blown air. Some manufacturers have turned to tubular heat pipes to cool their chips, but transferring heat from the flat chip to the cylindrical pipe has been a problem. To improve on this, Sandia makes heat-transfer tubes within the chip's substrate. Using standard photolithography and electroplating techniques, they form layered ridges from 5 to 50 micrometres wide on a pair of flat plates, which they press together to form a grid of tiny interconnected heat pipes. They then add a drop or two of coolant, usually methanol, and seal the structure around its edges.

Heat evaporates the coolant, which expands through the pipes to reach the outer regions of the structure, transferring heat from the centre to the outside more efficiently than a simple metal plate. After releasing the extra heat, the coolant condenses, and capillary action through the lattice of openings pulls it back to the central region, where the chip heats it again. (Source: *New Scientist*, 1 August 1998)

High-temperature superconductors

After several years of stagnation, superconductivity research is hotting up once more. A team led by scientists at IBM's laboratories in Zurich has devised a way to double the temperature at which one compound will conduct electricity with zero resistance. If the approach works for other materials, it may be possible to achieve superconductivity at temperatures nearing 200 kelvin—around -70°C. This would open the door to superconducting devices that do not require prohibitively expensive cooling systems.

The new IBM research, led by Jean-Pierre Locquet, builds on the discovery that this same material will superconduct at up to 164 K if subjected to high pressure. The pressure effect arises from changes in the spacing between atoms in the complex layered crystals from which superconducting ceramics are formed. But the direction in which the pressure is applied can be crucial. Squeezing superconducting ceramics along some crystal axes can increase the superconducting temperature, but squeezing them along others can lower it.

Locquet and his colleagues report that squeezing the atoms together increased the highest temperature at which the material would superconduct from 25 K to 49 K. Stretching the atomic spacing in the film reduced this temperature to 10 K.

The big question is how far the results can be extended to other materials. "This technique is broadly applicable to other high-temperature superconducting ceramics", claims Locquet, who believes that bismuth-based materials might be made to superconduct at 180 K, but the effects of applying pressure to different axes of many ceramic superconductors remains unknown. Locquet picked the lanthanum-strontium-copper compound because he knew how to grow substrates with the desired spacings. Growing films of other compounds may be more difficult. (Source: *New Scientist*, 1 August 1998)

A small revolution in motor mechanics

European researchers have built what could be the world's smallest motor: a single molecule that spins millions of times per second.

The discovery, by an international team led by James Gimzewski at IBM's Zurich Research Laboratory, shows that it is theoretically possible to build mechanical devices a thousand times smaller than the tiniest silicon-based machines available. Because its components are built from single molecules, the motor will not wear out or need lubricating, allowing it to work at extremely high efficiencies.

The team stumbled across the molecular motor while examining how voltage pulses from a scanning tunnelling microscope (STM) caused reversible changes in specially designed "propeller-shaped" molecules. They noticed an unexpected phenomenon occurring with a layer of hexabutyldecacyclene molecules on a copper sheet.

The hexabutyldecacyclene formed a layer just a single molecule deep on the copper. In a concentrated layer, the molecules arranged themselves into a two-dimensional lattice structure. But when the researchers created a less concentrated layer of the chemical they realized that one of the "propellers" had moved slightly into an adjacent gap in the lattice.

STM images showed that the molecule was in a fixed position and rotating, suspended by weak interactions with surrounding molecules and the copper. The team recorded rotation rates approaching a billion revolutions per second. Gimzewski explains that surrounding molecules created a "bearing" within which the propeller could spin, but could not move laterally.

The researchers accept that it will be difficult to interface such tiny devices with the macroscopic world. The spinning molecule displays a periodic energy potential which cannot be harnessed to do meaningful work, Gimzewski says, but he believes the experiment proves that, in principle, single molecules could be harnessed to act as moving parts within a machine.

Gimzewski hopes that supramolecular chemists, who create arrays of designer molecules, could exploit the discovery in the future to make nanoscale motors. (Source: *Chemistry & Industry*, 3 August 1998)

150 nm copper process for SRAMs

Motorola (Austin, Texas) announced a CMOS SRAM process using enhanced contacts, copper metalization and a feature size of 150 nm (0.15 μm) and has produced fully functional 4 Mb SRAMs with the process.

The use of enhanced contacts not only allowed the SRAM cell geometries to be reduced by approximately 35 per cent, it also dramatically improved interconnect reliability, since copper can support 10 times the current density than aluminium.

The company believes that the technology will enable a new class of solutions for next-generation computer server and workstation applications. The first SRAM product using the technology is expected in the fourth quarter of 1998.(Reprinted with permission from *Semiconductor International Magazine*, August 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

NEC develops embedded FeRAM for smart card chips

NEC Corp. (Tokyo, Japan) has developed an embedded ferro-electric random access memory (FeRAM) for smart card LSIs designed to be 10,000 times faster while consuming 10,000 times less energy than conventional EEP-ROMs. A prototype with integrated FeRAM and central processing unit (CPU) in a smart card controller that meets these targets has been fabricated and tested successfully.

The technology developments involved include a two-layer aluminium standard logic process that enables integration of the FeRAM, a FeRAM circuit modularization technology that allows it to have direct access to the CPU memory bus and a screening technology using an offset sense amplifier for detection of bad memory cells. These developments enable smart cards to be powered only by energy in electronic waves, improving the performance of contactless smart cards while saving significant energy. Placing the FeRAM directly on the CPU memory bus allows the FeRAM and CPU to be synchronized for fully random, high-speed readout and write operations in the same manner as static RAM (SRAM). (Reprinted with permission from *Semiconductor International Magazine*, August 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Efficient oxidation process for ultrathin gate oxides

The Inter-University Microelectronics Centre (IMEC, Leuven, Belgium) has developed a novel, high-efficiency, environmentally friendly oxidation process that allows the growth of ultrathin gate oxides in a conventional furnace using a standard CMOS processing environment. It has been designed to satisfy the increasing requirements for thinner gate oxides to meet the continuous downscaling of CMOS device dimensions. The good thickness control that is necessary for this process requires relatively mild oxidation conditions, using a low-temperature environment and a reduced oxygen concentration. This indicates the use of chlorine containing organic molecules to introduce chlorine in the furnace.

IMEC researchers say this technique enables a high-quality thin layer of silicon dioxide to be formed on a silicon substrate with a thickness of 1-8 nm or more. (Reprinted with permission from *Semiconductor International Magazine*, July 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

The revolution that is system-on-a-chip

While Wall Street watches for the next "killer application" in electronics to drive the high-technology stocks to new peaks of valuation, participants in the semiconductor industry are busy defining their role in the latest revolution: system-on-a-chip manufacturing, or more specifically, design reuse of intellectual property (IP).

Reuse of intellectual property is the productivity engine driving the semiconductor industry into the next millennium. In fact, as explained by Aart de Geus, chairman and CEO of Synopsys, reuse and the changes brought about in the design and manufacturing community to enable the profitable production of systems-on-a-chip "are natural extensions of Moore's Law". System-on-a-chip devices today can include cores from a number of different companies. The key, however, is designing these cores from the start to be compatible and easily integrated. In order to integrate cores including microprocessors, DSPs (digital signal processors), memory, control functions, analog, rf and other devices, they must initially be designed for reuse.

IP reuse is now necessary as the industry becomes engineering design limited in a time of ever-shortening time to market and proliferation of applications for chips of very high functionality. In addition, the challenges of deep submicron manufacturing, together with requirement for lower signal delay, high reliability, low noise and low power have become so limiting that the industry will benefit more from designing and manufacturing cores that can be reused, rather than designing highly integrated chips (with millions and soon billions of transistors) from start to finish for each new application.

The implications for chip producers are far reaching. As the owners of the majority of IP in chips today, their future positioning will rely not only on manufacturing expertise, but also on proper management of IP—designing in its area of market expertise while licensing necessary cores from other companies with (increasingly) faster turnaround time for the customer. Along with the semiconductor manufacturers, traditional ASIC companies, fabless firms, EDA software vendors and silicon foundries will, in one way or another, redefine their business models to reflect the needs of the industry.

Successful companies will be those who best engineer methods for bringing sophisticated IP together, while understanding the tools, technology and methodology needed to get there.

IP reuse becomes profitable only when the initial design costs can be optimized and the reuse is maximized. The companies that move fastest in attaining this objective will profit the most. System-on-a-chip integration can lower system cost, expand functionality, improve reliability, reduce power consumption and speed access to revolutionary end products.

Some argue that beyond the changes needed to allow a sharing of IP in the semiconductor industry are the changes needed to make fabs more productive and cost-effective through changes in the customer/supplier relationship. Philips is advocating a shared partnership between semiconductor equipment suppliers and fab managers in which a balance of risks and rewards is predetermined so that equipment and materials suppliers, as well as chip producers, can better weather the volatility of the market and better manage increasing costs. (Reprinted with permission from *Semiconductor International Magazine*, July 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

System maps wafers using space technology

Precision measurement of thin films to a few thousand angstroms is becoming routine in semiconductor processing, particularly with the coming of 300 mm. Although a constant awareness of film thickness on wafers is essential for process control, this kind of metrology can be time-consuming, particularly if these data are needed to characterize new processes and tools for 300 mm.

Some time ago, IPEC Precision (Bethel, CT) developed its AcuMap tool. Originally intended for measuring the thickness of layers used in SOI wafers by imaging the entire wafer, eliminating the need for a stage to measure from

one spot to another, it is now finding new applications in 300 mm.

Digital imaging camera technology originally developed by Kodak for resolving the Earth's surface from orbit is at the system's heart. It uses a CCD with a 2,048 × 2,048 pixel array as well as light from a halogen lamp passed through a 24-filter wheel, each representing a discrete wavelength. The light from the filters illuminates the entire wafer and is captured digitally as it reflects from a precisely adjusted mirror. The reflective spectrum of the wafer surface is measured simultaneously at up to 4 million sample points (pixels), and these spectra are matched to stored values to determine film thickness. It takes 90 sec to capture and process up to 33,000 points.

Today's applications go beyond the measurement of SOI bonded wafers. They include thickness measurements of dielectric thin films—oxide, photoresist or any other semitransparent dielectric.

The system provides a selection of different displays and statistics, depending on the kind of information being sought, across the whole wafer, instead of just discrete data points. This capability is valuable when running a resist track, because it makes it possible to fine-tune dispensers; dispense positions, angles and spin speeds; and immediately see the results on the resist film. Resist tolerances are much tighter, and defects are more subtle, for 300 mm.

Although an optimum resource for process and tool characterization, ÅcuMap is a complementary tool: it is not designed to measure specific features or sites, as it lacks a pattern recognition and cannot be trained to go to a specific point. Its purpose is to provide a visual "big picture" view across the entire wafer, which is useful for characterizing a wide range of processes. (Extracted with permission from *Semiconductor International Magazine*, July 1998, Copyright by Cahners Publishing Co., Des Plaines, IL, USA)

Fingerprint recognition

Imaging chips are normally employed in the taking of electronic pictures. With a few modifications, however, they can also be used for fingerprint recognition, forming the basis for a whole new series of applications in security systems. Several prototypes of such systems have now been built, and they should be appearing on computer keyboards shortly.

In 1995, Lucent Technologies came up with the idea of making an array of touch-sensitive pixels. Each pixel is a tiny conducting plate covered with a dielectric film. When a finger touches this, the skin acts as a second conductor, forming a crude capacitor. The ridges in the skin are closer to the pixels than the valleys, so measuring the capacitance at each pixel in the array produces an electronic snapshot of the fingerprint. In 1996, Lucent and a number of venture capitalists established Veridicom to market the idea.

Using conventional chip fabrication techniques, Veridicom can create a postage stamp-sized array of 90,000 pixels. This offers sufficient resolution to map the characteristic patterns of whorls and bifurcations for subsequent identification by image recognition software.

The French company, Thomson-CSF, has developed a chip which detects the different heat levels exhibited by the ridges and valleys on the fingertip. Based on infra-red imaging techniques, this chip converts the heat into an electrical signal.

At present, both types of chip require separate processors to undertake pattern recognition, which is why computers and mobile phones (which have their own built-in processors) are likely to be the first to feature the new sensors. Enhanced versions, however, will build the

processing power directly into the sensing chip. (Source: *New Scientist* (2135) 23 May 1998)

Nanotechnology

Conceived by Richard Feynman in 1959, nanotechnology (construction at the atomic level) is rapidly becoming a reality. IBM's Zurich laboratory, for example, has created a working abacus, in which each "bead" is a single molecule of buckminsterfullerene, a "buckyball" consisting of sixty carbon atoms.

The Nanocomputer Dream Team—a virtual research group which corresponds by e-mail and exchanges ideas via the Web—plans to unveil a nanocomputer by 2011. Nobody is quite sure how to achieve this, but one of the more promising ideas is to employ "rod logic" to create transistors, which in turn could be used to build a NAND gate, the basis for every other logic component required.

Determining whether particular configurations are possible requires simulations at the molecular level to be run. Already, prototype tools—such as *NanoCAD*—are available for the purpose. (Source: *Personal Computer World*, September 1998)

Intel's Pentium II Xeon

Intel's new Pentium II Xeon chip is an enhanced version of the current Pentium II, or rather, the Pentium II with its limitations removed. Running at 400 MHz, it fits into a Slot 2 motherboard and features a 100 MHz bus architecture. A 450 MHz version will be available towards the end of 1998.

The chip is being positioned as a component for mid-range servers and high-performance workstations. In the UK, a dozen major system suppliers—including Compaq, Dell and Gateway 2000—are or will be shortly offering servers and workstations based on the chip.

From Intel's point of view, this is a product which will demonstrate once and for all that the company's chip designs are scalable and suitable for enterprise-wide systems. The chip can be used to build servers priced in excess of $7,500 and scaling up to four processors. Two variants of this server will be available: the basic, and the enterprise-class model. The latter will use the 450NX chip set and be priced at about $12,000 for a basic configuration. Servers will be linked using Intel's Virtual Interface (VI), regarded as more cost-effective than the alternative Non- Uniform Memory Architecture (NUMA). The lower-end server configuration will use the limited version of the same chip set, but not support the VI clustering technology.

As regards workstations, these will be based on the 440GX chip set. This offers improved graphics performance via the Accelerated Graphics Port (AGP) and the faster speeds delivered by the AGP 2x bus.

Full utilization of the improved performance offered by the Xeon, however, may have to await the appearance next year of *Windows NT Server 5.0*, which will support Very Large Memory (VLM). (Source: *Information Week* (32) 24 June-7 July 1998)

Chaos for secure communication

Chaotic communications sounds like just the sort of activity the military would wish to avoid. Yet the US army has just awarded a research contract to investigate just that.

Chaos theory promises the ultimate in secure communications, enabling signal transmissions which are indistinguishable from background noise.

While the US military is interested in secure communications, the motivation for the research is more fundamental to explore how nonlinear dynamics, and chaotic techniques in particular, can be applied to common

communication tasks like signal encoding, encryption and modulation.

Moreover, the theory will also be practically applied in the form of a basestation demonstrator using chaotic techniques for wireless and optical communications.

The research is being undertaken at the University of California, San Diego and University of California, Los Angeles and at California-based Stanford University.

A chaotic communication system requires that the receiver has an identical, or near-identical, structure to the transmitter. Communication is possible because the transmitter and receiver are auto-synchronizing—the receiver adopts the state of the transmitter and follows deviations caused by the transmitted input message. Distortion on the received signal represents the modulation—ignoring channel distortion.

The research project is a three-year one, with the option for a two-year extension. Media contact: Michael Baum. Tel.: (301) 975-2763. (Source: *Electronics World*, July 1998)

"DNA chips" and tiny tubes make genetic studies practical

Powerful technologies that offer extraordinary advances in the speed and convenience of DNA analysis are boosting our abilities to decode genes, manage diseases, discover new drugs and cut costs in the US healthcare industry. These systems are initial spin-offs of an ongoing joint venture co-funded by the Advanced Technology Program of the National Institute of Standards and Technology. The project is aimed at making low-cost, hand-held diagnostic devices for quickly analysing DNA samples in doctors' offices.

The devices will feature a combination of the technologies developed in the ATP project by two small biotechnology firms in California: Affymetrix Inc. and Molecular Dynamics. The ATP funding has enabled advances in sample preparation and data analysis and has helped validate components. ATP-funded work continues to combine and miniaturize features and make the resulting devices easy to produce.

Affymetrix Inc., adapted a photolithography manufacturing process to make postage stamp-sized DNA chips, which contain hundreds of thousands of gene sequences that detect matches in blood or tissue samples up to 100 times faster than conventional methods.

Molecular Dynamics recently introduced a system that sorts and sequences DNA in 96 tiny capillaries (tubes the size of a human hair) faster and more efficiently than traditional methods. (Source: *Tech Beat*, August 1998)

Sub-100 nm features with single-layer 193 nm resist

Linewidths of 80 nm using a 193 nm exposure tool have been achieved by a research team at the University of Texas (Austin, Texas), headed by Dr. Grant Willson. The features were generated using an alternating aperture phase shift mask produced by Du Pont Photomasks (Round Rock, Texas). Phase shift masks are designed to shift the phase of the exposure light when it passes through prescribed areas, producing interference effects for improved depth of focus and resolution. Exposures were made using Integrated Solutions Inc.'s (ISI, Tewksbury, Mass.) 193 nm ArF MicroStep.

The successful introduction of 193 nm lithography requires the availability of a high-performance, single-layer resist, upon which high-volume semiconductor device manufacturing is currently based. Alternative, more complex technologies are bilayer and top surface imaging, which separate resist layers for the pattern delineation from the etch barrier. The 193 nm resist, developed by the Willson group,

marks the first demonstration of a single-layer resist to produce sub-100 nm features.

This new resist consists of a polymer that incorporates chemically amplified (CA) resist technology. Chemical amplification, used to enhance photosensitivity, is based on a catalysed system where a catalyst, in this case an acid, is photochemically generated and subsequently regenerates another molecule of acid to spur chemical reactions. The acid catalyses a deblocking reaction, which results in a solubility differential between the protected and unprotected polymer, between the exposed and unexposed areas.

Conventional polymers used for 248 nm resists, such as styrenes, are too opaque to be used at 193 nm. Styrene-based DUV polymers have good etch resistance but lack sensitivity because the transparency is too low. In contrast, acrylates have good transparency at 193 nm but poor etch resistance.

The new polymers that have been developed allow the light to pass through the polymer matrix and reach the photosensitive compounds, yet they are etch resistant. The alicyclic polymer used by the Willson group combines the good transparency characteristics of acrylates with the etch resistance of styrenes. An acid catalysed deblocking reaction is incorporated into the Alicyclic polymers. The result is a photoresist having the sensitivity and speed comparable to that of 248 nm DUV resists. In a single-layer process, the positive-tone resist was used to produce 80 nm device features, hitting the resolution limit of the photomask.

The UT group will be investigating post-exposure delays, contamination from airborne amines and optimization of the materials formulation and process in the months to come. They are collaborating with Professor Jean Frechet's group at the University of California, Berkeley, to explore the utility of new structures that offer promise for further performance improvement. (Reprinted with permission from *Semiconductor International Magazine*, April 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

World's fastest transistor

A group at the Defense Evaluation and Research Agency (DERA, Malvern, Worcestershire, England) claimed to have fabricated the fastest transistor yet produced with an fT of 74 GHz. This enhancement mode device has a gate length of 0.7 μm (70 nm), but the workers predict 185 GHz operation when the gate length is scaled down to 0.25 μm (250 nm).

The transistor employs indium antimonide as the basic semiconductor material. This has a high electron mobility, while its high saturation electronic velocity (the greatest speed electrons can achieve in its lattice) is at least five times that of gallium arsenide. These factors enable high speed of operation to be achieved even with fairly low internal electric fields. However, the small energy gap of indium antimonide of about 0.7 eV results in a high leakage current because of thermal carrier generation. The main advance made by DERA is the reduction of this leakage by the use of minority carrier exclusion and extraction. The researchers have proposed the fabrication of a depletion mode device that will not require such accurate alignment of the gate electrode. This will not only simplify the fabrication process, but enable the gate width and hence the gate capacitance to be reduced to improve performance for a given feature size.

Tim Ashley of DERA said his group foresees digital applications for the device, such as very fast digital signal processing with operation from supplies of some 0.33 V. He said a number of unnamed industrial companies are collaborating with DERA in this work. It is likely that a major semiconductor manufacturer will purchase rights to the

process, as it has features in common with gallium arsenide and could be fitted into a modified fab. It cannot yet be used to develop CMOS products, as only n-channel devices have been made. However, Ashley said p-channel products will probably be produced but will involve more process steps and materials. (Reprinted with permission from *Semiconductor International Magazine*, April 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

SiGe devices

Temic (Heilbronn, Germany) is sampling two silicon-germanium (SiGe) heterostructure bipolar transistor chips. One is a front-end, broadband radio frequency amplifier device for cordless telephones, while the other is a low-noise amplifier for mobile telephone handsets. They are seen as low-cost direct replacements for gallium arsenide devices where minimum power consumption and compact dimensions are important for extremely high-frequency use.

Temic will sample a third SiGe chip, a power amplifier that does not require a negative supply voltage or a high side switch, in the second quarter of this year. It can therefore be used to reduce the number of external devices and hence the system cost.

Temic, a company owned by the Daimler Benz motor manufacturer (Ulm, Germany), is also providing SiGe foundry services to various large telecommunications companies that are designing chips to be fabricated in its SiGe line at Heilbronn. The Temic SiGe line operates as an upgrade of its existing UHF silicon line and will be able to produce high-device volumes economically.

This will be the first commercialization of SiGe technology. (Reprinted with permission from *Semiconductor International Magazine*, April 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

World's strongest oscillation from a free electron laser

The Japan Atomic Energy Research Institute (JAERI) recently produced a stable oscillation of far-infra-red light of 100 W average output with the free electron laser (FEL) device using a superconducting RF linac. The FEL is a powerful, highly efficient laser which can deliver variable and monochromatic light. Thus novel applications for it are expected to be found, but an increase in its output is required.

As for FEL output, 10 mW in the country and about 1 W abroad have been confirmed to date. In the present experiment, the peak output value of 1 MW and an average light output about 100 W with a wavelength of 28 μms and a pulse width of 0.4 millisecond were observed, and thus the world's strongest FEL oscillation was achieved. Based on this result, JAERI will achieve 1 kW output for practical uses in the future.

Since the superconducting RF linac has almost no ohmic losses and can achieve an output of 100,000 times or more as large as the conventional normal-conducting RF linac, it is expected to provide novel optical research tools not only for nuclear research but also for basic research of the physical properties of materials, in bioscience, for applied research of electronics and optical communications, and in medical treatment. (For further information, contact the FEL Laboratory, Department of Reactor Engineering, JAERI. Tel.: 029-282-5464.) (Source: *STA*, 1988)

Flash: audio storage for the future

The long awaited ultimate audio storage medium—chips—will be with us by the end of the year, says Hitachi, as it prepares to sample 256 Mbit flash memory.

Two 256 Mbit flash chips can store an hour of music. Postage stamp-sized packages will allow a purse or trouser pocket to hold twenty or thirty.

Hitachi will sample the chips by the end of the year and is bringing up a 0.18 μm production line which should be making 500,000 chips a month by the middle of 1999. (Source: *Electronics Weekly*, 20 May 1998)

New GPS IC locates to 10cm

Within three months IMEC, the International Microelectronics Centre at the University of Leuven in Belgium, will commercialize a global positioning system(GPS) chip which can track a location to an accuracy of 10 cm.

The chip uses either the American satellite constellation or the Russian Glonass constellation to establish a position. It also conforms to the European global navigation satellite system standard for air traffic control. IMEC intends to be sampling the single-chip device early in 1999.

IMEC is already working on even more accurate versions of the chip and has also developed a process for putting the connections directly onto the back of silicon dies—so avoiding the need for packaging. (Source: *Electronics World*, February 1998)

Single-chip MPEG-4

A copper interconnect process, ferroelectric memory and a single-chip IC for MPEG-4 are just some of the projects involving IMEC and its industrial partners.

IMEC—the International Microelectronics Centre at the University of Leuven, Belgium—expects to have a complete copper tracking process ready for transfer to industrial partners within eighteen months. After six months of work, IMEC has completed some modules of the full process and is working on finding out how one module affects another. IMEC is negotiating terms with seven semiconductor companies for the process.

Ferroelectric memory is being pursued by IMEC as a technology to be embedded into CMOS chips. The problems are still mainly materials problems—IMEC is focusing on PZT—and the contamination of one material by another. This year, IMEC started making wafers on its 0.5 μm ferro process and next year it hopes to have a 0.25 μm one, with an integrated c-mos/Ferro process in operation by 2000. Ten companies are involved with IMEC in negotiations on the project. (Source: *Electronics World*, February 1998)

Novel paper-thin display

A pioneer of liquid crystal material technology has developed a novel paper-thin display. Professor Damien McDonnell, liquid-crystal display researcher at the Defence Evaluation and Research Agency (DERA) in Malvern, has developed a display technology called zenithal bistable device (ZBD) which is thin, flexible and electrically rewritable.

ZBD is not based on the usual bistable ferroelectric technology but uses a nematic crystal. "Bistability comes from the way the crystals are anchored", said McDonnell. "This can be shifted using a small electric field and stays where it is left.

Transmissive and reflective displays, with contract of 100:1, can be made. We have made one with 4-bits of grey scale and I think seven or 8-bits are possible."

McDonnell stresses that making LCDs is only part of the problem in establishing an industry. "The major one is that there isn't any room in the LCD market" he said. His belief is that the advent of electronic paper will open up a whole new range of applications. "Something that is very thin, flexible, can be written and rewritten, and used without power could be this product", he said. (Source: *Electronics World*, February 1998)

IBM researchers break own hard disc data density record

IBM researchers say they have broken through the ten billion bits per square inch data density level, which will lead to the industry's most advanced disc drives.

The achievement caps a year of impressive hard disc technology achievements, and more than doubles IBM's world record for area density. The record now stands at 11.6 billion bits per square inch.

IBM scientists say they will soon come up against physical limits affecting how tightly data can be packed onto a hard disc.

As data bits become smaller, they become affected by tiny fluctuations in room temperature requiring new technologies or radically different data storage methods such as holography.

The latest breakthrough will not only produce hard drives with higher data capacities but will also let IBM make lighter, cheaper and lower power drives. (Source: *Electronics Weekly*, 7 January 1998)

Sharp flash fillip

Sharp of Japan, joint market leader with Intel in flash memory, has developed a proprietary flash architecture which has the potential to be a worldbeater. The company is currently debating how to bring it to market and whether to second source it.

The architecture allows for 16 transistors to share a single connection, so reducing die size but without losing access speed. Sharp's architecture is similar to NAND flash architecture in having one contact for several transistors. However, unlike NAND, Sharp's architecture allows random access, giving it access times comparable to the mainstream NOR flash architecture. This gives the dual benefit of a smaller die size than NOR with the same access time as NOR—a potentially world-beating combination.

Until now, Sharp has been Intel's partner in manufacturing NOR-type flash. At one time they shared 90 per cent of the world flash market. That has been cut back to 30 per cent.

Sharp is building a 0.25 µm flash fab for high volume production in 1999. That will give it 64 Mbit and 1.8 V capability. In 2000 it expects to be producing 0.9 V flash on a 0.18 µm process. (Source: *Electronics Weekly*, 7 January 1998)

MEMS active fibre microactuator

Using MEMS technology, researchers at MCNC (Research Triangle Park, N.C.) and Boeing (Seattle, Wash.) developed an active fibre microactuator (AMFA) that is small enough to be integrated with an optoelectronic device package. The three-axis aligner will allow for in-package alignment of fibre optic and micro-optic components with submicron accuracies. The microaligner is fabricated using a combination of surface and bulk micromachining of silicon, high-aspect ratio lithography and electroplating.

According to the researchers, the key to the successful operation of this device is the thermal actuator technology they developed. It provides electrically controllable forces that are large enough to overcome friction, wirebonds and fibre optic constraints over the necessary displacement range. The aligners are capable of motions exceeding 30 µm in all three axes in an in-package configuration.

Their first prototype devices are currently small enough, at 4×4×0.5 mm, to fit into virtually any package, and it is said that no additional package design is necessary to take them into account.

Current procedures for aligning fibre optics and micro-optics are very labour-intensive and require expensive capital equipment. The microaligners can be programmed to perform all necessary in-package alignments quickly and inexpensively, eliminating the current bottleneck in the automated fibre pigtailing process. (Extracted with permission from *Semiconductor International Magazine*, December 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

Quantum detection

In a startling demonstration of the weirdness of quantum theory, researchers at the Los Alamos National Laboratory in New Mexico announced they had detected and studied a variety of objects using laser light which never went anywhere near them.

Common sense dictates that to find out anything about an object, there must be some form of interaction—even if you only shine light on it. However, the quantum nature of light—in particular, its ability to behave both as a wave and a particle—allows so-called interaction-free measurements to be made.

In 1993, Avshalom Elitzur and Lev Vaidman of Tel Aviv University suggested that this trick could be achieved by allowing light to go along two different paths, one of which can contain the object.

When the object is absent, the setup can be arranged so that a particle-like photon of light can travel via either path with equal probability. Its wave-like properties then produce destructive interference, so the emerging photon continues along the same path and thus no signal is registered at the detector.

Once an object blocks one of the paths, a photon travelling along it cannot complete its journey and create the destructive interference needed to stop activation of the object detector. So any photon that chooses the path without the object can then make a choice when it reaches the beam splitter, and there is a 50 per cent chance that a signal will be detected—allowing the photon to reveal the presence of an object despite never interacting with it in any way.

Interaction-free detection has since been demonstrated in the lab, prompting physicists to dream up real-life applications. Now Andrew White and his colleagues at Los Alamos have taken a key step towards such practical devices by measuring the dimensions of small objects, despite the fact that about half the photons emitted effectively never interacted with the target.

In a paper in a forthcoming issue of *Physical Review A*, the team describe how they measured the thickness of objects, which included a knife-edge, a wire and human hair, by passing them across one of the optical paths. And at an international conference on quantum electronics held in San Francisco last week, the team announced that a more sophisticated system has boosted the level of non-interaction to over 70 per cent.

The research could open the way to a radically new form of imaging, in which sensitive targets—such as living

cells—could be examined using virtually no photons at all. (Source: *New Scientists*, 16 May 1998)

First optical devices produced in chip form with semiconductor manufacturing process

Assoc. Prof. T. Mizumoto and his research team of the Department of Physical Electronics, Faculty of Engineering, Tokyo Institute of Technology, have succeeded in producing optical devices in chip form for use as the arithmetic operation and memory devices of optical computers. The chip form device can be switched ON and OFF by optical signal input, and its use enables optical signals to be changed. Similar optical devices had been available, but this is the first time that the optical device has been produced in chip form by the semiconductor manufacturing process.

The device developed by the research team is stabilized at a high output level when strong optical pulses are passed through it, and conversely stabilized at a low output level when the pulses are momentarily weakened. Using this device enables switches, memories and arithmetic circuits to be fabricated which can be controlled simply with optical signals.

With this device, a grating with notches equivalent to one-half of the light beam wavelength is provided in the waveguide that transmits the light beam. Normally, optical energy storage called resonance occurs inside the device, so the output light becomes smaller with respect to the input (OFF state). When the light intensity is changed and exceeds a certain intensity level, the refractive index of the device materials (gallium-indium-arsenide-phosphorus) is changed, resonance prevented, and the output becomes larger (ON state). The critical value differs when the input light is raised or lowered, so ON/OFF switching can be accomplished with ease by the method of combining the pulsating light with a standing wave having a value lying between both critical values.

The prototype device had an output that is only one-tenth the input or involves a big loss at present, and the physical speed of changing the refractive index is also slow, so the element lacks the performance enabling use in place of existing electronic devices. The research team plans to use materials of faster response and with less optical signal deterioration, and to improve the grating to commercialize an optical device operating at a higher speed than electronic devices. Further details from Tokyo Institute of Technology, Dept. of Physical Electronics, 2-12-1, Ookayama, Meguro-ku, Tokyo 152. Tel.: +81-3-5734-2578; Fax: +81-3-5734-2578. (Source: *JETRO*, November 1997)

Compact high-speed, high-density chain FRAM

Toshiba Corp. has developed a new ferroelectric random access memory (FRAM) circuit with a cell area 50 per cent smaller and cycle time over three times faster compared with those of conventional counterparts. The ferroelectric capacitor was previously connected in series with the element (transistor), but in the new cell the capacitor is connected in parallel to form a block structure in which the components, including the bit selection element, are connected in series. This reduces the chip area to 63 per cent, reducing the manufacturing cost, and achieves a high speed comparable to that of the dynamic random access memory (DRAM) despite being a volatile type. Since this new cell has a structure resembling a chain, the company calls this new circuit the CFRAM.

The FRAM cell area is limited theoretically to eight times the square of the minimal dimensions, but the new circuit makes a breakthrough in this concept and reduces the

area to one-half, or to four times the square of the minimal dimensions. In addition, since connection is achieved in bit line in block units, the bit line capacitance burden is reduced compared with series connection of the respective cells in the conventional bit line format, so that the area of the sensing circuit is reduced to one-fourth. The cumulative effect is to reduce the chip overall area by about 40 per cent.

Conventional types of FRAM are driven by changing the plate voltage so the cycle time is 250 ns, or rather slow, but with CFRAM, the plate voltage is fixed and a speed of 70 ns is attained without refreshing action, or a high-speed cycle time comparable to that of the DRAM is realized. With CFRAM, data can be retained without refreshing simply by switching off the bit line selection element during waiting. Readout is achieved by switching on the bit line selection element, and random access possible by switching off the cell concerned. The company plans to apply the new technology and to develop next-generation version FRAMs. Further details from: Toshiba Corporation, Corporate Communication Office, 1-1-1, Shibaura, Minato-ku, Tokyo, 105-01. Tel.: +81-3-3457-2105, Fax: +81-3-3456-4776. (Source: *JETRO*, November 1997)

Highest performance high-temperature superconducting sensor

Assoc. Prof. K. Enpuku of the Department of Electronic Device Engineering, Kyushu University, has developed the world's highest performance high-temperature superconducting quantum interference device (SQUID) sensor, in collaboration with Physikalische-Technische Bundesanstalt (PTB) Berlin, Germany.

The sensor magnetic field resolution is 32 fT, a performance that is two to three times better than conventional types of SQUID sensors using liquefied nitrogen. Due to the introduction of optimum design and high-performance Josephson junction techniques, the sensor performance as well as regeneration capability have been improved substantially to enable the sensor to be used in medical science and industrial applications.

To realize the high-performance design, the research team optimized the device parameters and attained a resistance of about 10 ohm at the Josephson junction and a critical current of about 20 μA, and an inductance of 50-150 pico-henry. A bicrystal bonding technique was established that replaces the usual inclination of 24 and 36.8 degrees with an inclination of 30 degrees.

As a result, the high-temperature superconducting SQUID sensor has improved the terrestrial magnetism resolution from one part of 300 million to one part of one billion. Compared with the SQUID sensor using liquefied helium, the resolution is inferior, but it uses low-cost liquefied nitrogen that is easier to obtain, so the sensor can measure to the domain of the cerebral magnetic field, by which its range of applications has been expanded to the sectors of biomagnetism measurement, non-destructive inspections and global environment measurements. Further details from Kyushu University, Dept. of Electronic Device, Engineering, ISEE, Hakozaki, Fukuoka City, Fukuoka Pref. 812. Tel.: +81-92-642-3954; Fax: +81-92-641-5866. (Source: *JETRO*, November 1997)

Photoconductive semiconductors manufactured microgravity environment

Hokkaido National Industrial Research Institute (HNIRI) has succeeded in manufacturing high-performance photoconductive semiconductors by synthesizing the raw materials in a low-gravity environment. The institute used a drop tower that is 10 m tall and synthesized photoconductive

semiconductors in 1.2 s. Photoconductive semiconductors of excellent photoconductive absorption characteristics were produced, which are anticipated to be applicable to the manufacture of infra-red ray photoconductive sensors. These experiments corroborated that a drop facility with a micro-gravity environment is amply applicable as an industrial means for producing electronic materials.

The experiments were conducted by using indium-antimony, the drop container was an ultrahigh-vacuum processing chamber, and rapid heating and cooling were performed in a vacuum environment of 10^{-8}atm. To prevent material vapourization and infiltration of impurities into the material, a semiclosed tube process was used. The raw materials were packed inside a tube made of crystal, and dropped in the vacuum environment.

In an environment of micro gravitational force, the raw materials are maintained in safe condition without contact to the container walls, and maintained in a state of supercooling with the cooling process. Subsequently, the coagulation speed is increased rapidly by concussion to promote monocrystallization most effectively. The diameters of the monocrystallines are about 5 mm, about 100 times larger than usual. The absorption characteristic of light for converting infra-red radiation into electricity was 40 per cent higher than that of standard types of crystal materials.

The energy band gap, the measure of reaction of infra-red ray wavelengths, was also observed to undergo a change depending on the raw material composition ratio. This research is certain to expand the range of utilization of electronic materials. Further details from: Hokkaido National Industrial Research Institute (HNIRI), Research Planning Div., 17-2-1, 2-Jo, Tsukisamu-higashi, Toyohira-ku, Sapporo, Hokkaido 062. Tel.: +81-11-857-8402; Fax: +81-11-857-8901. (Source: *JETRO*, November 1997)

Supercomputers pooled to set factoring record

Researchers at the Netherlands National Research Institute for Mathematics and Computer Science (CWI) have used 85 Silicon Graphics/Cray computers to factor a 180-digit number. The number is the largest ever factored using the Special Numerical Field Sieve (SNSF) method, and took 12 days of computation. Prior to the CWI effort, the factoring record had been held by an international consortium which factored a 167-digit number using two months of computing time on computers that communicated over the Internet.

The CWI research group attributes the five-fold increase in calculation speed to the recent improvements to the software, originally developed by the Dutch mathematician Arjen Lenstra. According to the CWI researchers, factoring algorithms plays an important role in cryptography. The related General Number Field Sieve algorithm is used for checking the reliability of cryptographic codes, for example. Microsoft has acquired the right to use the CWI code to become familiar with factoring technologies. (Source: *Scientific Computing World*, November 1997)

Fastest computer put to test

Scientists at Ecole Polytechnique Federale de Lausanne (SPFL) in Switzerland were among those to put the world's most powerful commercially available supercomputer to the test, before its dispatch to an undisclosed customer recently. The computer was the Cray T3E-900 system, which is equipped with 1328 processors, each with 128 Mbyte of dedicated memory. It runs at a peak rate of 1.195 Tflops and is said to have run real-world applications at "unmatched levels of performance".

The Swiss scientists used the LAUTREC code to conduct molecular dynamics solutions for medical research. Also under trial on the machine was the HIRLAM code for the creation of a numerical short-range weather forecasting system for Northern Europe, run by the High Resolution Limited Area Model consortium. The HIRLAM consortium includes meteorological institutes in Denmark, Finland, Iceland, Ireland, the Netherlands, Norway, Spain and Sweden. Their model is a hydrostatic grid-point model with present resolutions of 55 to 5 km horizontally and 16 to 31 levels in the vertical. Source code is written in Fortran 77 with some extensions.

Other applications included quantum chemistry for the Pacific Northwest National Laboratory in the USA; Earth modelling research for the Los Alamos National Laboratory; and space research to develop the first 3-D, multiscale model of the heliosphere for the University of Michigan. (Source: *Scientific Computing World*, November 1997)

Binary neural network system can reason

A hardware and software system developed at the UK's University of York is said to be capable of symbolic reasoning. The Advanced Uncertain Reasoning Architecture (AURA), designed by Jim Austin and colleagues at York's Advanced Computer Architecture Group, employs binary artificial neural networks (ANNS) based on correlation matrix memories (CMMS) to process information.

The AURA project was initially conceived in cooperation with British Aerospace for the purpose of developing a real-time system that would help aircraft pilots make decisions using incomplete or confusing data. Research is now underway to apply the AURA technology to activities as diverse as postal sorting and molecular database searching.

Unlike most mainstream ANNs that deal with continuous patterns, the AURA system treats information as discrete symbols such as number and letters. According to the researchers, the discrete approach is more appropriate for dealing with many common information types such as databases. Before the symbols can he processed by the CMMs they must be converted into binary patterns. According to Austin: "The preprocessing of different data types was a major piece of work in AURA."

Most ANNs also employ real numbers; CMMS, however, encode relationships using binary (on-off) synapse connections. According to the York researchers, an important benefit of using CMMs is that they can be trained much faster than most other ANNs.

The AURA system also consists of a specially built hardware system that the researchers claim can process binary neural networks 200 times faster than standard workstations. Called PRESENCE, the latest prototype features a pipelined sum-and-threshold processor and 128 concurrent bit-sums, and interfaces with an SGI Challenge server via a VME bus. (Source: *Scientific Computing World*, November 1997)

Infra-red lasers

A group of scientists headed by Federico Capasso at Bell Laboratories (part of Lucent Technologies) in New Jersey has been working on getting infra-red light from an alternative device called a quantum cascade laser.

In normal semiconductor lasers, the wavelength—and hence the colour—of the light emitted is directly related to the so-called "band-gap" of the semiconductor. The band-gap represents, for electrons moving about in the material, a range of forbidden energies—a sort of electronic hurdle. Applying a big enough voltage to the material gives the electrons an energetic push over this hurdle. But they soon

fall back again, re-emitting the energy as light. Under the right conditions, the light waves emitted by the different falling electrons oscillate in lockstep, which is what gives laser light its unique properties. The smaller the band-gap—the less the energy an electron emits on falling back—the longer the wavelength of the resulting light. Infra-red light has much longer wavelengths than visible red light, and so requires materials with extremely small band-gaps.

Rather than trying to lift electrons over an energy hurdle and letting them drop back, the researchers designed a material in which electrons could be pushed down a series of small energy steps—hence the name "cascade laser". At each step, the electrons would emit a small amount of energy as infra-red light.

The trick in making lasers this way is to fabricate the individual steps of the cascade by spraying layers—just a few atoms thick—of gallium, aluminium, indium and arsenic on to a surface. In each layer, electrons exist at a different level of energy, determined by the layer's thickness. The differences between these levels are the energy steps in the cascade.

By carefully tailoring the semiconductor layers, the researchers can make lasers that shine in two bands of infra-red light to which the atmosphere is highly transparent—allowing the light to travel a long way. More-over, such a laser can be fine-tuned over a smaller range of wavelengths simply by varying its temperature. Almost all molecules absorb infra-red radiation at certain precise wavelengths; the wavelengths a given molecule absorbs are like a unique fingerprint for it. By tuning the quantum cascade laser and measuring how much of the infra-red radiation is absorbed on its way to a detector, hazardous gases in between can be identified.

In addition, since a single electron travelling through the device emits light not once (as in most other lasers), but many times, quantum cascade lasers are powerful: Dr. Capasso's group has recently shown that they beat conventional semiconductor lasers by a factor of 20. Above all, they can be made intense even at room temperature, whereas competing technologies require bulky, expensive cooling systems. This gives the quantum cascade laser an edge for applications outside the laboratory.

It could, for instance, be particularly useful in environmental monitoring of smokestacks and car exhausts. The group is also looking into medical applications: the laser might, for example, help to detect in a patient's breath molecules characteristic of ulcer formation. (Source: *The Economist*, 20 December 1997)

Philips makes RF identification tag chip entirely from polymers

Philips has announced a circuit made entirely from polymers. It claims polymer ICs are cheaper than their silicon counterparts and as they operate when the foils are sharply bent, are suited for integration into product wrappings.

The company has demonstrated a polymer RF identification tag comprising a programmable code generator that produces a 15-bit stream in 0.5s. It has 326 transistors, 300 vias and occupies 27 mm^2. Further cost reduction and an increased bit rate is expected by improving semiconductor charge carrier mobility and scaling down the device's size.

The circuit's substrate is a polyamide film with a polyaniline layer containing a photoinitiator. To make the circuit, the layer is exposed to deep-UV light, masked to create interconnects and electrodes. This turns the conducting polyaniline to non-conducting leuco-meraldine.

A 50 nm semiconductor layer of polythienylenevinylene is then applied by spin coating and converted at elevated temperatures using a catalyst. A spin-coated layer of polyvinylphenol is used as a gate dielectric and as insulation for the second layer of interconnect. This interconnect is created in the top layer of polyaniline using a second mask. Vias to link transistors to interconnect layers are made by punching through the foil. (Source: *Electronics Weekly*, 17 December 1997)

Top gear

Sandia National laboratories has made a three million-to-one gearbox for its famous micromotor. One revolution of the input gear generates a calculated displacement of the output gear of only 0.08 nm. Output force is enough to move a 0.5 kg object, said researcher Steve Rodgers: "We believe this is by far the most force ever generated by a polysilicon micromechanical device." According to Sandia, micro-machines need power in larger amounts than first thought because of the adhesion and static friction. One reason for these is that, after a gear is etched out of silicon, the surface oxidizes into SiO_2, which binds to local stationary surfaces. (Source: *Electronics Weekly*, 17 December 1997)

A new way to detect tiny quantities

Using a technique called "scanning SQUID petrology", researchers have demonstrated the ability to detect tiny concentrations of superconductors in a "soup" of other materials. The possibilities include detecting concentrations of less than one part per million in samples weighing a fraction of a microgram. Scientists used scanning SQUID (superconducting quantum interference device) microscopy, in which a barely visible dot of crystal is cooled to near absolute zero in the presence of a small magnetic field. Superconductors show up as a reduction in the strength of the magnetic field. The research was done by a team from Columbia University's Lamond-Doherty Earth Observatory, Palisades, NY, and IBM's T. J. Watson Research Center, Yorktown Heights, NY. (Source: *Industry Week*, 17 November 1997)

Device manufacture

Researchers from United Microelectronics Corp. (Hsinchu, Taiwan) are reporting on a versatile 0.25-0.18 μm CMOS process with six layers of planarized metal for fast turn-around foundry manufacturing. The process flow incorporates self-aligned process modules for salicide, borderless contacts and unlanded vias, serving to maximize the process window. A combination of shallow trench isolation and retrograde wells ensures excellent interwell and intrawell isolation. By combining a DUV inorganic anti-reflective coating for linewidth control with a full-ship optical proximity correction technique, critical dimension variation was within 17 nm. The pre-metal dielectric was deposited using high-density plasma CVD oxide and PECVD doped oxide. CMP of both tungsten interconnects and oxide layers resulted in a fully planarized six-metal-layer process.

Another process that makes heavy use of self-aligned structures is the process for 4G DRAMs proposed by engineers from Japan's Fujitsu. This 0.15 μm process uses high-aspect-ratio pillars for cell capacitors and peripheral vias, which are simultaneously fabricated. Five different self-aligned processes make the process more manufacturable. In addition, this design stretches the use of nitrided-oxide and Ta_2O_5 capacitor dielectrics, foregoing the transition to more challenging dielectrics such as BST (barium strontium titanate) and others.

Perhaps less practical, but nonetheless astounding, are the reports such as IBM's (Hopewell Junction, NY) announcement that it has demonstrated the fastest CMOS process ever—featuring a world-record gate delay of 7.9 psec (trillionths of a second) at room temperature (and 5.5 psec at liquid-nitrogen temperature). The devices used in the study are non-fully depleted silicon-on-insulator (SOI) structures built on standard-dose SIMOX wafers. Although SOI devices are not generally considered production-ready (as the substrates cost four to five times that of pure silicon), such accomplishments are still amazing. IBM's process flow includes shallow trench isolation, deep source/drain junctions with ultrashallow extension and a self-aligned silicide process. Delay of the NMOS device in an unloaded 83-stage CMOS inverter ring oscillator is shown in the figure.(Extracted with permission from *Semiconductor International Magazine*, November 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

New FeRAM cell structure

NEC researchers have developed a FeRAM cell structure with one transistor and two ferroelectric capacitors. The researchers say that although conventional two-transistor/two-capacitor structures can be stably operated, the cell area is too large to be suitable for high-density FeRAMs. A one-transistor/one-cell structure, on the other hand, has a small cell area, but is unstable.

The new design is said to overcome both problems in that it is stable and is also small enough to be used in 256 Mb FeRAMs. The two capacitors are connected in series, and the connection node is joined with a bit-line. PZT capacitors measure 3 μm×3 μm. The word-line is made of polysilicon, the bit-line of WSi, the capacitor a sandwich of Pt/PZT/Pt/Ti, the transistor is N^+ gate CMOS, the wiring is a single level of aluminum and the SiO_2 that caps the PZT capacitor is TEOX/ozone film deposited by CVD. (Reprinted with permission from *Semiconductor International Magazine*, November 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

Intel stores multiple bits per cell

Intel Corp. (Folsom, CA) recently announced its multiple-bit-per-cell flash memory technology, called StrataFlash memory. The 64 Mbit StrataFlash memory stores two bits in each memory cell. According to Gordon Moore, co-founder and chairman emeritus, "Two bits in the space of one starts a new direction in memory technology. This will lead to lower cost and new applications".

Precision control of voltages and time during programming are key to its operation. A directly connected NOR architecture is used to make the most direct connection to reference voltages. Published data show that the threshold voltage for the intermediate states (01 and 10) is controlled to within 0.30 V.

Intel will manufacture StrataFlash memory using its 0.4 μm ETOX process in its Fab 7 and Fab 9 facilities in New Mexico. Production will migrate to the new Fab 18 facility under construction in Israel in the second half of 1998. (Reprinted with permission from *Semiconductor International Magazine*, November 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

Three atom transistor

A tiny transistor, with a gate oxide just three atoms thick, has ben developed by Bell Labs, the R&D arm of Lucent Technologies.

With a channel length of 60 nm, and a three atom, or 1.2 nm thick gate oxide layer, the MOS transistor is not the smallest ever prototyped, but the designers claim it is the smallest that is manufacturable.

Bell Labs has used electron beam rather than conventional optical lithography to print the silicon surface with the transistor's features.

The result is a device that flows 1.8 mA per micron, the highest yet reported for a MOS transistor. It runs off power supplies as low as 0.6 V.

Compared with today's 0.25 μm devices, the 60 nm transistors are five times faster and use up to 160 times less power. (Source: *Electronics Weekly*, 26 November 1997)

Smallest storage device

The world's smallest solid state storage device has been launched by SanDisk. The device, called MultiMediaCard (MMC), was conceived by Siemens Semiconductor, but has been jointly developed with SanDisk in flash and ROM versions. It measures 32 mm by 24 mm, and is 1.40 mm thick, approximately one fifth the size of existing CompactFlash miniature cards.

Initial MMC samples storing 2 or 4 Mbytes are scheduled with higher capacities being available in 1998. SanDisk says there is a need for small "semi-permanent" audio and data storage for mobile phones, pagers and other handheld devices.

MMC will be supported by Nokia, Ericsson and Siemens' Wireless division. (Source: *Electronics Weekly*, 5 November 1997)

Grey matter on a chip

Scientists have built the first "neurochip", a silicon chip equipped with living nerve cells. It could be a precursor to bionic devices made from silicon and living neurons, but for now, neurobiologists want to use the device for understanding how nerve cells grow and talk to each other.

Jerome Pine, a neurophysicist at the California Institute of Technology in Pasadena, has reported how his team of electrical engineers and biologists created a microscopic neural landscape on a 4-centimetre-wide silicon rectangle. The chip, immersed in a petri dish, had 16 tiny wells with short tunnels leading to the surface. The researchers placed an embryonic rat brain cell in each well. As the cells grew, they sent out dendrites that eventually wound their way through the tunnels (which kept the cells clamped in place) and contacted other dendrites, establishing normal electrical activity. Wires in the underlying silicon listened in on the chatter.

So far the researchers have been able to keep cells alive for only two weeks at a time. Once they can sustain cells longer, they hope to study how small groups of neurons "learn" after being stimulated repeatedly. (Source: *Science*, vol. 278, 7 November 1997)

Rock buster

A large 2-megawatt laser capable of punching through slabs of rock is being tested by the Chicago-based Gas Research Institute as a tool for speeding up the drilling of oil and gas wells. The Pentagon originally developed the laser as part of the Star Wars programme. It has already drilled through a 6-centimetre sandwich of sandstone and shale in a second, says Richard Parker, who manages the institute's basic research.

The idea of using lasers to drill through rocks is not new, but experiments in the 1960s were disappointing. The institute decided to take a second look at lasers after the Pentagon started encouraging the civilian use of its technology following the end of the Cold War.

The biggest of the Pentagon's high-powered lasers, the Mid-Infrared Advanced Chemical Laser (MIRACL), can generate a steady beam of more than 2 million watts for up to 5 seconds. It is a hundred times as powerful as the largest industrial laser.

Drilling a well is a slow process. The different layers of rock frequently force the drillers to change bits. Lasers could simplify the process, possibly by softening up the rock before drilling, so that the bits would not need to be changed so often. (Source: *New Scientist*, 28 March 1998)

Copper and nickel to replace palladium in ceramic products

In a radical departure from convention, capacitor maker AVX is to replace palladium with copper and nickel electrode materials in its ceramic products. These materials promise to reduce the cost and improve the high frequency performance of the capacitors.

Palladium is the normal electrode material used in ceramic capacitors, sometimes with a nickel barrier at the contact face. The company aims to replace this with nickel for some applications and copper for others. Both materials are cheaper than palladium, and copper has a lower resistance, which leads to lower parasitic resistance and better high frequency performance.

Ceramic capacitors have to go through a curing process when they are manufactured. Palladium is used for the electrodes because it is compatible with the process, being resistant to oxidation in the curing atmosphere. Copper and nickel are not compatible as they are most susceptible to oxidation.

Current production of the capacitors is going through a qualification process. (Source: *Electronics Weekly* 12 November 1997)

A better way to build a battery

Instead of screening thousands of chemical compounds at random to find drugs, pharmaceutical companies often use a technique called rational drug design to create them from scratch. At Massachusetts Institute of Technology, materials scientists are taking the same tack.

A group of MIT professors describe the invention of a lightweight and inexpensive cathode for lithium-ion batteries, which could replace a pricey lithium-cobalt compound that is widely used today. Instead of testing thousands of possible replacements, the MIT team calculated the optimum characteristics for the cathode—one of two electrodes in a battery that combine to create a current. Then the scientists concocted a cobalt-aluminium mixture to fit the bill.

The professors have licensed the new cathode to Pacific Lithium Ltd., New Zealand, supplier of high-grade lithium. The company plans to market the cathode in late 1998. And it could reduce battery prices by 25 per cent. The MIT team has also licensed Pacific Lithium a second cathode design, for which patents are pending, which will bring further reductions in battery weight and price. (Extracted from *Business Week*, 27 April 1998)

E-beam lithography produces 3 nm wires

Kelvin Nanotechnology, a company formed by the Department of Electronics and Electrical Engineering of the University of Glasgow (Glasgow, Scotland), claims to have made the world's thinnest wires. Features were fabricated using direct-write electron-beam lithography into a layer of polymethylmethacrylate (PMMA) on a silicon substrate. The PMMA was developed and a layer of nickel was evaporated onto the whole sample. The remaining PMMA and the

metal were removed by lift-off, leaving the 3 nm diameter wires.

Recent work at Glasgow has demonstrated that it is possible to make 3 nm nickel or nickel-chromium wires that are self-aligned to larger contact leads. Both mask plate production and direct writing onto samples is performed by Kelvin Nanotechnology. (Reprinted with permission from *Semiconductor International Magazine*, March 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

An optoelectronic approach to sorting

Twenty years ago, the operation of sorting consumed up to 25 per cent of all computing time. Used for various functions from routing phone calls and managing data to searching for information on the web and tracking wafer lots, sorting is a computationally intensive operation, requiring countless comparisons. For example, a list of 1,000 wafer ID numbers sorted into ascending order may require as many as 500,000 comparisons.

A traditional electronic computer is limited by the I/O bottleneck by executing the sorting operation as a series of single comparison steps, each comparing only two words. Optical transmission can avoid this limitation and enable the simultaneous comparisons of multiple word pairs. Therefore, the number of steps to sort a list of 1,000 ID numbers can be reduced by 80 per cent to ~1,000 comparisons.

The clear advantage of optical transmission is the absence of physical wires and minimization of problems associated with increasing I/O pad densities. A laser beam can be accurately focused to approximately the wavelength of the light, ~1 μm, using current semiconductor laser technology. Since adjacent beams of light do not interact, thousands of laser beams can be focused onto a very small area with virtually no cross-talk.

Ways to route information optically are currently under development throughout the industry. One approach, studied at the University of Cincinnati (Cincinnati, Ohio) and Colorado State University (Ft. Collins, CO), is the parallel routing of information onto a CMOS chip. This work involves the use of smart-pixel technology using silicon photoreceivers, CMOS logic circuits and vertical cavity surface emitting laser (VCSEL) based optical transmitters.

The integration of all smart-pixel components into a single chip that can be fabricated using standard device fabrication processes is the near-term goal. For this demonstration, a simple low-impedance photoreceiver circuit, including a silicon photodetector, was designed to convert optical input to CMOS-compatible electrical signals. The CMOS chip and VCSEL arrays were packaged on separate device mounts.

An array of light and dark spots (1's and 0's) from a spatial light modulator, for example, are detected by photoreceivers in the CMOS circuit and converted to an electrical signal. Word comparisons are then performed between adjacent words beginning with the most significant bit (MSB) and progressing to the least (LSB). A difference in the digits indicates the relative magnitude of the words being compared. Based on the result of word comparisons, electronic logic gates switch the word positions so that the larger word is always moved to the right. This operation is aptly called compare and exchange (C&E).

Comparisons are made in both smart-pixel arrays with optical transmission between the two, requiring data conversion back and forth between the electrical and optical domains. These conversion steps are implemented using silicon-based photoreceiver circuits on the smart-pixel array

input and VCSEL-based optical transmitters on the array output.

To verify proper sorting operation, the optical input and output signals were monitored using a video camera. Four randomly ordered four-bit words, or ID numbers, were input in parallel to the system. The sorting unit performed word comparisons in each smart-pixel array and communicated intermediate results to the opposite smart-pixel array. Several comparisons occurred in parallel: words 1 to 2 and 3 to 4 in array 1, words 2 to 3 in array 2 (each comparison was made on a bitwise basis starting with the MSB) and subsequent pipelining to the LSB. Four words require just four cycles, however the remaining cycles are necessary to flush the three-bit pipeline. The last video image indicates that the initial input pattern has been completely reorganized to produce a sorted set of numbers, increasing from left to right. (Reprinted with permission from *Semiconductor International Magazine*, March 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Low-k porous SOG material developed

A new material called hydrophobic porous SOG (HPS), which has a dielectric constant (k) less than 2.5, has been developed by researchers at Fujitsu's Fine Chemicals Research Center in Japan.

The new film is said to compare favourably with better-known aerogels, which are low-density, low-k films obtained by the controlled gelation and drying of the precursor. The problem with aerogel films, according to the Fujitsui researchers, is that they are mechanically weak, and it is difficult to control their pore structure (porosity and pore size) and pore surface character. By comparison, in the case of HPS, it is easy to make the pore surface hydrophobic, since HPS consists of a hydrogen silica sol (a colloidal suspension of a solid in a liquid) that has the si-H group on its surface. The film strength is controllable by the amount and composition of the binder. The pore size is determined by the size of the sol. (Reprinted with permission from *Semiconductor International Magazine*, March 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Isotopically pure silicon-28 epitaxial wafer

Isonics Corp. (San Jose, CA) has developed an isotopically pure silicon-28 wafer. The company says it believes the improved thermal characteristics of the wafers will facilitate the manufacture of higher density integrated circuits resulting in increased performance, improved chip yields and shorter time-to-market for new designs. While having better thermal properties than standard silicon, the isotopically pure silicon requires no change in semiconductor manufacturing processes.

According to the company, tests have shown that isotopically pure silicon-28 has >50 per cent better thermal conductivity than natural silicon. The wafers are grown as an epitaxial layer on a standard silicon single-crystal wafer. (Reprinted with permission from *Semiconductor International Magazine*, March 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Miniature silicon display

A British research consortium has developed a high-resolution silicon liquid crystal miniature display (SLIMDIS). The consortium employs commercial CMOS foundry techniques to form an array of 786,432 pixels on a 12 μm pitch. The resolution is better than 80 lines/mm. This display is very suitable for use in lightweight head-mounted viewers.

Admit Design Systems (South Queensferry, Scotland) developed the pixel driver circuitry that can operate the active matrix at speeds of up to 4 Gpixel/sec. Davin Optical (Borehamwood, Herts.) designed and developed the plastic wide-field viewer, and Swindon Silicon Systems (Swindon, Wiltshire) worked on the backplane design. GEC-Marconi Research Centre (Great Baddow, Chelmsford) and Edinburgh University (Edinburgh, Scotland) completed the consortium. (Reprinted with permission from *Semiconductor International Magazine*, March 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Polymer lining

As micromachining is becoming an accepted way of producing sensors and actuators, the need is increasing for an etching process that can produce straight-sided structures and deep parallel-sided holes.

There are several existing methods, but all suffer from loss of precision as structures get higher and holes get deeper.

The problem is that all etchant processes cut sideways while they cut down, or fail to etch into corners properly. The result is holes get wider or narrower as they go down.

Surface Technology Systems (STS) of Newport does not claim to have developed a perfect solution, but it believes that its advanced silicon etch (ASE) is the best so far, producing holes nearly 40 times deeper than their diameter and silicon walls with 90° ±2° sides.

The polymer also coats horizontal surfaces, but its chemistry is chosen to be eaten away quickly under the direct onslaught of the plasma etch. The polymer is also eroded on the vertical surfaces, however the periodic polymer re-coating prevents the silicon being touched.

Careful balancing of all parameters in the process results in accurate results. At an etch rate of 3 μm/minute, the process yields an anisotropy of greater than 99 per cent, vertical smoothness of better than 0.25 μm and horizontal flatness of greater than 0.1 μm. (Source: *Electronics Weekly*, 29 April 1998)

Gallium nitride semiconductor quantum dots formed

Y. Aoyagi and S. Tanaka of Japan's Institute of Physical and Chemical Research (RIKEN) are conducting an atomic scale processing project as a link of an atomic scale scientific-engineering programme, and have succeeded in establishing an entirely new technique to form semiconductor quantum dots. The semiconductor quantum dots are expected to manifest new physical phenomena different from those displayed by the conventional type of three-dimensional bulk, and are quite interesting not only from the aspect of elucidating the low-dimensional physical properties of substances, but is also expected to have applications to shortwave laser diodes at room temperature, which are anticipated to bring about considerable progress in high-performance electronic devices and optical devices.

With the newly established technique, the surface energy of a wafer crystal is controlled artificially to enable the formation of quantum dots in systems where this had been impossible previously, and the dot size and density can be controlled flexibly. For example, gallium nitride (GaN) quantum dots are formed successfully, of which application to the fabrication of shortwave lasers is anticipated. With conventional types of techniques, the formation of GaN on aluminium gallium nitride (AlGaN), which is indispensable for forming device structures (Carrier confinement), had been possible only in the form of a thin film (due to the small lattice mismatching and the surface energy balance advantage

of film growth), so the formation of dot type structures had been impossible.

Reacting a chemical substance on the wafer surface beforehand was found to be effective for dot growth, which enabled control of the growth mode. Also, by changing the experiment conditions, it was possible to control the size and density of the quantum dots flexibly. In addition, success was achieved for the first time in generating and observing stimulated emission (lasing) from the GaN quantum dots by laser excitation. Compared with a structure using the conventional type of quantum thin film, characteristic values can be considerably decreased.

The new technique is expected to permit the formation of quantum dots in systems consisting of gallium arsenide (GaAs) or zinc selenide (ZnSe), which are typical compound semiconductors, as well as the formation of silicon (Si) quantum dots. These materials had been produced previously only in the form of quantum wells and quantum wires, which prevented the formation of quantum dots of natural formation. Therefore, even in connection with these materials, the manifestation of new properties by the quantum dots (low-dimensional systems) raises the possibility of commercializing new types of optical and electronic devices utilizing lasers of higher performances. Further details from: Institute of Physical and Chemical Research (RIKEN), Semiconductors Lab., 2-1, Hirosawa, Wako City, Saitama Pref. 351-01. Tel.: +81-48-462-1111; Fax: +81-48-462-4659. (Source: *JETRO*, January 1998)

Data processing board made of LSI patterned after cerebral meninx

The Electrotechnical Laboratory of the Agency of Industrial Science and Technology of Japan has developed an LSI patterned after the cerebral meninx (large-scale integrated circuit) that incorporates the learning function, and by applying this chip has made a prototype data processing board.

The cerebral meninx type LSI (processor) that is central to the data processing board mimics about 1,000 nerve cells and about one million synapses (links between nerve cells) with an electronic circuit. It applies the conventional neural network technique of changing the circuit linkage mode by repeated signal input, while introducing a mechanism not present in the neural network to feature actions which are closer to those of the human brain.

An element in charge of short-term memory storage is provided at each synapse junction point, and when the element equivalent to an independent nerve cell inputs a signal, the synapse junction point investigates and elucidates what kind of signal was received by each cell just prior to signal input, based on which the synapse junction point mode of linkage is changed appropriately. This means that biological organisms are capable of learning the time sequences in which events occur. By incorporating this mechanism, the processor can acquire a function of resolving problems by itself through the trial and error method even without instructions for the procedure.

The data processing board has a height of 10 cm and breadth of 20 cm, mounts two processors, and a memory and input/ouput unit. Simply linking the board to a versatile type personal computer enables the system to be used as an inferential processing brain for image processing in a manner resembling that of human visual process, and can recognize handwritten characters. Further details from: Electrotechnical Laboratory, AIST, 1-1-4, Umezono, Tsukuba City, Ibaraki Pref. 305. Tel.: +81-298-54-5059; Fax.: +81-298-54-5349. (Source: *JETRO*, January 1998)

Optical device workable in temperature range from -260 to 1,100 °C

Yoshinobu Maeda of Toyota Technological Institute in Japan has developed an optical device that can operate in the temperature range from -260 to 1,100°C. The device was developed by using a substance featuring the negative nonlinear absorption effect (Maeda Effect) displaying the negative light input/output characteristic.

Specifically, the optical transition characteristic of erbium (Er), a rare earth element, is utilized. The device uses the optical transition of the inner shell of the erbium atom, so is hardly influenced by the ambient temperature and can operate in a very wide temperature range. Experiments have confirmed that the device is workable in a broad temperature range from -260°C to 1,100°C, implying that the device can work within the temperature range from cryogenic temperature to an extremely high temperature.

Another distinct characteristic of this optical device is that it is an all-optical device working at superlow power. It will operate at a minimum of a few dozen nW/cm^2, a power level that is more than ten digits less than that of an existing device based on the nonlinear optical effect. Also, since this new device displays a negative light input/output property, it can be used to comprise an optical NOT (inverter) circuit that is indispensable for a theoretical optical circuit, and a basic optical computer device could be designed for controlling the entire range of optical signals by using optical signals. Upon the realization of an optical computer with superparallel arithmetic function, it will become possible to anticipate the emergence of computers displaying performances which are definitely higher than existing electronic computers.

Fig. 1 shows a conceptual diagram of a measurement system, and Fig. 2 (a) and (b) the waveforms of light transmitted through a device heated to 1,050°C and the incident light, respectively. The waveform of the transmitted light is inverted with respect to the waveform of the incident light, indicating that the device is acting as an optical signal inverter. Upon the commercialization of this inverter, it will become possible to fabricate an entire series of theoretical digital optical circuits. Further, this phenomenon has been confirmed to occur at an extremely low level of power of minimum 60 nW/cm^2, and is responsive down to frequencies of 1 GHz (switching speed of 10^{-9}s).

With this device, the erbium element acts as an optical device, so the device can be fabricated by doping erbium into various types of substances such as crystals and glass. Therefore, devices of various substances and shapes can be made. Further details from Toyota Technological Institute, Department of Information and Control Engineering, 2-12-1, Hisakata, Tenpaku-ku, Nagoya City, Aichi Pref. 468-8511. Tel.: +81-52-809-1886; Fax: +81-52-809-1721. (Source: *JETRO*, April 1998)

Scientists promise lighter batteries

US researchers have made a fundamental discovery in lithium ion (Liion) battery technology which promises lighter, cheaper batteries.

Liion cells use a lithium-based "sponge" on their cathodes to soak-up lithium ions during discharge. Common wisdom is that the sponge has to have a transition metal in its molecule as this is where ions are stored.

$LICoO_2$, containing expensive cobalt, is the most common sponge material, although attempts are being made to replace the cobalt with cheaper manganese.

"We have determined that the transition metal is not the host for the lithium ions. It is the oxygen in the molecule that stores them", said Gerbrand Ceder, associate professor of

materials science at the Massachussetts Institute of Technology (MIT).

If true, this opens up a whole range of options for ion sponges. Principal among these, according to Ceder, is to replace part of the cobalt with lighter, cheaper aluminium.

With its new understanding of ion storage, the MIT team is modelling sponge materials from first principles using quantum mechanics. (Source: *Electronics Weekly*, 22 April 1998)

Characterization of silicon wafer haze

Over the course of the past several years, advances in high-resolution surface imaging have made a significant impact in solving routine processing problems related to high volume semiconductor manufacturing. In particular, atomic force microscopy (AFM) routinely determines the surface roughness of silicon wafer substrates following manufacturing processes such as ion implantation, diffusion, and thin film deposition.

Prior to the acquisition of AFM technology, both optical microscopy and scanning electron microscopy (SEM) were used for imaging surface roughness, while optical interferometers were used for measuring surface roughness. However, small changes in silicon substrate micro-roughness, in the range of 15 to 30 angstroms, frequently could not be conclusively detected via these systems. This has been particularly true when the areas of analysis are small. The example put forth in this case study illustrates the application of AFM to address variations in silicon wafer micro-roughness that were mistakenly attributed to the presence of surface contamination, a common problem in semiconductor wafer processing.

Haze defects

In high-volume semiconductor manufacturing, illumination by high-intensity continuum sources has been the method of choice to inspect bare silicon wafers. However, this technology causes many defects to appear as a "haze" on the wafer. To identify which contaminant causes the haze, several materials characterization methods have been designed. The primary techniques have historically been either Auger Electron Spectroscopy (AES), and/or high resolution Field Emission Scanning Electron Microscopy (FESEM). Unfortunately, surface contamination has rarely been confirmed as the root cause of the defect.

In this study, AES and FESEM analyses of a wafer haze were once again unable to confirm the presence of contamination in the defective area. In an effort to determine if micro-roughness variations were responsible, three areas on the same wafer were imaged via AFM.

In terms of root mean square roughness, the AFM data indicates that the roughness value of the normal surface differs from the roughness value of the silicon surface containing the haze by approximately 15 to 20 angstroms. These results clearly indicate that surface micro-roughness, and not surface contamination, is responsible for the wafer haze noted on this reject wafer sample. Shown in the table are the individual roughness values for the three silicon surface areas that were evaluated.

Sample surface roughness values

Evaluated region	Figure	Roughness R_a,Å	Roughness R_{rms},Å
Unaffected surface	2	10.55	13.85
Line defect/edge surface	3	26.09	33.69
Center haze zone	4	24.07	29.33

For more information: Mark Schade is technical staff scientist, Motorola Semiconductor Components Group, 5005 East McDowell Road, P004, Phoenix, AZ 85008; Tel.: 602/244-6140; Fax: 602/244-5073; E-mail: R16234@email.sps.mot.com. (Source: *Advanced Materials & Processes*, March 1998)

Onsite ultra-pure chemicals

Air Products and Chemicals has designed an onsite generation system for producing ultra-pure chemicals such as ammonium hydroxide and hydrochloric acid for the semiconductor industry. The system is said to help reduce particles and metallic impurities in wafer cleaning process chemicals, resulting in fewer surface defects.

The onsite generation is accomplished by mixing ultra-high purity anhydrous gases such as ammonia, hydrogen chloride and hydrogen fluoride with ultra-pure water to form wafer cleaning or oxide etching chemicals.

Process temperature control in the generating vessels is achieved with heat exchangers cooled by a closed loop recirculation chiller. Microcontamination is controlled through recirculation of the generated chemical by an ultra-high purity pump to a recirculation vessel.

Other advantages claimed for the system include lower costs than conventional packaged chemicals for medium- and large-volume users, enhanced safety as a result of less handling of concentrated chemicals, and the elimination of chemical packaging and associated container disposal costs. (Source: *European Chemical News*, 20-26 July 1998)

The future of computer processors could be spherical

The silicon chip may be no more if one American company has its way. Ball Semiconductor Inc. (BSI) believes that in the future, silicon circuits will be spherical.

Microchips got their name because they are "chipped" off a flat silicon wafer upon which circuits have been etched. But wafer processing is slow and expensive, says BSI. Instead, it says it is close to making computer processors in the form of silicon spheres.

The company claims to have used conventional lithography to etch diodes onto the surface of a silicon sphere 1 millimetre in diameter. It is now working on ways to speed up and refine the production process. The company claims that it should be able to build a production line for $100 million—a tenth of the cost of a conventional chip plant.

Ram Ramamurthi, vice-president of R&D at BSI, which is based near Dallas, Texas, says that the company will be able to make processors so cheaply because its production method assimilates the different processes involved, eliminating the need for vast clean rooms. Keeping a production line free from the microscopic dirt particles that can cripple chips is a very costly business. Instead, BSI wants to do everything—from making the silicon spheres to packaging the circuits—in one continuous process. It hopes to be able to produce ball circuits in days rather than the weeks it typically takes to make chips.

In place of clean rooms, BSI is proposing to process the spheres in hermetically sealed quartz tubes 2 millimetres wide. The spheres will be shuttled through the various steps of the production process along these tubes. This technique could not be used for chips. The balls emerge only when the circuits are being etched.

Making the balls begins with molten polysilicon granules being cooled and formed into spheres by being dropped down a long tube, just as musket balls were once made in "shot towers". Next, the circuitry is laid down using the same masking, etching and cleaning process that conventional chips go through. The big difference is that the circuits are etched onto a sphere rather than a flat plane, Ramamurthi says. The company is currently using 2D design software and has had to write special programs to wrap them around a 3D ball. Ball has developed a mirror with 45 facets that allows it to transfer a pattern onto more than 70 per cent of the sphere in one flash of light.

So far, the company has etched only various kinds of diode onto a sample sphere. Ramamurthi says the company will be creating components 1 or 2 microns across rather than the submicron sizes that some chip-makers are working with. The spheres will have bumps on their poles to act as contacts. (see diagram).

A well-rounded processor

1 millimetre

The circuitry is etched on the silicon sphere with a prism and mirror system

Contact
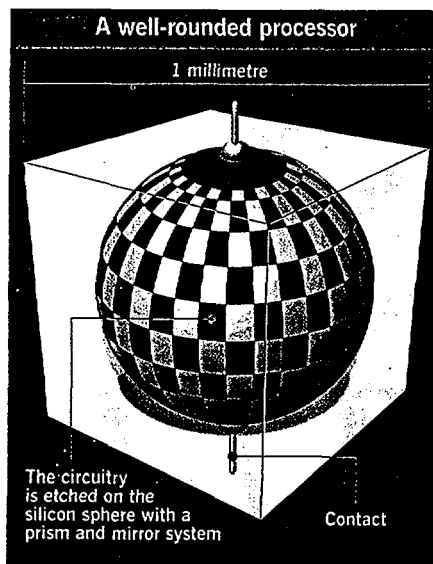
(Source: *New Scientist.* www.newscientist.com, 25 July 1998)

Easily solved?

After years of approximations and fudging, chemists finally have a way of working out the probability that any given pair of atoms or molecules will react together. Researchers at the University of California at Berkeley have developed an algorithm that can calculate this probability exactly. But there is a hitch: they need a quantum computer to run it, and nobody has built one yet.

The probability that two atoms or molecules will react with each other depends on factors like their shape, orientation and momentum when they meet. To calculate this probability, chemists have to solve Schrödinger's equation, the mathematical expression that describes the world on the quantum scale. This equation is so complex that it has seemed impossible to solve for chemical reactions that involve more than five electrons.

Now Daniel Lidar and his colleagues at Berkely have come up with a way to solve the equation, at least in principle. Lidar's idea is to develop a mathematical model of the behaviour of the nuclei and all the electrons participating in the reaction, and then to superimpose this onto a three-dimensional grid. He then proposes solving Schrödinger's equation at each point on this grid, using a quantum computer.

The algorithm relies on the predicted ability of quantum computers to carry out huge numbers of calculations at the same time. Similar calculations with a conventional computer rapidly become too complex to manage, so chemists have had to rely on sweeping simplifications and approximations for the answer.

These approximations lead to significant inaccuracies when chemicals are being produced on an industrial scale, says Lidar. With an exact value, the optimum conditions for a reaction could be calculated fairly precisely.

Lidar's algorithm is one of a growing number designed for quantum computers, and is thought to be the first in the field of quantum chemistry. But as yet, any notion of actually building a quantum computer comes up against an insuperable obstacle: the state of any particle carrying information is lost if the particle is disturbed in any way. (Source: *New Scientist*, 25 July 1998)

Holes pack more power into optical fibres

In a conventional optical fibre, light passes down a central silica core that has been doped to raise its refractive index. This ensures that light is transmitted down the fibre without escaping—but with a particular dopant it only works for light of a single wavelength.

The fibres have to be thin—typically 1 to 2 micrometres in diameter. If they are too wide, the required "single mode" transmission breaks down: the light bounces around inside the fibre, and different parts of the beam arrive at their destination at different times. Later-arriving components will then corrupt the signal. However, the narrow fibre puts a limit on the power of the signal that can be transmitted, so it has to be boosted at regular intervals.

Instead of doping the core, Philip Russell and his colleagues at the University of Bath guide the light with very fine air holes that run the length of the fibre. The benefit of this arrangement is that the core can carry a wide range of wavelengths, each of which can be used to carry a separate stream of data, vastly increasing the fibre's capacity. And because there are no dopants, the light guide can be broad, allowing more powerful signals to be transmitted and so reducing the number of amplifiers needed en route.

The Bath researchers' system, which they call a photonic crystal fibre (PCF), places no limits on the width of the fibre, while guaranteeing that the fibre transmits single-mode light of any wavelength. PCF's secret is a regular array of tiny holes that run the length of the fibre. The holes are 0.01 nanometres in diameter—one-thousandth the width of a human hair—in a fibre that could stretch distances 10 kilometres or more.

The team makes the PCF by stacking pure silica tubes in a hexagonal array, and then heating and stretching it. This reduces the width of the structure, while retaining the geometry.

Traditional fibres have a silica core, which acts as the conduit for the light signal, surrounded by a thicker cladding with a slightly lower refractive index. With PCFs, the core takes the form of a "missing hole", where a solid silica rod has been used in place of one of the hollow tubes in the stack. The hexagonal array of holes surrounding the core acts as a waveguide.

By creating fibres with more than one core, the Bath researchers have further expanded the data capacity of their fibre. (Source: *New Scientist*, 18 July 1998)

The future is carbon

Semiconductors and conductors made of carbon could one day be used in planes and cars that collect and store their own solar energy.

Carbon composites are built by cementing together layers of carbon fibres using epoxy resin. By doping the fibres with chemicals that donate or mop up electrons, Deborah Chung and Shoukai Wang of the State University of New York at Buffalo have found a way to make them act as conductors and semiconductors.

By combining these fibres in layers, Chung says she can build solar cells, capacitors and other electronic components that can be wired together with conducting fibres. "They are very cheap to make compared with silicon technology", she says. (Source: *New Scientist*, 14 March 1998)

Researchers close in on easy-to-make lasers for optical fibre communications

For the first time, a long wavelength vertical-cavity surface-emitting laser has been grown directly on a simple GaAs substrate. Previous successful attempts have involved complex processes like substrate back-etching and wafer to wafer bonding.

Convention semiconductor lasers are made horizontally in a wafer and are long (0.5 mm) rectangular structures. Once they are cut from the wafer, two edges of each chip are polished to form the end mirrors for the laser cavity. The chips then edge-emit.

Ignoring technical performance, this method of construction has several practical disadvantages. The structures cannot be packed very closely together on the wafer, limiting the number that can be made at a time; edge polishing is a fiddly process, outside mainstream semiconductor processing, and edge-emission means that non-standard chip mounting is required if an optical connector is to be mounted on top of a package. On the other hand, edge emission is an advantage if a laser is to inject into surface optical waveguides, like those in Bookham Technology's optical Asics.

Vertical cavity lasers pack tightly on to wafers (<0.1 mm centres), do not require edge polishing and emit at right angles to the wafer surface.

A vertical-cavity surface-emitting laser (VCSEL) consists of a cavity and, occupying the bulk of the structure, a pair of distributed Bragg reflectors (DBRs).

The cavity is a sandwich. Its filling is a very thin quantum well. Above is a P-doped semiconductor, below is equal thickness of N-type. The cavity is one wavelength thick and forms a P-I-N diode where photons are emitted during the recombination of carriers.

Above and below the cavity are the Bragg reflectors.

Making a reflector using semiconductors is not easy. Bragg reflectors use the reflecting effect caused when materials of two different refractive indices are in contact. A large difference in reflective index makes a good reflector, but semiconductors have small differences. The answer is to have a stack of interfaces, each one wavelength apart—a DBR.

An electrode is plated onto the top of the upper reflector. The substrate is the other contact and emission is through the bulk of wafer and out of its back.

In this case, the emissive quantum well is GAInNAs within a GaAs cavity. The laser's distributed Bragg reflectors are both made from alternating layers of GaAs and AlAs. The top has 21 periods, the bottom 25.5. The whole thing sits on a N-type GaAs substrate.

Emission is at 1.18 µm and its designers now see a route to a version for use in the 1.3 µm optical fibre transmission window.

Hitachi's Central Research Laboratory made the laser and the work was performed under the management of Real World Computing as part of the MITI program "Interconnection for the high-density data bus". (Source: *Electronics Weekly*, 3 June 1998)

Indium phosphide tunnels into low power memory

Indium phosphide is showing a lot of promise in a novel form of high speed low power memory.

One company that is making a significant commitment to InP is Raytheon TI Systems, formerly a research arm of Texas Instruments.

InP is fast in both digital and analogue circuits, but it is as a memory, using a strange device called a resonant tunnelling diode (RTD), that most excites the Raytheon researchers.

Tunnel diodes have an "N" shaped V-I curve. That is, between certain voltages, the device has a negative resistance and current falls with increasing voltage.

Resonant tunnelling diodes (RTDs) are a type of tunnel diode made using heterostructures rather than P-N junctions.

If two RTDs are connected in series across a fixed voltage supply of around half a volt, the central node will assume one of two stable voltages. The state of this node can be set to one value or the other by injecting or extracting current briefly through a transistor.

The transistor and diodes form the basis of a memory cell which can be read like a DRAM, but is inherently bistable and does not need periodic refreshing.

The disadvantage is that the cell needs a continuous current flow which is where its power consumption comes from.

Raytheon has managed to make RTDs with very low quiescent currents, reducing power consumption to 50 nW per bit while maintaining sub-nanosecond access times. Silicon DRAM bits use around 1 pW, but are far slower. GaAs SRAM cells are as fast as the RTD cell, but use 200 times more power.

Raytheon reckons that a mature InP memory technology could have a density of 2 Mbit/cm^2 and dissipate only 5 mW/Mbit.

Indium phosphide shows a lot of promise for memory. However, there is a long way to go. Raytheon is still at the prototype stage, with a 16-bit memory. 100 mm wafers are the latest thing in InP, with 75 mm still the norm and the material is expensive and brittle. (Source: *Electronics Weekly*, 27 May 1998)

Sensor puts finger on mobile security

STMicroelectronics is preparing to put its fingerprint recognition IC into production for products such as mobile

phones and laptop PCs. A prototype was first shown in May last year with 390 dpi resolution. This latest version ups the resolution to 508 dpi.

"Our product is based on a sensor which detects capacitance between the finger and a plate. This can recognize the difference between ridges and valleys of fingerprints", said product manager Herve Martin.

All the associated electronics, including A/D converters, is integrated, so the sensor can easily be interfaced to a controller using an I^2C bus. Resolution and sensitivity of the sensor are high enough to detect the difference between a live or dead finger.

Martin expects the sensor to be integrated into phones and laptops next year. It is small enough for such applications because the entire sensor is constructed on silicon. (Source: *Electronics Weekly*, 27 May 1998)

Bluetooth bites into wireless

Wireless communications and PC firms have joined forces to present a radio-based datacommunications technology for home networks and wireless e-mail applications.

Known as Bluetooth, the technology was developed by Ericsson, IBM, Intel, Nokia and Toshiba.

The tiny Bluetooth transceiver is contained in a 0.5 in square package that can fit into such devices as cellphones, digital cameras, notebook computers and printers. It works over a ten metre range and transfers data between Bluetooth equipped devices automatically.

Bluetooth can handle 700 kbit/s, to be boosted to 2 Mbit/s once the first Bluetooth products come out in the second half of 1999.

"The goal is to combine the baseband chip with the radio transmitter onto one chip", said Richard Beyer, CEO of VLSI Technology, which helped develop the baseband chip used in Bluetooth.

The technology has won wide support from the electronics industry. Full specifications will be released later this year. Companies joining the Bluetooth development group include Motorola, Qualcomm, 3COM Palm, Compaq, Dell, Lucent Technologies and TDK. Other companies are also invited to join.

Bluetooth could end up competing with two other RF links for digital equipment, the HomeRF system and wireless LAN. All three work at the same frequency and have similar goals, although Bluetooth is designed to work anywhere, including away from the home or office. The systems should not interfere with each other because they use frequency hopping, spread spectrum techniques. (Source: *Electronics Weekly*, 27 May 1998)

Microchips could soon be used to rapidly identify pathogens

The "laboratory-on-a-chip" took another step forward when a Californian company revealed that it had developed a penny-sized microchip that extracts bacteria from blood samples using electricity.

Current laboratory tests take days to identify the bacterium causing an infection. In an effort to speed things up, biotechnologists have been developing the lab-on-a-chip concept so that smart slivers of silicon can analyse blood or saliva in just a few minutes.

A major stumbling block has been how to isolate pathogens, often present only in very low numbers, from the millions of human cells in a blood sample. Now Jing Cheng and his colleagues at the biotechnology company Nanogen in San Diego have successfully tested a square-centimetre array

of electrodes that can be programmed to attract only the cells researchers want, rapidly separating them from the blood.

The array of electrodes produces a high-frequency alternating current in a blood sample. In such a field, a given cell will become either positively or negatively charged, depending on its electrical properties. By trial and error, Chen worked out a frequency that gave the bacteria a negative electrical charge, but left a positive charge on the human cells.

After zapping a sample of blood spiked with *Escherichia coli*, Cheng switched the array to direct current. The bacteria stuck to the now positive electrodes like iron filings to a magnet, while the blood cells were repelled.

Cheng then ruptured the bacteria with a 400-volt shock. After washing away the cell membranes and proteins, he analysed the purified genetic material on a second electronic chip for the presence of bacterial DNA. The entire procedure took just 30 minutes.

So far, Cheng has separated four types of bacteria from blood, including *Streptococcus* and *Staphylococcus*. The chip has also singled out cultured carcinoma cells, raising the possibility that the technique could be useful in diagnosing cancer.

In theory, the array can pick out any type of cell, once its behaviour in electric fields is known. Cheng says that is a major advance over earlier "passive" cell-sorting techniques, such as filtration.

Cheng is now developing more compact arrays that contain 10,000 electrodes. That, together with improvements in the washing reagents, should speed up the process even further.

Another company, Orchid Biocomputer of Princeton, New Jersey, is working on a different kind of lab-on-a-chip. Its "Chemtel" chip contains 144 chambers, each capable of sustaining a different chemical reaction—hopefully speeding the hunt for new drugs. (Source: *New Scientist*, 6 June 1998)

Aerogel insulators could double computer speeds

Aerogel insulators could help computer chips run twice as fast as they do now. say researchers in the Semiconductor Research Corp. Center for Advanced Interconnect Science and Technology (Caist) at Rensselaer Polytechnic Institute. Aerogels, substances so porous they are more air than solid material, are better electrical insulators than silicon dioxide, the insulating material currently used on most chips. SiO_2 has a dielectric constant of about four and aerogels about two. Air, the perfect insulator, is rated at one. Better insulators let chips run signal lines closer together, thus minimizing lead length and propagation delay, and boosting speed.

Highly porous silica films created at Caist are between 65 and 90 per cent air with a dielectric constant ranging from 2.3 to 1.4. Porosity and thickness can be controlled, Caist has found, and the new films do not absorb water during processing and stand up well to high temperatures.

Joel Plawsky, a Caist researcher, says aerogels could be commercialized within five years, though there are still technical problems. Texas Instruments has successfully tested Xerogel, a similar substance, with copper wiring, and estimates that new designs incorporating it could boost computer speeds tenfold in the next decade. (Source: *Machine Design*, 2 April 1998)

Popeye power for miniature machines

The tiny generators found in the leaves of green plants could soon be used as batteries or components in miniature electronic devices.

Elias Greenbaum and his colleagues at Oak Ridge National Laboratory in Tennessee are studying the chlorophyll-based photo-synthetic reaction centres in spinach leaves to see if they could be adapted to power nanoscale electronic devices.

In photosynthesis, plants turn carbon dioxide, water and minerals into oxygen and energy-rich carbohydrates. Complex pigment-protein structures in chlorophyll use electrons freed by sunlight to power this process.

Greenbaum and his coworkers James Weifu Lee and Ida Lee have been extracting these reaction centres from the leaves of spinach plants—which are especially rich in these structures—to see if they can be used as molecular generators. They found that the reaction centres do not entirely stop working when deprived of water and carbon dioxide: incident light still causes electrons to absorb energy and circulate within the structure, generating a current.

Greenbaum says the reaction centres are potentially very attractive to anyone needing to power tiny devices. They are only 6 nanometres across, take only 5 to 10 picoseconds to start working, and are easy to extract. And despite their tiny size, the chlorophyll complexes can, in principle, produce a potential difference of as much as 1 volt.

Eventually Greenbaum hopes that the reaction centres will be used as tiny photobatteries powered by the incoming light. He admits that there are a lot of problems still to be overcome, not least of which is finding a method of making and attaching ultra-thin wires to arrays of the reaction centres. (Source: *New Scientist*, 23 May 1998)

DNA is helping to shrink electronics

DNA could soon help tiny electrical circuits to build themselves, Israeli researchers predict. Using tiny strands of DNA as templates, they have "grown" silver wires that are just a few nanometres wide between two electrodes.

As electrical circuits become ever smaller, it will eventually become impossible to build them using conventional techniques such as photolithography. So Erez Braun and his colleagues at the Technion-Israel Institute of Technology in Haifa turned to the remarkable properties of DNA for help. "Self-assembly with DNA is well developed in nature," says Braun's colleague Uri Sivan. "The whole toolbox is already there".

First, the researchers chemically anchored short DNA strands 12 base pairs long onto the surface of tiny gold electrodes. These acted as selective hooks for a longer strand of DNA, forming a bridge between the electrodes. They then added positively charged silver ions, which stuck to the negatively charged DNA. Reducing the ions to silver metal particles with a solution of hydroquinone created a silver wire bridge 12 micrometres long between the electrodes.

The beauty of the technique is its flexibility, Braun says. By changing the anchor's base pairs, Braun and his team can select where the DNA will bind. So with a network of electrodes carrying different anchors, each targeting DNA bridges of different lengths, it should be possible to make a nanocircuit to order.

However, the technique has its drawbacks. The silver wires have unusually high resistance, possibly due to poor electrical contact between the silver grains. Braun's team hopes to improve the connections, for instance by using gold, which is a better conductor than silver.

Braun says their work confirms that using DNA and proteins as templates for building nanoscale electronics is feasible. (Source: *New Scientists*, 21 February 1998)

Stars of the small screen

Diamonds can make the screens of laptop computers glows as brightly as the monitor on a desktop, according to researchers at Motorola. Screens using carbon films with some of the properties of diamonds are sharper, brighter, and have a better viewing angle than the liquid crystal displays of laptops—and they could be on the market by the end of the decade.

Bulky desktop monitors and laptops use entirely different technologies. In monitors, an electron gun at the back fires electrons at a phosphor screen. One reason for their size is the need for the gun to scan the screen. Laptops use LDCs which, instead of glowing, selectively block and filter light from a lamp behind the screen. The displays are dim and cannot be seen from every angle.

The solution to this problem could be devices called cold cathodes, which emit electrons at a low voltage—and could illuminate a phosphor screen. Several companies have tried using tiny pyramid-shaped pins of molybdenum to inject electrons, but the tips do not last.

Jim Jaskie, an engineering physicist at Motorola in Arizona, has found that carbon is much better at throwing electrons at the screen. "The crystalline structure of graphite and diamond are very close, but they have bizarrely different electrical properties", he says. "Graphite is a good conductor, but with diamond, an electron would rather leave the crystal".

A thin film of carbon, if deposited correctly, has some of the characteristics of each. If a small current is applied to the carbon film, electrons flow through the graphite-like part and jump out of the diamond sections to illuminate a phosphor screen.

Unlike the pin-based cathodes, the carbon sheets are flat, cheap and durable. According to Jaskie, carbon-based laptops could soon be on the market. (Source: *New Scientist*, 17 January 1998)

Electrons help light through minute gaps

Light can squeeze through what seem like impossibly small holes, physicists have found. They say that the frequency of light transmitted through a grid of holes can be changed by altering the pattern, and that the effect could eventually be used in devices that control light, such as optical computers.

A team led by Thomas Ebbesen of the Louis Pasteur University in Paris and the NEC Research Institute in Princeton, New Jersey, made the discovery by chance when they set out to make "quantum cavities" in a glass-backed metal film. To check the quality of the cavities—holes bored through the metal to the glass—they illuminated them with a range of wavelengths.

"To our astonishment, we saw light transmitted with 100 per cent efficiency at a wavelength 10 times bigger than the diameter of the hole", says Ebbesen. Theory has suggested that the photon has an effective size roughly equal to its wavelength. "So it should not be able to squeeze through a smaller hold", says Ebbesen.

The researchers have now carried out more experiments using a metal film riddled with millions of holes about 150 nanometres across and 0.5 micrometres apart. They say that there are peaks of transmission at various wavelengths, and these change if the hold spacing and arrangement changes.

Ebbesen suggests that the light manages to squeeze through the holes thanks to "plasmons"—the natural sloshing motion of electrons in the surface of the metal. If the frequency of incident photons matches that of a plasmon, the photons are absorbed by the electrons on one side of the film and reradiated on the other, yielding perfect transmission.

But depending on their positions, the holes hinder plasmons at certain energies.

Oddly, the team have even observed 200 per cent transmission—twice as much light emerging on the far side of the film as impinges on the holes. "This occurs because even the light which falls between the holes can excite plasmons, producing light on the far side of the film", says Ebbesen.

The team says that the phenomenon might one day find a use in "photonic" devices that control light. It could also overcome a fundamental limitation of photolithography, the technique used to make silicon chips. Light shining through a mask casts the shadows of electronic components on a substrate. Unfortunately, making components smaller than the wavelength of the light requires correspondingly small openings in the mask and light will not pass through them. "However, we have shown we can get 1000-nanometre light through 150-nanometre holes", says Ebbesen. (Source: *New Scientist*, 7 March 1998)

Mighty disc

IBM has broken its own memory storage record with a hard-disc drive that can store 1.8 billion bits of data per square centimetre. The new disc stores more than double the previous record set by IBM a year ago. Although the new drive is only a laboratory prototype, the company hopes to produce a commercial version by 2001. If so, analysts expect the cost of hard-disc storage to fall by a third. (Source: *New Scientist*, 10 January 1998)

Bringing order to amorphous silicon

Amorphous silicon is the semiconductor of choice for large-area, low-cost electronics such as solar cells and the displays in laptop computers because it can easily be laid down from a vapour over large areas. But its disordered arrangement of atoms cuts into the performance of these devices. To do better, manufacturers would have to turn to single-crystal silicon (the material used for high-end computer chips), but it is prohibitively expensive to put down as a thin film over a large area. Now a team of researchers from Columbia University in New York City may have found the perfect compromise.

Materials scientists James Im, Robert Sposili, and Mark Crowder have reported that they have come up with a laser technique that allows them reliably to create islands of crystalline silicon in a thin amorphous silicon film. Their colleagues, Paul Carey and Patrick Smith at Lawrence Livermore National Laboratory in California, then crafted transistors over these crystalline regions and found that they performed as well as devices made on conventional crystalline silicon wafers.

Using powerful ultraviolet beams, other groups have managed to create crystalline silicon, but the results have been inconsistent and impossible to control. Instead of reconnecting into a continuous crystalline lattice, the atoms often formed an array of tiny crystallites or some other amorphous jumble.

Two key innovations enable Im and his colleagues to produce large islands of crystalline silicon reliably. The first was to start small, melting a region just a few micrometres across. The second was to shine their laser light in bursts through a chevron-shaped slit in a metal template, or "mask". The bursts melt the amorphous silicon film just in this region, which cools and begins to solidify almost instantly. The chevron shape is important because as the silicon resolidifies, it preferentially forms elongated crystalline grains. The grains grow from the outer edges of the chevron into the melted region in the middle, orienting themselves perpendicularly to the edges. This produces an unusual result just below the

peak of the chevron: Here the initial grain boundaries growing up from the bottom edge of the chevron's two arms diverge, leaving a diamond-shaped single-crystal region in the middle.

To expand this region, the researchers simply move the mask up about a micrometre and hit the silicon film with another laser pulse over an area that overlaps the first chevron. The light melts the new amorphous silicon and part of the crystalline silicone produced by the previous pulse. As this new melted region cools and solidifies, its structure follows that of the crystalline area produced earlier. By simply repeating the process over and over, the researchers could grow crystalline regions 100 micrometres square, which they then patterned with working high-performance transistors. By shining laser pulses through masks bearing thousands of chevron-shaped slits at once, Im and his colleagues can grow thousands of crystallites in parallel, patterning a region the size of a display screen in less than 5 minutes, he says. (Source: *Science*, vol. 279, 27 February 1998)

Novel fuel cell for mobile phones

By the end of 1999, you may be able to talk nonstop on your mobile phone for more than four days, without having to recharge the batteries. The secret is a tiny fuel cell developed by Robert Hockaday who says that the fuel cells, which use methanol as their energy source, will allow people to talk for 100 hours on a mobile phone, compared with the 2 hours provided by most of the nickel-cadmium batteries now used by mobile phones.

Hockaday has two patents on the fuel cells, and a third pending. He has assigned the patents to the venture capital company Manhattan Scientifics.

Last month the company agreed to invest $1 million on developing the fuel cells and to produce a working prototype by the end of 1999. Manhattan Scientifics expects that a larger company will then license the patents or fund large-scale production.

Hockaday says his cells can already produce several milliwatts of electrical power at room temperature. Over the next year, Hockaday plans to boost that output to the 400 milliwatts needed by mobile phones "by tweaking three well-understood parameters, including our choice of catalysts".

Hockaday designed the fuel cell, which holds 44 cubic centimetres of methanol, to be exactly the same size as the nickel-cadmium batteries used in today's mobile phones. (Source: *New Scientist*, 7 February 1998)

SAFT Li-ion cell "biggest capacity yet"

SAFT has introduced a 5Ah rechargeable lithium ion cell and claims it is the highest capacity single cell available.

The parts are rectangular cells. These make better use of volume in battery packs and most single cell applications.

Prospective uses include mobile phones, laptops, video cameras and other hand-portable equipment.

Called MP144350, -74865 and -76065, the cells have capacities of 1.8 Ah, 3.9 Ah and 5.0 Ah respectively. Nominal cell voltage is 3.6 V and physical size is indicated by the part number, i.e. MP144350 is 14×43×50 mm. (Source: *Electronics Weekly*, 25 February 1998)

Butterflies have some cool tips for chip designers

Researchers at Tufts University in Maryland are studying the structure of butterfly wings to find out how they dissipate heat and scatter light. They are hoping to copy the tricks butterflies have evolved for thermoregulation and use

them to keep chips within their working temperatures. The team has been studying four different butterflies: *Colias eurytheme, Morpho menelaus* and two sub-species of *Papilio palinurus*.

As more and more components are crammed onto silicon chips and the number of layers in a chip increases, managing the heat produced by the components becomes a big problem. "Progress in the semiconductor industry means more layers and smaller structures that are more complex", says Peter Wong, director of the Thermal Analysis of Materials Processing Laboratory at Tufts.

When the layers are very thin, heat effects become unpredictable and traditional methods of siphoning off heat, such as fins and fans, begin to fail.

Wong says butterflies might help because, like many other cold-blooded animals, they keep themselves alive by heat transfer. Butterflies bask in the sun and their wing structure helps them distribute the heat they collect. The wings either warm the air that flow over other parts of the insect or conduct it directly into the butterfly's body.

Anyone handling a butterfly will end up with their fingers covered in a fine white powder. Under a microscope, this powder consists of scales shaped like flattened sacks about 100 micrometres long. Each scale is made up of many alternating layers of air and chitin, the polysaccharide that makes up the creatures' exoskeleton.

Light penetrating the wing is scattered at every interface between chitin and air, and some is reflected out of the layer, causing the wings of many butterflies to be iridescent. The insects use these effects for signalling, courting, camouflage and display. Light is also scattered because of the cross-ridges on a wing scale that divide it up into a fine grid. Wong points out that these ridges make the surface of a butterfly's wings slightly rough, while chips are smooth.

The ridges resemble the outline of Christmas trees, and the gaps between "branches" roughly match the wavelengths of light falling on them. Because of this, some light is reflected and some absorbed, making the wing shimmer.

Wong and colleagues found that much of the heat is absorbed and conducted away by the ridges. By mimicking this structure, the researchers hope to be able to siphon off heat in a chip or dissipate it over a wide area. (Source: *New Scientist*, 31 January 1998)

E-beams to pattern chips

Oak Ridge National Laboratory in the US is proposing a way of using electron beams to pattern chips in commercial quantities. An e-beam gives more resolution than deep-UV lasers, but one e-beam is too slow. ORNL aims to write each part of a wafer with a different e-beam, from an array of commonly scanned, but individually modulated diamond cathodes on the surface of a control chip. The plan is to use 600 million cathodes, six million per 1 cm square chip in a 10×10 chip array. (Source: *Electronics Weekly*, 18 February 1998)

First LEP makes on-screen debut

The first light emitting polymer (LEP) screens for laptops, desktop computers and television sets are expected within four years following a deal between Cambridge Display Technology (CDT) and Japanese printer maker Seiko-Epson.

The colour LEP screen is expected later this year followed by a full-size version. Other CDT licensees Philips and Hoechst are busy preparing simple LEP screens such as backlights for mobile phones and screens for VR headsets.

The monochrome prototype display screen, which is only 2 mm thick, can show television pictures. Unlike LCD screens, the prototype display screen has no restrictions on viewing angles or blurring of fast action shots. (Source: *Electronics Weekly*, 18 February 1998)

Worm sniffs out mines

Giving a robot a set of wheels or a pair of legs is absolutely no use if it has to operate in a thicket. And that is the environment that future robots will have to be at ease in should anyone ever develop a foolproof way to automatically detect mines.

The problem is that minefields are, or should be, no-go areas. What was open pasture or fields will often not be grazed or farmed after it is mined. By the time it comes to be de-mined, the ground will be overgrown.

The mechatronics department within the Swiss Federal Institute of Technology may have an answer to delivering mine detection equipment to areas covered by undergrowth: the SniffWorm.

This is a long thin articulated robot that perambulates by wiggling its body. It will carry an odour sensor designed to detect the smell of TNT that escapes from mines.

It is possible that electronic odour detectors will become sensitive enough to detect the minute quantities of TNT that pervade the ground near mines, but the originator of the SniffWorm, Professor Jean-Daniel Nicoud, has another idea.

"Cockroaches", he said, "are very sensitive to smell and can operate over a wide range of environmental conditions".

His idea is to carry cockroaches in the nose of the robot and use a microphone to monitor their reaction as the worm moves across the ground.

"Experiments to associate the smell of TNT with food will be undertaken at the Zoology Museum, Lausanne. A hungry cockroach should get very excited in the presence of the explosive. The problem then is to find a way of eliminating other environmental actors that excite them, and keep them hungry and alive."

Other robots that are being considered are an Archimedes screw type developed by the Lawrence Livermore laboratory in the US and a tracked vehicle.

The Archimedes robot has two parallel rollers which rotate in different directions. Helical ridges on the roller surfaces are wound in different directions with the result that the robot moves along the roller axes when placed on a rough surface. A 40 cm robot of this type is planned. (Source: *Electronics Weekly*, 11 March 1998)

Little big disc

The new SuperDisk that has been developed by Imation, the spin-off from 3M, can store 120 megabytes of data—enough to hold the entire records of a small company. But the SuperDisk is the same size as a floppy disc, and just as easy to steal. So the disc will contain software that automatically encrypts data as it is stored. The disc can then only be read if you know the correct password. (Source: *New Scientist*, 11 April 1998)

Take your chips

A radical new approach to the timed release of drugs is being patented by the Massachusetts Institute of Technology (WO 98/00107), which uses a silicon microchip etched with thousands of tiny pits, each one filled with a dose of a drug and covered with conductive film that acts as an electrode. Transistors on the chip selectively open these reservoirs by feeding a current from a tiny battery to the electrodes, which then break down and release the drug.

The release can be controlled by a timer on the chip or by radio signals from a computer. The chip, which is implanted under the skin, can operate for years. MIT says the system is ideal for animals, and for people who forget to take their medicine. (Source: *New Scientist*, 18 March 1998)

Quantum leap

The era of quantum computing has begun in earnest, scientists say. For the first time, they have made a quantum computer that can carry out a task in a way that is impossible with supercomputers.

The bits of a conventional computer can only exist in two states, 0 or 1. In quantum computers, the bits (or "qubits") can be the spin states of a proton, for instance, which exist as a "superposition" of both 0 and 1 until a measurement is made.

This allows quantum computers to explore different routes through a mathematical problem simultaneously. In theory, they can quickly perform some tasks, such as factoring huge numbers and cracking ingenious cryptographic codes, that would take a conventional supercomputer years.

Lov Grover, a physicist at AT&T Bell Labs in New Jersey, showed last year how a quantum computer could "guess" a chosen number in a certain range. The task is similar to a game of "higher/lower"—homing in on a number by repeatedly asking if the one you guess is too high or too low.

Repeated questioning would be all a classical computer could do. But Grover showed that a quantum computer could divine the number in one attempt, just like packing all the questions into the states of a qubit.

Isaac Chuang of IBM's Almaden Research Center in San Jose and Neil Gershenfeld of MIT have made a quantum computer that works through another of Grover's algorithms, answering two questions about one of four numbers. The problem is similar to asking which of the numbers 1, 2, 3 and 4 is odd and greater than 2.

The researchers have described how they used the nuclei of a carbon atom and a hydrogen atom in a choloform molecule as two qubits. Both nuclei had spin 0 and spin 1 states, giving four combinations which existed simultaneously: 00, 01, 11 and 10. Using magnetic fields and radio waves, the researchers manipulated the atoms' spins, making them dance a nuclear jig corresponding to the algorithm's logic.

The correct answer to the calculation came when a measurement of the spin states "snuffed out" those that did not match the target state. Chuang and his colleagues have since been working on other quantum algorithms, such as the "Deutsch-Jozsa" algorithm, which spots some properties of a mathematical function far faster than a classical computer.

Although cracking codes is still years away, Grover says the new work proves quantum computers are no longer just an idea. (Source: *New Scientist*, 18 April 1998)

Optical fibre switch

When data on copper wires has to be switched between two paths there are plenty of options to choose from including relays, switches and semiconductors.

The same thing cannot be said for data on optical fibres where choice of switching solutions is very limited. Particularly if cost and size are issues.

The difficulty is that the ends of optical fibres have to be very accurately aligned before light from one fibre will enter another with any reasonable efficiency.

The conventional solution is to use precision metalworking to hold the fibres and move them with respect to each other.

Now researchers at the University of Dortmund in Germany have developed an optical fibre change-over switch that can be mass-produced using semiconductor techniques.

It uses etched V-groves to align the fibres—a well understood technique—and thermally steered cantilevers to manipulate the fibres.

The cantilevers are horizontal and have two parallel arms which are joined to the substrate, and at their tips.

Heating one arm causes it to expand and bend the cantilever sideways. Heating both arms cause the cantilever to bend down because, although both arms expand equally, their tops get hotter than the undersides.

Two cantilevers face one another. One carries two input fibres in parallel groves, the other cantilever has the output fibre sticking out of its end.

This protruding end lays in one or other of the two grooves on the input cantilever, butting up against one of the input fibres.

To change over the circuits, the input cantilever ducks down, the output cantilever moves left or right to select an input channel and, cooling naturally, the input cantilever moves back up to catch the output fibre in the appropriate input groove.

The output cantilever can now be allowed to cool.

Fabrication is straight forward. In the prototypes, 12 switches have been made side-by-side. (Source: *Electronics Weekly*, 11 March 1998)

Now measure that!

Sandia National Laboratories in New Mexico has made a transistor so fast that it may be beyond measurement.

Called the double electron layer tunnelling transistor (DELTT), the lab claims that it may operate at "trillions of operations per second".

"It is not easy to measure high speeds, which are near the limits of what can be measured with conventional equipment", said a Sandia spokesman. Power consumption is said to be low: "tens of millivolts and microamps". (Source: *Electronics Weekly*, 4 March 1998)

Constructing an RF front end in standard CMOS

An often discussed aspect of mobile phone design is the technology used to construct the RF front end.

Today gallium arsenide (GaAs) is king, as high saturated electron velocities result in faster operation in GaAs when compared with CMOS. But its expense, power consumption and inability to integrate with the rest of the baseband components are cause for concern.

Interest outside of GaAs has been mainly in BiCMOS and silicon germanium (SiGe), where results are promising. The University of Leuven, however, has gone with standard CMOS and constructed a complete RF transceiver chip for the DCS-1800 protocol.

To avoid the high frequency filtering required by a true heterodyne receiver, Leuven's chip uses direct up conversion, while down conversion uses a very low intermediate frequency of 100 kHz. Direct down conversion was not chosen because of its higher sensitivity.

At 2.5 V operation, the down converter and low noise amplifier has a noise figure of 4.9 dB. At 1.88 GHz, conversion gain is 32.5 dB.

Parasitic modulation of the oscillator from the antenna can occur with direct up conversion, so a voltage controlled oscillator (VCO) is fully integrated, including an inductor.

Thus there are no external nodes capable of picking up the transmitted antenna signal.

In a standard 0.25 µm CMOS process, the chip occupies 8.6 mm². From a 2.0 V supply power consumption is 192 mW, while at 2.5 V power rises to 240 mW. (Source: *Electronics Weekly*, 11 February 1998)

Samsung speeds SRAM

Samsung Electronics' memory design team has taken technology originally destined for DRAMs and used it to speed up SRAM.

Its double data rate (DDR) 4Mbit SRAM runs off 2.5 V and at room temperature can clock at 417 MHz. A DDR chip clocks data out on both edges of the clock, so the chip has an effective data rate of 833 MHz. Clock to data output is just 1.2 ns.

With the high speed of the circuit, time was spent improving the noise immunity of bit lines and the overall power consumption.

The chip has been architected to reduce the length of the main data lines. With an internal bus width of 72-bits, the effect of their capacitances at 417 MHz would be significant.

Manufactured in 0.25 µm CMOS, each memory cell takes up 12.2 µm², while total die size is 115.5 mm². Average operating current is 760 mA at the maximum frequency. (Source: *Electronics Weekly*, 11 February 1998)

Japanese make novel three-level quantiser

If the goals of IC design can be simply stated, it is to advance the speed performance of circuitry while minimizing the resulting transistor count.

This is the aim of work at Japan's NTT System Electronics Laboratories. It has created a novel 10 GHz, 3-level logic quantiser based on extremely fast (1.5 ps) resonant-tunnelling diodes (RTDs)

Using the circuit as a building block, the labs claims it can make a 10 GHz, 4-bit flash A/D converter requiring only a quarter of the active components required for a conventional flash converter.

This multi-valued logic block has been adopted as the basis for the 4-bit flash A/D converter. Here NTT has used 4-level quantisers as well as binary encoders, multiplexers and D-type flip-flops.

The resulting circuit requires only a quarter of the components needed for a conventional 4-bit flash A/D. The main reason for the savings is that five 4-level quantisers are needed rather than the 15 binary comparators employed in a standard converter.

Using simulations, NTT believes that the 10 GHz performance will be achieved with a power consumption comparable with conventional flash A/Ds. (Source: *Electronics Weekly*, 11 February 1998)

Tiny magnetic relay can be mass-produced

Magnetically activated microrelays no bigger than a dime have set records for low contact resistance and the ability to switch large current loads. Developed at the Georgia Institute of Technology, the relays operate using 5 V, with contact resistances of less than 10 mΩ, and can switch currents of up to 1.2 A.

Compared to traditional electrostatic relays, magnetic versions use a larger air gap able to switch higher voltages. Traditional relays are also hand-assembled. The new relays can be batch-produced using photolithographic techniques—with hundreds on a single wafer. The relays range in size from 3×4 mm up to 7×8 mm, and are less than 200 microns tall. They can be configured as normally on,

normally off, or as a multipole relay, and have been tested through 850,000 operating cycles. Researchers believe they will find applications in automobile electronics, test equipment and other areas requiring low-actuation voltages. (Source: *Machine Design*, 16 April 1998)

New engineering material: porous silicon

Porous silicon, identical in make-up to the silicon in microchips and glass, emits light when hit with UV radiation or electricity. But after a few weeks, the silicon oxidizes and forms a rough brown coating, which cuts its ability to emit light. Recently, however, Jillian Buriak, a scientists at Purdue, discovered a way to stabilize the surface of porous silicon while letting it retain its luminous and electronic behaviour. Buriak coats the porous silicon surface with Lewis acid, forming a greasy protective coating. This paves the way for making flat, millimetre-thick silicon displays for computers and TVs or computer components that use light rather than electrical signals. Other applications include sensors that respond immediately to environmental changes for medical or industrial use. (Source: *Machine Design*, 16 April 1998)

PC clusters make inexpensive supercomputers

A team of computer scientists at Ames Laboratory are turning desktop PCs into supercomputers by clustering as many as 64 together and harnessing their combined power to do parallel processing. Six PC clusters already tackle various tasks at Ames, including material simulations and modelling materials with magnetic properties. The largest effort to date involves 64 PCs, each with two central processors. "This computer should be four times as fast and have four times the storage capacity and memory as the largest supercomputer we have here at the Scalable Computer Lab at Ames, which cost just shy of a million dollars", said David Halstead. "So it gives us a machine that is four times as fast for a third of the price". The team plans on introducing a "cluster cookbook" for the WWW on how to construct cluster networks. "We are trying to bring high-performance computing into university departments, individual research groups, and the classroom," says researcher Mark Gordon. (Source: *Machine Design*, 16 April 1998)

Brilliant result

The light output of microscopic lasers has been increased a thousandfold by a team from Bell Labs and Yale University in the US and the Max Planck Institute of Physics in Germany. Earlier devices emitted light around the edge of a semiconductor disc a few micrometres wide and a fraction of a micrometre thick. In *Science* (vol. 280, p.1556) the researchers announce their new design, a cylinder 70 micrometres wide designed to reflect light chaotically inside it. This produces an emission pattern shaped like a bow tie, which generates four laser beams, each of about 10 milliwatts, from the points of the bow. (Source: *New Scientist*, 13 June 1998)

Incredible shrinking solar panels

A Dutch team has worked out how to make films of metal ions or semiconducting particles just one molecule thick. Such films hold out the prospect of one day making ultra-thin charged surfaces for photovoltaic solar cells or light sensors.

In the 1930s, Irving Langmuir and Katharine Blodgett of the General Electric Laboratories in Schenectady, New York, discovered that amphiphiles—molecules that are water-soluble at one end but not at the other—can be made to fan out over the surface of water in a layer one molecule

thick. The molecules they used were electrically charged at the water-soluble end. Positively charged metal ions in the water bound to the film and made it electrically neutral.

Arend Jan Schouten and colleagues at the University of Groningen in the Netherlands have now made a similar film with molecules whose water-soluble ends are ligands—groups of atoms that bind to metals but which are not charged. As a result, metal ions form a charged layer when bound to the film.

The team has also made thin films of semiconducting particles. The film can be lifted onto a glass plate, and sandwiched against another film, made out of a different ligand. "The ion or particle then experiences a different electromagnetic environment on one side compared to the other," says Schouten.

A semiconductor film could act as a photovoltaic cell. Thin films might also make good sensors, says Schouten. A single molecule of gas, for example, could deform the optical or electrical properties of the film enough to be readily detectable. (Source: *New Scientist*, 13 June 1998)

New laser lines in far infra-red hydrazine spectrum

NIST scientists, working with scientists from the Brazilian State University of Campinas, have discovered more than 144 new laser lines in the far infra-red (known as FIR) spectrum of hydrazine. The newly defined lines are located in a part of the spectrum where very few lines for laser magnetic resonance—an extremely sensitive spectroscopic technique for studying the absorption and emission of electromagnetic radiation in atoms and molecules in a magnetic field—were known previously. The new lines should improve the use of LMR for studying molecules in the upper atmosphere and outer space. Understanding the behaviour of such molecules is important for studying and assessing the Earth's climate and energy budget.

The 144 new hydrazine lines are particularly noteworthy because only six lines had been known in the LMR range between 50 and 200 micrometres wavelength prior to the NIST research. In addition to the sub-200 micrometre lines, the research team has discovered and measured the frequency and strength of hundreds of other FIR lines in hydrazine, methanol and difluoromethane during the past few years. (Source: *NIST Update*, 8 June 1998)

Single electron three-value memory array

Assoc. Prof. Y. Suda and a research team of the Tokyo University of Agriculture and Technology have developed a single-electron, three-value memory array featuring a new control technique in which the three values of 0.1 and 2 are controlled by a single electron.

With this new control technique, the memory cell that is the basic unit of the memory device has a special type of construction. A capacitor capable of storing electrons is sandwiched between a pair of insulating elements called tunnel junction which enables electron passage freely, by which information can be memorized in three values. Specifically, the memory array can assume three states, one electron on the capacitor upper side, and a hole on the underside, one electron on the underside of the capacitor, and a hole on the upperside, and neither electron nor hole on either side.

Simulation tests were conducted by assuming a source voltage of 10 V. There were four types of voltages by which information can be stored or retrieved, indicating that the array is usable as a memory. Ordinary types of memory devices store information in the form of 0 or 1

with respect to two voltages, but the new memory features an arithmetic function as the information inside the memory cell is changed when a specific voltage is impressed. By fabricating a data processing circuit in the periphery of a memory displaying this characteristic, it will be possible to commercialize a new type of ultrahigh-speed integrated circuit. Further details from: Tokyo University of Agriculture and Technology, Faculty of Technology, 2-24-16, Naka-cho, Koganei City, Tokyo 184. Tel.: +81-423-88-7129; Fax: +81-423-88-7129. (Source: *JETRO*, December 1997)

Ultrafast all-optical switch

Prof. T. Nagamura and his research team of the Research Institute of Electronics and the Graduate School of Electronic Science and Technology, Shizuoka University, have changed the complex refractive index of waveguide structure thin films by optical reaction and switched ON/OFF a beam of light in parallel with a separate beam of light. They devised an ultrahigh-speed parallel all-optical switch that can retain these states without consuming any power, and by using a prototype switching device, conducted tests which corroborated the nanosec ON/OFF response and image recording capability.

Silver is vacuum vapour deposited on a slide glass to a thickness of several dozen nanometres, over which is formed a polymer film of several hundred nanometres containing a photochromic pigment that changes its colour in conformance with the light response. When the readout light is irradiated on a prism in this state, the light is normally reflected by over 90 per cent. On the other hand, with a specific angle of incidence, a wave guide mode is obtained in which the light reflecton becomes very slight and less than a few per cent. This resonance condition is determined by several parameters, one of which is the polymer film refractive index. This is a complex quantity and the resonance angle swerves from left to right when the real value part is changed, and when the imaginary value part is increased, the reflectance is increased, with the same resonance angle. This mechanism is utilized as an optical switch.

In experiments, an ultraviolet/visible laser beam was irradiated as an ON/OFF write-in light beam on a photochromic pigment known as spiropyran, by which the polymer film complex refractive index was changed in concert with a change in the pigment colour. When the reflection ratio was set at its minimum angle and a blue laser beam irradiated, the reflection ratio with the same nanosec pulse width was increased by over 10 times to permit switch ON. It is possible to instantaneously record two-dimensional information on a separate light beam as a positive image, and this state can be retained without any power. Switch OFF is possible by irradiating red light, in which case a nanosec response was also confirmed.

The signal intensities at ON/OFF are basically determined by the write-in light intensity and the quantum yield of optical response. Several types of photochromic pigments featuring high efficiencies and excellent repetitive durabilities have been developed recently, so this new system is conceived to be applicable to the creation of two-dimensional cache memories and parallel optical switches. By utilizing the complex refractive index change based on organic pigment optical excitation by a similar optical device developed by the same research team last year, it will be possible in principle to apply this ultrafast all-optical switch to ultrahigh-speed data processing systems together with spatial optical modulation with a response characteristic of over GHz level. Further details from: Shizuoka University, Research Institute of Electronics, Graduate School of Electronic Science and Technology, 3-5-1, Johoku,

Hamamatsu City, Shizuoka Pref. 432. Tel.: +81-53-478-1306; Fax: +81-53-478-1348. (Source: *JETRO*, December 1997)

Data storage system requiring no power unit

System Design Co. Ltd. has developed a data storage system that requires no power unit whatsoever. This data storage system is used in linkage with the interface RS232C that is in wide use, and its applications include use to input machining programs in linkage with an NC machine tool, long-term retrieval of data, and collation of sales information in linkage with a point-of-sale cash register.

The internal control circuit power is derived from the RS232C interface with a high-efficiency power conversion circuit developed by the company. The internal control circuit is designed for thorough power conservation, the system is the first of its kind, and patents are pending for the system.

The system uses a flash memory that requires no backup with a battery, and data can be retained semi-permanently. Without any mechanical mechanism, it retains stored data with extremely high reliability even if there are magnets or static electricity in its proximity. The system is available in the three storage capacities of 1 M, 2 M and 3 M. Further details from: Systems Design Co. Ltd, 3-2712, Kida, Fukui City, Fukui Pref. 918. Tel.: +81-776-33-7724; Fax: +81-776-33-7864. (Source: *JETRO*, December 1997)

Notebook operates for ten hours on a fuel cell

Scientists at the Frauenhofer Institute for Solar Energy Systems ISE in Freiburg have developed a power supply for notebooks, which could revolutionize the entire battery technology for portable appliances. A new, miniature fuel cell allows operation for up to ten hours—for a similar volume and weight as conventional batteries.

The core of the new technology is a banded structure membrane fuel cell, which converts hydrogen to electricity. The patented internal series connection allows a flat, space-saving design. The fuel cell can thus occupy minimal volume and still provide the output voltage required for the portable computer.

The hydrogen supply is kept under slight overpressure in a metal hydride storage unit from the company GfE Metalle und Materialien GmbH. "The hydrogen storage unit can be charged at home with a miniature electrolyser or simply replaced like a battery", according to the project leader, Dr. Roland Nolte.

In addition to the longer operating time, the new technology offers two further advantages: compared to rechargeable batteries, the fuel cell fundamentally has a very long lifetime. Also, the idea of current leaks is foreign to the hydrogen storage unit. Even after a year on the shelf, it is still full of energy.

The technology of the Fraunhofer scientists is suitable for practically all battery-powered appliances. It is particularly interesting for portable applications such as camcorders, battery-powered tools and mobile phones—but in the future, metal hydride units could even replace "Mignon" batteries.

In the near future, the Freiburger researchers want to adapt the advantages of this power supply to the dimensions and geometry of a notebook, in cooperation with various industrial partners. (Source: *News Release*, 2 March 1998)

New nanostructures

The quest for smaller structures for microelectronic and data storage devices has scientists pushing the limits of current manufacturing techniques and searching for new ways to make to make even smaller devices. Physicists at the National Institute of Standards and Technology have demonstrated a technique to make nanowires about one-thousandth of the diameter of a human hair. While these are not smaller than features that other new methods emerging from research labs can produce today, the method of creating them offers advantages over current techniques.

Building on earlier work, NIST scientists etched the nanowires from rows of tiny chromium lines. Using an NIST-developed method called "atom optics", researchers focused chromium atoms through a laser to form rows whose spacings correspond exactly to the wavelength of the laser light. Now, placing the rows in a vacuum with plasma gas, the scientists etched through the chromium, leaving fine wires between trenches in the silicon surface. The same technique could be used to make wires from other metals. Its biggest advantage is that the combination of laser focusing and plasma etching can cover a relatively large surface with nanowires in a short time. (Source: *NIST TechBeat*, May 1998)

Magnetic RAM is a match for flash

IMEC, the Belgian research organization, has demonstrated a competitor to flash memory based on magnetic quantum effects.

Called magnetic RAM (MRAM), it is non-volatile random-access memory technology. "We have made a demonstrator and its performance matches simulation results. This gives us confidence to predict that MRAM can match the density of flash while beating it on speed and lifetime", said Jo de Boeck of IMEC.

The memory cells use "spin valves", similar to the structures used in the latest generation of hard disk drive read heads.

The cells are made in a structure consisting of two thin film magnetic layers separated by a non-magnetic insulating layer. Interaction between the magnetic layers means that they can exist in one of two states, set by locally applied fields.

The magnetic field in the insulator controls the number of conductors that tunnel through it—causing it to adopt one of two conductivities.

Fabricating a diode in series with each magnetic cell has allowed the IMEC team to connect them together in a DRAM-like array.

The demonstrator has 3×3 cells on a GaAs substrate. The next step is to transfer this to silicon. (Source: *Electronics Weekly*, 1 July 1998)

1 Gbit/s optical receiver in 0.35 μm CMOS claim

Researchers from Bell Labs have, to the best of their knowledge, fabricated the first 1 Gbit/s 850 nm optical receiver in standard 0.35 μm CMOS.

Applications are seen in short distance optical interconnects and local area networks.

Fabricating the device in standard CMOS means that in principle integrating the receiver into CMOS Asics will be straightforward.

Silicon photo-receptor structures typically generate carriers with many different lifetimes when excited. Those that have the longest lives tend to dominate operation at high frequency and swamp device response due to faster carriers.

The Bell sensor has a new structure which discards the slower carriers, removing the swamping effect and effectively increasing device bandwidth, at the expense of sensitivity.

For 1 Gbit/s operation, the receiver has a sensitivity of -6.3 dBm. At lower bit rates sensitivity improves. Only -8.6 dBm of input power is required to produce a bit error rate of 10^{-9} at 622 Mbit/s and -14 dBm at 155 Mbit/s.

Power dissipation is 1.5 mW at 1 Gbit/s, maximum operation speed is 1.25 Gbit/s.

850 nm is not the best wavelength for long-haul communications, which use the two glass attenuation "windows" at 1.3 μm and 1.5 μm. This is the reason that the Bell receiver is more suited to communication over short distances. (Source: *Electronics Weekly*, 1 July 1998.

Fujitsu memory boosts access speed of DRAM

Fujitsu has developed a novel memory which significantly improves the access speed of DRAM.

Called fast cycle RAM (FCRAM), the first 64 Mbit samples have a 26 ns random access time—the time it takes for data to emerge after first addressing the memory. Pipelining gives it a 20 ns read cycle time—the time between successive address issues. This contrasts with today's synchronous DRAM which has a typical random access time of 30 ns and a much longer cycle time of up to 80 ns.

Fujitsu has achieved the speedier performance by re-designing the memory core. The main change is with the addressing. FCRAM present the row and column address simultaneously, unlike conventional DRAM where the row address is presented first followed by the volume address.

According to Manfred Mettendorff of Fujitsu's product marketing engineering/DRAM division, when the same row of memory is being accessed (with only the column address being changed), FCRAM's access time is no better than that of SDRAM. "But with random access, presenting a new row and a new column address, SDRAM cycle times are between 70 and 80 ns. That is why FCRAM is good for graphics, where there are no real address patterns".

The non-multiplexed addressing scheme also halves DRAM's typical power consumption, claims Mettendorff. This is because FCRAM's addressing activates the minimum sub-array block in the column direction with only 2,048 sense amplifiers being active. For conventional 64 Mbit DRAMs, 16,384 sense amplifiers are usually active at a time, said Mettendorff.

The address cycle time of FCRAM is shortened with the use of pipelining, allowing a new address to be applied while previous data is still in the output stage. An address can be applied in 20 ns even when the same memory bank is being accessed.

The benefit of FCRAM's enhanced speed is at the expense of a non-standard pinout. Thus, for applications such as graphics and high end servers, the use of FCRAM will require additional design effort.

Engineering samples of FCRAM are expected by mid-1999 with volume production of the memory starting by the first half of 2000. (Source: *Electronics Weekly*, 1 July 1998)

LCD incorporates a diffraction grating for the first time

Research company DERA in Malvern has invented a new LCD mode which offers a wider viewing angle than traditional twisted nematic types.

Called voltage controlled twist (VCT) it requires the incorporation of a diffraction grating into an LCD for the first time. Although unusual, this should not cause too many problems for LCD manufacturers, says co-inventor Guy Bryan-Brown, because makers of holographic equipment already have the technology.

Diffraction gratings are normally used for their optical effects but this is not the case in a VCT display. Indeed, optical effects are minimized by making the grating of a material with the same refractive index as the liquid it is in

contact with. Optical effects disappear in the same way that rubies in port are invisible.

In the display the grating acts as an alignment surface for the liquid crystals. This is more usually done by brushing the inner surface of the display glass, but a low energy surface is required for VCT and surface treatments that achieve this also mask the effects of brushing.

The X-Y viewing angles of VCT are said to be ±60° and ±30°, against ±35° and +20° to -40° found in unmodified TN displays. This kind of wide viewing angle is found in in-plane switched displays which are more complex and less optically efficient. Modified TN displays are also capable of meeting wide viewing angles, again by adding complexity. (Source: *Electronics Weekly*, 8 April 1998)

Double Helix doubles as engineer

A marriage of optics and electronics could produce a new generation of computers many times faster than today's. But like many unions, this one is threatened by some serious incompatibilities. Many of the best lasers, detectors, light modulators, and other optical devices are made from semiconductors such as gallium arsenide and indium phosphide, whereas conventional electronic devices are made of silicon. As a result, the two kinds of devices have to be made separately, then mated. Although integrating one or two devices is relatively easy, assembling hundred, thousands, or millions into a single array would defeat conventional "pick-and-place" technology.

A team of researchers at the University of California, San Diego (UCSD), and Nanotronics Inc., also in San Diego, has come up with a novel way to create these hybrid devices. Like so much of the mating game, it involves DNA, which in this case serves as a selective glue for sticking the devices to the surface of the chip. Described at a meeting of the International Society for Optical Engineering early this year in San Jose, California, the work has intrigued experts in the field. Electrical engineer Joseph Talghader at the University of Minnesota, Minneapolis, for example calls it "an exciting technique and one that merits a great deal of future work".

A strategy developed by Talghader and others was actually the starting point for the San Diego team, which is led by UCSD's Sadik Esener. In the earlier technique, known as fluidic self-assembly, the optical devices are fabricated as geometric shapes ("pegs") that can then slot into similarly shaped "holes" etched in the silicon substrate. The pegs are suspended in a liquid and spilled out over the substrate, with luck sliding into the right hole and sticking there thanks to weak van der Waals forces.

The San Diego researchers were looking for a way to help the right peg find its hole, and they settled on DNA. The chemical bases that make up DNA—cytosine, guanine, adenine, and thymine—will bind to each other only in particular pairings: C with G and A with T. Hence, a single strand made up of the bases ATTTGC will bind strongly with its complementary strand, TAAACG, and not with any other sequence. The researchers set out to exploit this selectivity by attaching short complementary strands of DNA to the pegs and substrate to help the devices find their correct positions.

In their first experiment, the team coated a substrate with a particular short strand of DNA. They then covered parts of the substrate with a mask and exposed it to ultraviolet light. The light chemically altered the DNA in exposed areas so that it could no longer bind to complementary strands. The researchers then coated some microbeads—which acted as dummy devices—with strands of DNA complementary to those on the substrate. When a

fluid carrying the coated beads was splashed over the substrate, the beads successfully bound only to those areas that had not been exposed to UV light. One drawback of the technique is that it worked only for small devices, several hundred micrometres across, that would flow easily and not block other devices.

In a second experiment, designed to show that several varying kinds of "devices" could be deposited at once, the group used masks to deposit four different types of DNA strands onto a substrate and then attached complementary strands to four different fluorescent molecules. When the labelled molecules were splashed onto the substrate, the pattern of fluorescence showed that they had bound only to the appropriate regions of complementary DNA. In a real system, this would mean that four completely different types of devices could be attached to many selected sites on a chip.

The researchers realize, however, that just providing the glue is not going to be enough. They are now looking for more active ways to guide the devices to their correct positions. One possibility is to add extra chemical groups to the DNA on the devices to give them an electric charge, then create electric fields on the substrate to attract the charged devices to "landing sites". The team is also investigating other techniques, such as creating currents in the fluid that would sweep the tiny devices to the right places.

An even bigger challenge will be creating an electrical connection between the devices and their host semiconductor. The team is looking at the possibility of putting the DNA glue on the top of devices and bonding them, upside down, onto a dummy substrate. Once all the devices are in position, the dummy could be flipped over and pressed down on the real substrate. The substrate might be coated with molten solder, which would add an electrical bond to the mass marriage. (Source: *Science*, vol. 279, 27 March 1998)

D. MARKET TRENDS AND COMPANY NEWS

Solar power markets boom

Sales of solar cells expanded more than 40 per cent in 1997, according to a new report from the Worldwatch Institute. Solar power is now the world's second fastest growing energy source—at an average growth rate of 16 per cent per year since 1990.

"World solar markets are growing at ten times the rate of the oil industry, whose sales have expanded at just 1.4 per cent per year since 1990," say the report's authors, Christopher Flavin and Molly O'Meara. "Solar energy may now join computers and telecommunications as a leading growth industry in the 21st century."

The roughly 800 megawatts of solar power capacity now in place is sufficient to run 40 million 20-watt radios, but still represents less than 1 per cent of global power supplies. But as governments move to implement The Kyoto Protocol on climate change and replace fossil fuels, solar power is poised to benefit.

"If solar power is to reach its long-term potential, scientists will need to improve the technology and drive prices down, and governments must lower barriers to the industry's development," say the Worldwatch researchers.

Already, new technologies are lowering the cost of manufacturing solar cells, which are closely related to the silicon semiconductor chips found in today's computers. Several companies are focused on a new generation of "thin film" solar cells that require cheaper raw materials—and less of them. Scientists believe that such technologies can cut solar cell costs from $4,000 per kilowatt today to $1,000 in the next decade, which would make them a competitive source of electricity in many parts of the world.

In sunny climates, where air-conditioning drives power demand up on summer afternoons, this price would make solar power competitive with fossil-fuel-based electricity, according to the report, which will appear in the September issue of *World Watch* magazine. Solar electric systems can also increase the reliability of the power supply in cities such as Chicago, which have recently experienced brownouts due to over-dependence on long-distance transmission lines and giant coal and nuclear plants.

Currently valued at about $1 billion a year, the solar business has recently attracted sizable investments by major energy companies such as Enron, Amoco, British Petroleum, and Royal Dutch Shell. These companies and others are investing in new manufacturing plants: factories announced over the last year alone could double global production of solar cells in the next few years.

A growing portion of the world's solar cells is going to meet the needs of ordinary households, according to Worldwatch. Form tiny huts in the rural Dominican Republic to trim suburban homes in Osaka, Japan, some 500,000 homeowners are now generating their own power. For the 2 billion people worldwide who are not yet connected to power lines, solar energy is often the most affordable way to get electricity.

"In industrial countries, companies are now integrating solar cells into roofing tiles and even window glass, allowing homes and office buildings to effectively generate some of their own power, and to sell extra electricity back to the utility. In Sacramento, CA, some 420 homeowners already have rooftop solar systems, thanks to a programme under which the local utility partially subsidizes them."

"Much of the recent growth in solar sales has been spurred by similar rooftop solar programmes, including some at the national level," say Flavin and O'Meara. Japan is the leader, with some 9,400 solar home systems installed in 1997, and another 13,800 expected by the end of 1998. Generous tax credits and high electricity purchase prices have given the Japanese programme a strong boost, encouraging major building companies to bring out new lines of solar-powered homes.

The European Union and the US have responded with "Million Roofs" programmes designed to install a million rooftop systems by 2010. The US initiative includes a proposed 15 per cent solar tax credit as well as funds to support 25 partnerships with utilities, builders, local governments, and financial institutions. It remains to be seen whether Congress will provide sufficient funds to achieve these goals, but the programmes have already attracted the support of private companies as well as state and local governments, encouraging investment in the industry.

"In the longer run, solar power has the potential to become a major contributor to the world's energy supplies—along with other energy sources such as wind power and hydrogen-powered fuel cells," Worldwatch concludes. "According to a survey in western Germany, existing rooftops could meet half the region's electricity needs. And a 1998 study by the oil company Royal Dutch Shell concludes that solar and other renewable energy

sources could supply half the world's energy by the middle of the next century."

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The energy companies of the future are shouting the news of renewable energy from the rooftops
By Christopher Flavin and Molly O'Meara

In June 1998, Oguz Capan, president of Turkey's ROC Oil Company, visited the Worldwatch Institute's offices in Washington. The purpose of his visit was surprising: low oil prices and a slow market had persuaded him to sell his small petroleum production business and invest the proceeds in wind and solar energy, enterprises that hardly exist in Turkey today. But Capan was optimistic. These new energy sources, he told us, will be far more profitable than oil. He wanted to know what we could tell him about how the new technologies are performing around the world.

Capan's timing may be propitious, because recent developments may soon allow solar energy to join computer software and biotechnology as a leading growth industry.[1] Last year, sales of solar photovoltaic (PV) cells expanded 43 per cent, a rate of growth that would be more familiar to Microsoft or Sun than to Exxon or Shell (see figure 1).
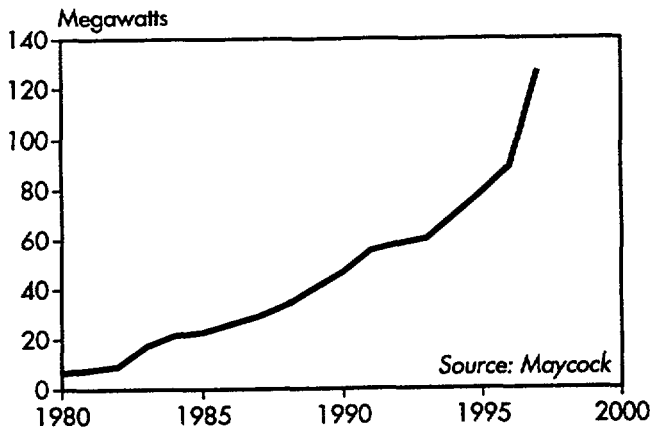
Figure 1: World Photovoltaic Shipments, 1980–97

That spurt gave the solar industry a fourth straight year of double-digit growth. "We are seeing PV change from a cottage industry into a profitable business worldwide", says Ken Zweibel of the US National Renewable Energy Laboratory (NREL). "Today, you can sell anything that you can make." By "anything", Zweibel is referring to the small silicon cells that form the technical basis of this business, and for which suppliers this year are having to scramble to keep up with demand.

[1] Wind energy, too, is growing fast; its total capacity worldwide has leaped from just 10 megawatts in 1980 to 7,630 MW in 1997, and grew by 25 per cent last year (see "Wind Power Sets Records in *Vital Signs* 1998, Worldwatch Institute, 1998).

Touted for more than two decades as an eventual replacement for fossil fuels, solar power has—until now—failed to make the commercial leaps needed to challenge conventional energy technologies. Made of silicon semiconductors closely related to those found in computers (much of the silicon used for solar cells is actually waste from the electronics industry), solar cells are one of the newest and most advanced energy technologies in use today.

Invented in the 1950s, and first deployed in the US space programme, solar cells accomplish a feat of near-alchemy—turning solar rays directly into electric current, without benefit of fuel, mechanical turbine, or generator. As early as 1957, *Business Week* was rhapsodizing about the potential of solar power, envisioning a solar car in which "riders sit comfortably in the back seat and perhaps watch solar-powered TV". That vision was a bit off the mark, as the solar market does not yet involve cars, though it has already taken on TVS.

Roughly half of the world market for PVs last year was in non-residential applications such as portable highway signals, radios, telecommunications repeater stations, and water pumps, where the only alternatives are high-cost ones such as diesel generators. Another 20 per cent is used in small consumer devices such as calculators and watches. Unlike most energy technologies, photovoltaics are lightweight, modular, and can be used economically in such devices.

The current boom in solar energy is being driven by a previously neglected small-scale application: providing power for individual houses one at a time, which accounts for most of the remaining 30 per cent of the market. From tiny huts in rural areas of the Dominican Republic to trim suburban homes in Osaka, Japan, some 500,000 homeowners are now generating their own power.

Since 1980, the price of solar cells has fallen by 80 per cent, as the technology has matured (see figure 2). In the past decade, the industry's advance has slowed, however, due to low oil prices, a lack of sufficient government support in many countries, and a reluctance of manufacturers to commit the resources needed to bring down costs. As a result, prices have temporarily stabilized—and while last year's sales surged, the market's expansion over the past decade has averaged only about 15 per cent per year.
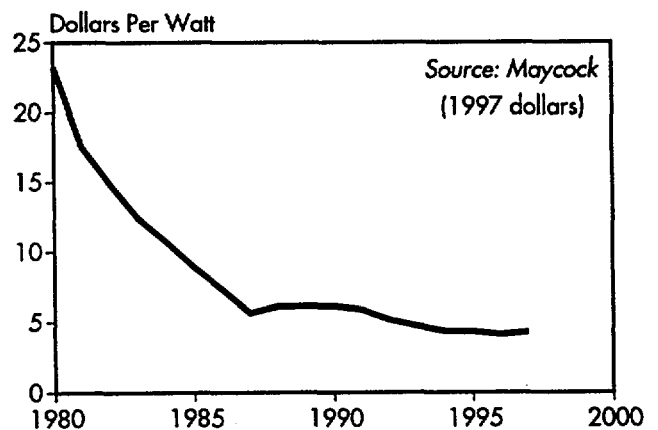
Figure 2: Average Factory Price for Photovoltaic Modules, 1980–97

The potential, however, is much larger. For the two billion people in the world who are still not connected to power lines, solar cells are often the least expensive means of meeting their needs for lights, radio, or even television. The World Bank, for example, has a programme to install solar

systems for 200,000 households in Indonesia, and similar efforts are under way in many other developing countries. And even many people in the industrial world are not connected to the grid. John Thornton, who works at NREL's Goden, CO lab, has seen solar homes grow in popularity in the Rocky Mountains. At $20,000 for a modest system that includes a battery to store the power for night-time use, they are a bargain compared to the $50,000 to $75,000 the local utility charges to extend power lines to a new home that is just one mile form the grid.

For the roughly four billion people in the world who are already connected to electric lines, solar power systems will cost two to five times the cost of providing power from the grid. However, technological advances are rapidly lowering that ratio.

One such advance is the integration of solar cells into roofing tiles and even window glass—turning standard building materials into nearly invisible power generators. Where available, some home buyers can now choose the option of a solar-powered home connected to the grid, which would meet most of their electricity needs for 30 years. It would add about $100 per month to the mortgage of a $200,000 house, while reducing power bills by roughly half that amount.

Government support for solar home systems—led by the Government of Japan, which provides generous subsidies for rooftop solar power—has triggered the current solar boom. Japan requires electric utilities to purchase any extra electricity produced by these systems at the same price they charge consumers—a price that is currently more than 20 cents per kilowatt-hour. The transaction is determined by "net metering", meaning that the rooftop's output is subtracted from the consumer's use of power from the grid. At the end of the month, the consumer pays a utility bill that covers the "net" electricity used. Some 9,400 solar home systems were installed under this arrangement in 1997, and 13,800 are expected in 1998. Japanese officials say they hope to have solar power systems in 70,000 homes by 2000, and to be able to eliminate direct subsidies by the year after that, as the market continues to grow.

Europe and the United States, too, have launched ambitious new solar power programmes. Each has announced a "Million Roofs" initiative designed to dramatically boost the size of their domestic markets. Neither has yet been fully formulated, but both have already spurred private companies to invest. The US plan includes several proposed federal policy changes, including a tax credit for 15 per cent of the cost of a new system. It will also rely on partnerships with electric utilities, non-profit organizations, and state and local governments to fulfil its aims. One key to making this programme successful is to encourage widespread net metering, as is already happening in Japan, Switzerland, and half of the US.

In Sacramento, CA, the locally owned utility has shown the way with its PV Pioneers Program, launched in 1993. Already, some 420 homeowners pay $4 per month to keep a 3- to 4-kilowatt solar panel on each of their roofs. As in Japan, these individual panels feed power into the local utility grid. (The utility subsidizes the initial cost—typically $20,000 per home.) Since the programme began, the cost of the systems has steadily declined. To ensure further progress, a long-term contract was recently signed with a solar manufacturing company to begin producing cells locally. By 2002, the fully installed cost of one of these systems is projected to fall by half, to below $3,000 per kilowatt. That would provide power for roughly 9 cents a kilowatt-hour, which is competitive with the cost of providing power at times of peak demand.

The success of Europe's Million Roofs Programme, which is equally divided between domestic installations and planned exports to developing countries, will depend on new European Union initiatives yet to be announced, and on policies enacted by the 17 member States of the EU—possibly building on programmes already in place in several nations. In Germany, some 3,500 homeowners now have solar power, thanks to government subsidies and a high utility purchase price for the extra power. Taking advantage of the construction boom underway in Berlin, the German Government has also built PVs into the new Parliament Building, Ministry of Economics, and Main Railway Station. Switzerland now has more solar power installed per person than any other country, including rooftop systems for 170 public schools, and has recently offered purchasers of PV systems a subsidy of up to 25 per cent of the up-front cost.

One of the advantages of these kinds of solar power systems is that they are located near the customer and can enhance the overall reliability of power supplies. This is useful because the world's electric grid systems are heavily dependent on large power plants and long transmission lines, which makes them vulnerable to various kinds of breakdown.

In recent months, waves of hot weather and a power grid debilitated by the shutdowns of nuclear plants led to a spate of brownouts in the US Midwest and Northeast. Utilities had to scramble for power, and in some cases were forced to purchase it from distant markets for over 100 times the usual price. Martin Cohen, Executive Director of the Illinois Citizens Utility Board, told the *Chicago Tribune*: "It used to be that the only power outages we had to worry about were the ones when aging infrastructure failed. Now we have a new vulnerability to outages in distant locations, transmission lines going down, or trouble at power plants far away." Solar cells, on the other hand, have no moving parts, and are at their most productive on hot summer afternoons when power demand is at its peak.

The restructuring of electric power markets, now underway around the world, may open up new ways to sell solar electricity. For instance, in New England, a newly formed electric company, Sun Power Electric, plans to mount solar panels on the numerous flat roofs owned by a large chain of retail stores. Electricity not used by the stores will be sold to other local consumers by way of a "green power" marketer. Sun Power president Steve Cowell says he thinks mass-production and assembly of the panels will bring down the cost of PV-generated power, so that it will be cost-effective within 10 years.

Market growth, combined with the spur of international efforts to slow climate change, has made solar power a hot field for profit-minded investors in the past two years. At least eight companies that draw more than 20 per cent of their business from PVs are now publicly traded, according to PV industry analyst Paul Maycock. And several major energy companies have also invested in solar power. The US firms Enron and Amoco, for example, have teamed up to increase investment in their jointly owned Solarex Company—most recently with a $7.7 million threefold expansion of their solar cell plant in MD.

In breaking with most of the rest of the oil industry on climate change policy last year, British Petroleum CEO John Brown said that his company would expand its investments in solar energy, boosting its output tenfold over the next decade—to $1 billion. And Royal Dutch Shell has formed a fifth core corporate group that plans to invest $500 million in renewable energy over five years. Of course, such numbers look small compared to these companies' other investments. Shell's expenditures on its new solar initiative, for instance,

will be only five per cent of what it spends annually on its fossil fuel production, processing, and marketing businesses. However, given the small base from which the PV industry is building, those announcements provide an important boost. The BP goal alone, for example, is equal to the PV industry's total world sales in 1997.

These companies and others are investing in new solar manufacturing plants—factories that are expected to further reduce the cost of solar power by deploying the latest technology and increasing the scale of production. Royal Dutch Shell, for example, has teamed with Pilkington Solar International to build a 25-megawatt factory, the world's largest so far—at least until planned expansions by companies such as Kyocera in Japan and Photowatt in France are completed.

One way these large plants are increasing efficiency is through automation. The silicon in solar cells typically accounts for only ten per cent of a module's cost, leaving ample room for streamlined assembly to reduce costs. And as companies scale up production, robotics will become more cost-effective. For several years, with producers racing to keep up with rising demand, the average price for PVs has remained at around $4,000 per kilowatt. However, according to the Massachusetts-based Spire Corporation, which makes equipment for manufacturing solar modules its latest equipment allows large factories to produce modules at $1,780 per kilowatt and potentially sell them for as low as $2,000 per kilowatt.

Also on the horizon are potential gains in the efficiency of the solar cells themselves. Single crystal cells, the mainstay of the industry for four decades, still accounted for nearly half of sales in 1997. Another 34 per cent consisted of the newer polycrystalline cells, which are a bit less efficient but also cheaper to produce. Researchers continue to investigate ways to bring down the major cost of these crystalline technologies, which entail growing silicon crystals and slicing them into solar cells. For instance, one promising technology under development reduces material and energy input by growing the silicon in long "ribbons" that are then cut into cells with lasers.

Leading PV producers, 1997

The top 5 accounted for 60 per cent of PV shipments in 1997		
Company	Country	Megawatts shipped in 1997
1. Siemens Solar	United States*	24.0
2. Kyocera	Japan	15.4
3. Solarex	United States	14.8
4. BP Solar International	United Kingdom	11.3
5. Sharp	Japan	10.6
Source: Maycock, *PV News*, February 1998. *Siemens is a German-owned company, but most of its production is in the United States.		

The other main class of solar cells in use today is the non-crystalline "thin film" cells that are less than one hundredth of the thickness of conventional solar cells. They do not need to be sliced or rigidly encased, and can be made into large, flexible sheets ideal for integrating into building materials such as shingles. These thin films also use

less raw material, so costs are cut further. Employing the new technologies, companies such as United Solar, Solarex, and Canon have recently expanded their annual thin film production capacity by 5 to 10 MW. The goal of researchers at the US National Renewable Energy Laboratory is to develop a thin film cell that slashes the installed cost of solar cells to a point where they can compete even in the highly competitive bulk power market.

Though still tiny by energy industry standards, the solar market has recently grown at ten times the rate of world oil production. If annual production were to grow at 25 per cent per year through 2020, solar capacity would reach 106,000 megawatts by 2020, generating as much power as 30 to 40 large nuclear plants. In Sacramento, the local utility estimates that the city could generate 400 MW of electricity, one sixth of the local peak demand, simply by covering the available south- to west-oriented roofs, parking lots and transmission-line corridors with solar panels.

At a broader level, researchers at the US Department of Energy estimate that if PV panels were mounted atop 5,000 square kilometres of roof space, they could generate 25 per cent of the electricity used in the United States. And a study by Shell projects that solar and other renewable energy sources could grow from less than 1 per cent of world energy use today to 5 to 10 per cent by 2020 and 50 per cent by mid-century.

The world still has a long way to go if the energy system is to be effectively "de-carbonized" over the next century, as most atmospheric scientists believe it must. Solar energy cannot do the job alone, but combined with other new technologies such as wind turbines and hydrogen fuel cells, as well as more resource-conserving urban designs, products, processes, and lifestyles, it may allow the world to live a little cooler in the twenty-first century.

Christopher Flavin is senior vice president of Worldwatch Institute and Molly O'Meara is a staff researcher at the institute. Flavin is co-author of *Power Surge: Guide to the Coming Energy Revolution* (W. W. Norton, 1994).

Market trends

Internet voice phone calls will dominate by 2000

The use of the Internet for making telephone calls will overtake fixed network traffic by 2000, according to a report by industry research company Analysys.

As Internet telephone calls become cheaper and easier to make, the service will begin to threaten the established operators, says the report.

However, the major European companies will not be introducing their own Internet telephony technology until they are forced to.

Price differences will disappear in the next three to five years, but for the moment international calls are cheaper on the Internet. Other long-term technological advantages will ensure the rise of the Internet call over fixed networks.

Efficiency gains offered by the use of packet networks, the low cost of deploying gateways and the potential for computer telephony integration are all set to drive the long-term growth of Internet telephony.

Providers of Internet telephony already offer their services to people without PCs by use of a code that connects the user to a local Internet service. (Source: *Electronics World*, September 1998)

Counting the DRAM costs

The costs of the DRAM Wars are being quantified. In early July, Vanguard International Semiconductor

Corporation (VISC) of Taiwan forecast that it will lose $136.3 million on DRAM sales of $277.6 million this year.

Recently Siemens announced it had lost $600 million on DRAM in the last nine months, and Mitsubishi Electric said it lost $700 million on the product in its last financial year. Texas Instruments has stated it was over $200 million in the red on the product in the twelve months before it pulled out of the DRAM market in June. (Source: *Electronics Weekly*, 29 July 1998)

What is likely to be a hit and what will fail in the US market in 1998

This promises to be a watershed year for several key technologies in the US in virtually all sectors of the computer and electronics industry. Inevitably this will have a profound influence on markets around the world.

Copper-based chips will make a debut, especially from IBM, Motorola and Texas Instruments, which have all announced breakthroughs in using copper instead of aluminium. Applied Materials, the leading chip equipment maker is backing this trend with a chemical vapour deposition system that will let other chip manufacturers make use of copper, resulting in faster chips without requiring a major redesign.

Memory chips should continue to fall in price in 1998, but there are factors that could start to stabilize DRAM prices. First, the emergence of Intel's 100 MHz specification for synchronous DRAMs, will keep the prices high for these devices, which are notoriously difficult to produce.

It seems Texas Instruments may be the first major to exit the DRAM market in 1998, but will it be the last?

National Semiconductor is among the silicon suppliers hoping to give the sluggish consumer PC market a kick with highly integrated systems-on-a-chip products. The plan is to hit the market with a range of cheap PC-type systems that could finally force PC-prices below the $500 mark.

Intel could face a couple of challenges in 1998. It will be introducing faster versions of its Pentium II microprocessor line, but it may have to shelve plans to discontinue its low-end Pentium line if it wants to be a player in the low-priced PC market targeted by National Semiconductor. The problem Intel faces is that the profit margins on the low end of the microprocessor market are nowhere near as good as on its high end line. There is also a dearth of applications that require very fast Pentium II microprocessors, unless, of course, its partner Microsoft or other software developers can come up with compelling mass-market applications that require fast systems.

Microsoft will be introducing Windows 98 in mid-1998, which will help boost PC sales and in turn boost the fortunes of many electronics firms that supply chips and systems to PC makers. Windows 98, however, might turn out to be a damp squib since it does not add too many extra features on the user interface side. However, it will offer greater support for key consumer PC technologies such as DVD, which will encourage some users to upgrade their software and hardware.

Windows NT 5.0 will debut in the second half of 1998, and will boost the business PC market as companies buy larger servers and client desktops to take advantage of the Unix-like operating system.

Network computers will feature more prominently in 1998. Sun Microsystems will have finished its JavaOs in the early part of the year and there will be volume production of Java processors from LG Semicon and others. But network computers will not turn out to be the PC killers they were originally made out to be, mainly because of fast falling prices of full feature PCs.

Java will further cement its role as the leading computer language. However, Sun's 100 per cent Pure Java campaign seems to be faltering and the reality is that Java will be increasingly optimized for specific hardware platforms because of its slow performance as a cross-platform technology. Java will almost completely replace C and C++ computer languages in virtually every software development project because of its superior features. (Source: *Electronics Weekly*, 7 January 1998)

Chipmakers to cut production

The three leading South Korean chipmakers, Hyundai, Samsung and LG Semicon, which combined account for approximately 30 per cent of world production, have announced plans to curtail production to relieve some of the downward pressure on chip prices. Prices have fallen by 50 per cent since the beginning of the year to under $10 per chip. Hyundai will reduce the output of 16M and 64M DRAMs by 25 per cent, while Samsung and LG Semicon Co. are each expected to reduce production by 20 per cent. In addition to oversupply problems, the companies have been dealt a severe blow by the country's currency crisis. Hyundai and LG Semicon are expected to post net losses for a second straight year, and Samsung is also expected to report a loss this year. (Reprinted with permission from *Semiconductor International Magazine*, August 1998. Coypright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

How chief executive officers in large organizations view the management of their information systems

As part of a research programme on key information systems (IS) management issues, a survey of Australasia's largest organizations was conducted to identify which issues were perceived by their chief executive officers (CEOs) as being important, problematic and critical over the next 3-5 years. The results reported are based on a moderate response rate (though perhaps reasonable for the target group) but formal testing showed an absence of non-response bias. The most critical issues were revealed to be a mix of technology management issues (managing and measuring the effectiveness of the information technology (IT) infrastructure, and disaster recovery), strategic management issues (business process redesign, competitive advantage, and information architecture), people and support management issues (organizational learning, and executive and design support) and systems development and data management issues (effective use of the data resource and effectiveness of software development). This reflects their interest in a wide range of issues, but all with an organization-wide focus. The non-critical issues were mostly related to the individual technologies and the place and role of IS in the organization. While the CEOs showed some agreement with their chief information officers (CIOs) on issues such as the IT infrastructure, competitive advantage and organizational learning, some distinct differences exist, particularly in relation to the quality and effectiveness of systems and processes and also how CEOs and CIOs perceive the IT knowledge of the CEOs. (Source: *Journal of Information Technology*, 13 (2) June 1998)

The role of external sources of information as a dynamic factor of competitiveness and performance for SMEs

The progressive penetration of the Internet in the business environment and SMEs in particular has created a false idea that all information is available on the Internet and that it is free. However, the great majority of information available through the Internet is of a promotional kind, while

access to information of high added value coming from reputable and reliable sources has a price and usually it is expensive. On the other hand, the proliferation of sources and the information overload raise problems of selection and quality control that demand subject knowledge on the part of users and professional experience of experts.

Although Internet technology is in constant evolution and increasingly new sophisticated systems of automatic information retrieval are made available, their usefulness and accuracy is highly dependent upon the individual skills and the subject knowledge of users. Powerful information retrieval tools using push technology are an opportunity for the creation of information systems specifically orientated at SMEs. Relevant information can be searched in the Internet using previously established profiles and sent directly to the user.

Organizations whose mission it is to support and contribute to the development and modernization of enterprises have an important role to play. By promoting the creation of information networks, based upon the most updated technology and information content that companies and SMEs in particular need, such bodies will in a practical sense contribute to socio-economic development. To implement these networks and information systems there is a need to recruit specialized information professionals who understand the business environment. (Source: *FID News Bulletin*, 48 (1) 1998)

Managing PC costs

Organizations are looking increasingly to system analysis and management tools to lower the total cost of ownership (TCO) for their systems including hardware, software, and support. Implementing best practices is complex. It requires detailed planning and analysis, technology like automatic discovery and inventory, electronic software distribution, remote diagnostics, remote control and help desk automation, and process improvement and people-oriented improvement based on training.

Supporters of Java, primarily Sun, IBM, Netscape, and Oracle, are among the most vocal proponents of one set of best practices. They tried to use TCO as a weapon against Windows. This camp argues that centralized management and fewer opportunities for users to make mistakes will give you a lower TCO than Windows clients with their limited support for centralized management. The client hardware platform favoured by the Java camp is the network computer (NC). This is a sealed box, subject to little or no user configuration, running a Java virtual machine in a browser or simplified operating system.

In response Microsoft has announced the NetPC, which is similar to an NC but running Windows and with a local hard drive for caching, and the Zero Administration for Windows (ZAW) initiative to provide software functions to reduce TCO. Like the Java camp, Microsoft targeted automatic system update and application installation, central administration, system lock down, and easy client replacement. (Source: *Byte*, July 1998)

Generation shift in DRAM chips to accelerate

A generation shift in the global semiconductor market from 16-megabyte dynamic random access memory (16M-DRAM) chips to 64M-DRAMs is expected to accelerate, partly because of the so-called "bit-cross" phenomenon.

The average prices of 16M-DRAM and 64M-DRAM chips are set at $3.3 and $12.8, respectively, for the second quarter of this year, indicating that the per-bit prices of the two memory chips have become virtually the same, according to the Nomura Research Institute in Japan.

The generation shift in the semiconductor market usually speeds up immediately after the bit-cross, the point when prices for two chips with different capacities become the same.

In the memory chip market, the price of 16M-DRAMs is not likely to drop further, since it has already fallen nearly to the level of production costs. Meanwhile, the price of 64M-DRAMs continues to fall steadily, the institute said.

The market for 16M-DRAM chips is expected to shrink by 25.4 per cent this year, contracting to 1.77 billion units from last year's 2.23 billion. On the other hand, the market for 64M-DRAMs is predicted to experience hectic growth of 515 per cent, swelling to 800 million units from last year's 130 million.

"Domestic semiconductor producers, who have the biggest market share in the global 64M-DRAM market, will probably engage in a tough battle with the Japanese, who are trying to compensate for their defeat in the 16M-DRAM sector by promoting 64M-DRAM sales," an official at the Korea Semiconductor Industry Association said.

In the meantime, Korea's three major semiconductor makers' capital investment is expected to decline sharply this year because of the economic climate and the supply glut.

The combined capital spending by Samsung Electronics Co., LG Semicon and Hyundai Electronics Co. is projected to reach $1.5 billion this year, about one third of the figure a year ago, said sources in the semiconductor industry and Nikkei Microdevice of Japan.

The domestic semiconductor industry is forecast to shrink further from the latter half of 1999, when 1998's sharply reduced capital investments will take effect, the Nikkei Microdevice said.

Global DRAM production is also expected to fall short of an initial forecast of 4.1 billion units, reaching 3.69 billion in 1998. The drop is attributed mainly to the shrinking capital spending by the two major semiconductor-producing countries.

The demand for DRAM chips is estimated to reach 3.4 billion units in 1998 and 5.4 billion in 1999, when demand will overtake supply. (Source: *Newsreview*, 23 May 1998)

Japan avoids 200 mm wafer shortage

Sales of monocrystal Si are expected to rise 7 per cent to reach 4,580 tons in FY98, representing a 5 per cent increase in Japan's demand to 2,860 tons and a 10 per cent increase in exports to 1,720 tons. Export value is expected to rise 10 per cent to $10 million. The Silicon Group of the New Metals Association announced data on high-purity silicon production and sale for FY97 and forecasts for FY98.

The forecast for the first half of FY98, reflecting uncertainties about the future economic climate and continuing production adjustments by semiconductor manufacturers, is stern. However, in the second half, demand is expected to surge primarily in 200 mm epitaxial wafers, supported by the faster Pentium II processor system bus (66-100 MHz) and a rise in PC demand driven by the release of the Windows 98 operating system by Microsoft.

The feared shortage of 200 mm epitaxial wafers in the fall of 1997 was avoided thanks to boosted production capacity on the part of the Si makers and production adjustments by the semiconductor firms as DRAM prices fell.

After the supply shortage of poly-Si at the end of 1995, investments into equipment in 1996 and 1997 led to a FY97 rise in production capacity of 31 per cent over the prior year, to 5,378 tons. As a result, inventory rose from one-and-a-half months at the end of 1996 to two months at the end of 1997. Considering the full-scale production stance now, the

association expects a 2 per cent rise to 5,500 tons for 1998. (Reprinted with permission from *Semiconductor International Magazine*, April 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

1997 world chip sales total $137.2 billion

The Semiconductor Industry Association (SIA, San Jose, CA) reported that world semiconductor sales hit $11.48 billion in December 1997, carrying the industry to a year-end total of $137.2 billion, the second highest mark in history. December sales were 4.5 per cent higher than December 1996. Total sales for 1997 represent a 4 per cent increase over 1996 sales.

With one major exception—Japan—1997 sales were up in all major markets. Sales increased 7.4 per cent in the American market, 9.9 per cent in Asia/Pacific and 5.5 per cent in Europe. Sales in the Japanese market in 1997 were 6.1 per cent below 1996 sales.

Global chip sales have increased dramatically during the 1990s. From $50 billion in 1990, sales jumped to a record $144 billion in 1995. (Extracted with permission from *Semiconductor International Magazine*, April 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Consumer demand drives chip market

Demand for consumer electronics should keep the world semiconductor market on course to reach $500 billion by 2005. So predicted Jean-Philippe Dauvin, group vice-president of SGS-Thomson Microelectronics.

Speaking at the Europartners Distribution Forum in Paris, Dauvin, who prepares market data on the chip industry as chairman of the World Semiconductor Trade Statistics Group, estimated that what he describes as "differentiated ICs" will represent 34 per cent of the world semiconductor market at $112 billion.

These ICs will be going into digital video which will grow 47 per cent as a consumer of semiconductor products by the year 2002, smartcard at 35 per cent, car multimedia at 30 per cent and digital mobile phones at 27 per cent.

Europe's strength in some of these markets, most notably mobile communications and automotive electronics, means it is the region most likely to benefit. Europe's growth of 22 per cent over the next five years will be matched only by that of the Asia/Pacific region. This would give Europe a 23 per cent share of the world semiconductor market ahead of Japan at 17 per cent. (Source: *Electronics Weekly*, 13 May 1998)

Embedded Risc market hits high as MIPS share grows

Shipments of embedded Risc processors grew by 55 per cent in 1997, with MIPS' market share reaching nearly half the total market, according to the industry newsletter *Inside the New Computer Industry*.

MIPS' increase of 129 per cent in shipments was only bettered by Advanced Risc Machines (ARM), which saw a rise of 133 per cent.

In 1997, ARM processors were shipped in over 9.8 million devices. It is now the third largest selling embedded Risc processor, confirming that 1997 was the turning point for ARM as regards volume.

Impressive gains made by ARM and MIPS have been largely at the expense of Hitachi, which had a bad year in the semiconductor market as a whole, and Intel's i960.

With the exception of PowerPC, all the other embedded RISC devices saw modest growth in volumes, leading to a reduction in their market share.

IBM and Motorola's PowerPC was the only device family that sold less in 1997 than in the previous year—3.8 million against 4.3 million. (Source: *Electronics Weekly*, 14 January 1998)

SEMATECH expects "decade of momentous change"

According to Mark Melliar-Smith, president of SEMATECH, the decade 2000-2010 will signify a "decade of momentous change" for all participants in the semiconductor industry. Melliar-Smith cited post-optical lithography, copper and low-k dielectric metalization and deposited gate dielectrics as potential show stoppers. Other factors that could reduce the industry's chances of staying on the historical productivity curve it has enjoyed for the past three decades (figure I) include the incremental changes associated with the move to 300 mm wafers and accelerated reductions in design rule.

The productivity engine in figure 1 refers to the combined benefits of shrinking feature size, moving to larger wafers, improving yields and improving equipment productivity, which traditionally have allowed 25-30 per cent per year reductions in cost per function (i.e. cost per bit in DRAMs, cost per million instructions per second (MIPS) for microprocessor devices). Rapid advances in lithography, interconnect structures and transistor scaling are needed to accelerate the movement to finer feature sizes (from 12-14 per cent reduction per year previously to a current rate of 16-18 per cent reduction per year). Not meeting these critical goals could limit future productivity gains.
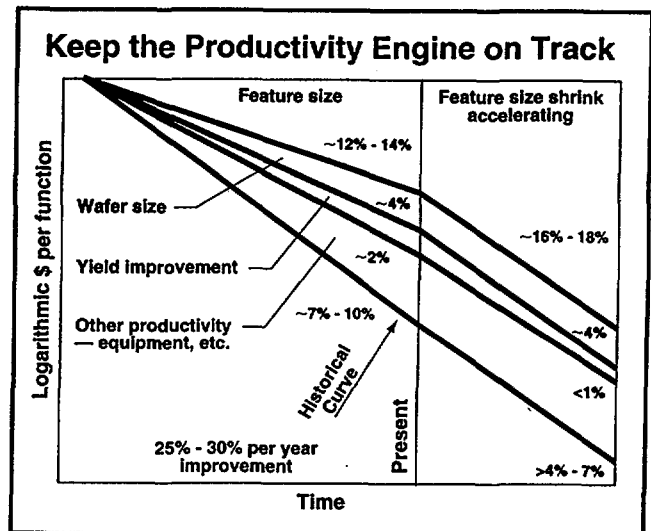
1. By accelerating feature size reduction and improving equipment productivity, the industry will maintain historical gains in overall productivity per year.

When optical lithography reaches its limit, at 130-100 nm (figure 2), new technology solutions must be developed from among e-beam, X-ray, extreme-UV and others. Throughput, cost per wafer and extendability targets must be reached, and the infrastructure for next-generation lithography must be in place to begin production in 2003. The technology driver—microprocessors—will be the first to require post-optical lithography tools.
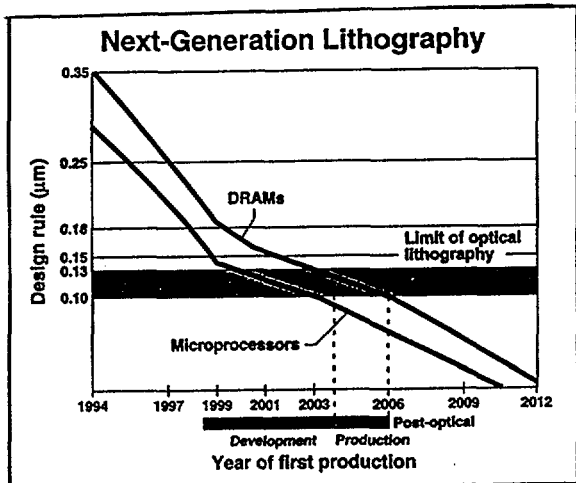
2. Post-optical lithography technologies must deliver high production throughput, low cost per wafer and extendability to future device generations.

3. Based on historical increases in total wafer area, 450 mm should follow 300 mm wafers. Pilot production of 450 mm (16 in.) wafers is projected to begin around 2008.

As logic manufacturers move to towering interconnect structures with eight levels of metal, many copper, and low-k dielectrics (0.10 μm generation), SEMATECH projects that a fab producing 10,000 wafers/week will spend between $750 million and $1.3 billion on back-end-of-the-line companies to begin using copper and low-k dielectrics within the same device generation, while others will transition to using either copper or low-k dielectrics first, bringing the other into the fab in the subsequent device generation. Copper electroplating and CVD appear most promising among the different deposition techniques. Among the low-k dielectrics, companies are likely to transition from high-temperature organics to amorphous fluorinated carbon and finally aerogels—beyond which insuperable barriers may exist.

Continued scaling of transistors in the future may require deposition of new, high dielectric constant materials for gate dielectrics, very shallow junctions in which dopant atoms must be counted, literally, and the use of metal gates. New gate dielectrics and electrodes are expected to enter first production early next century. Threshold voltage control will become especially challenging in devices with low-voltage operation (i.e. <1 V).

Regarding the important transition to 300 mm wafers, which, as shown in figure 1, contributes 4 per cent to productivity improvement, Milliar-Smith emphasized that the industry is slow in delivering a full, capable toolset for lithography, specifically production DUV steppers. Tool footprint and cost cannot increase more than 30 per cent over 200 mm tools. Patterned 300 mm wafers, needed to test all wafer processing tools for 300 mm, are scarce. Melliar-Smith commented that the industry must move away from the current trend of having equipment "specials" manufactured based on customer's specifications. Across-the-board standards must be used to reduce the cost of 300 mm processing. As shown in figure 3, SEMATECH expects the next-generation wafer size to be 450 mm, based on the logarithmic increase in total wafer area since 1976.
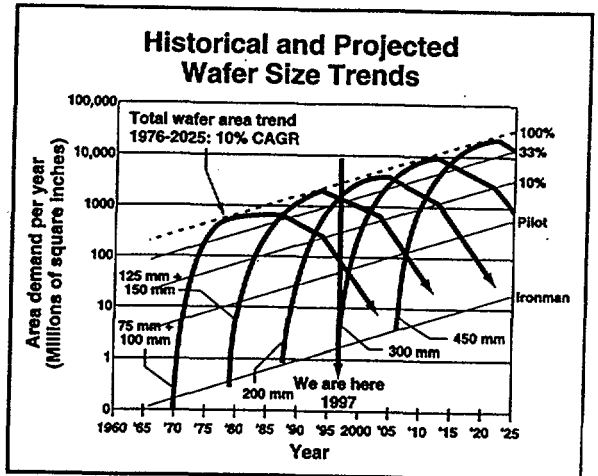
Finally, the importance of defect inspection and management was cited as increasingly critical as the industry transitions to smaller feature sizes. Automated analysis of defects, tools and products is required. Hardware and software are needed to perform spatial signature analysis of defects that are automatically classified. Defect-free equipment must be designed using contamination control modelling. Melliar-Smith said detecting a 25 nm defect on a 300 mm wafer is analogous to looking for a golf ball on earth from a microscope ~100 miles above the planet. (Reprinted with permission from *Semiconductor International Magazine*, December 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

SIA forecasts $232 billion chip market

The Semiconductor Industry Association (SIA) has forecast that the global chip market will grow 16.8 per cent during 1988, exceeding the $232 billion mark by the year 2000. The forecast, produced by market researchers of 70 of the top semiconductor companies forming the World Semiconductor Trade Statistics Organization, is predicated on the expectation that during 1998 the DRAM chip market will abandon the doldrums it has been in since 1996. During the present year, microprocessor sales surpassed DRAM sales to the tune of $23.6 billion vs. $20.8 billion for DRAMs.

The forecast also indicates that the Untied States is the major MPU market, representing 44.3 per cent of all sales with Europe, the second-largest, tilting the scale at 25 per cent. DRAM sales are expected to increase 20 per cent to $25 billion during 1998, reaching $41.7 billion by 2000. By that same year, the Asia/Pacific market is expected to represent 24.3 per cent of semiconductor sales, surpassing Europe and overtaking Japan. (Extracted with permission from *Semiconductor International Magazine*, December 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

Significant trends from ISS

The industry's leading analysts presented their outlooks for 1998 at SEMI's Annual Industry Strategy Symposium (ISS), held 4-7 January in Pebble Beach, CA. Most importantly, analysts emphasized the importance that the Asian currency crisis is having on industry dynamics. Attendees could take with them 10 key messages regarding the current and near-term economic conditions:

1. Gradual recovery of semiconductor market in 1998
2. Fab overcapacity remains, spending is focused on technology transitions and 300 mm R&D
3. Economic crises in Korea and Japan not likely to find rapid resolution
4. Japan's personal computer (PC) demand drops in 1998, rest of Asia/Pacific also down
5. Rising volatility and uncertainty in PC market, despite new drivers such as sub-$1,000 PCs
6. DRAM market could remain soft until mid-1999
7. High-tech fundamentals remain strong (accounted for 45 per cent of economic growth in the United States over past three years)
8. Semiconductor industry experienced highest unit growth (up to 23 per cent) in 1997 since 1984
9. DUV lithography transition buffers slowdown in 1997-1998
10. Revolution in new materials is occurring, faster "time to quality" and larger R&D budgets are required.

(Extracted with permission from *Semiconductor International Magazine*, March 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Chips up in 1999

The global chip market will show strong growth in 1999 but this year it will face much slower growth than expected, says US market research firm Dataquest.

Dataquest predicts that chip growth will be about 8 per cent this year to become a $159 billion market, compared with 3.5 per cent growth in 1997 and a market valued at $147 billion.

Strong growth of 18 per cent is forecast for 1999, but the DRAM oversupply situation is likely to persist throughout 1999 with a DRAM shortage forecast for 2000.

Meanwhile, fabless chip firms are doing very well, reports the Fabless Semiconductor Association (FSA), saying that a survey of its members shows they will need 45 per cent more silicon from their foundries this year.

The FSA says fabless chip firms are growing faster than the overall chip industry, able to take advantage of excess chip manufacturing capacity worldwide, and lower prices from Asia-based foundries.

The majority of fabless chip firms say that most of their chips will be manufactured in 0.35 μm or below this year, and they expect to raise production by 30 per cent in 1999. (Source: *Electronics Weekly*, 6 May 1998)

Electronic commerce in the European pharmaceutical market

In the pharmaceutical sector electronic commerce is expected to be the key force in making a genuine single European market a reality. The European Commission has already recognized this potential of electronic commerce to act as a catalyst. One of the suggestions to come out of a series of recent round-table meetings is to create a pan-European system of electronic commerce in drugs, medicines and health-care equipment. This would be accompanied by a pan-European database of products available to doctors in their surgeries, complete with advice on drug usage and possible patient reactions.

For the European Commission, which is funding a series of projects designed to build the pan-European networks that will be needed to support a suitable system, electronic commerce is seen as crucial to creating a more cost-effective means of delivering health care. It is the trend in the US, where the emphasis has for a long time been on the cost-efficiency of medical care and self-medication. Purchasing drugs over the counter is usually a far cheaper option than hospitalizing the sick.

However, growth for the main European markets average just 4 per cent compared with a growth rate in the US of 14. Member States wishing to sign up to a single European currency are taking it out on their health budgets to lower their budget deficits. The softest option has been to cut back on drug spending. In some countries there has been up to a 3 per cent cutback on spending on pharmaceuticals. (Source: *Information Strategy*, 3 (1) February 1998)

Bioinformatics in the pharmaceuticals industry

Glaxo-Wellcome, the world's biggest producer of prescription pharmaceuticals, has moved to apply information technology to the trials process to cut costs, shorten time to market and, ultimately, to better predict which products will succeed or fail. In the age of bioinformatics, the fusion of biochemistry and IT, there is a pressing need to automate the process of how you test and apply drugs.

Glaxo has teamed up with Pharsight, a California software start-up, in applying virtual clinical trials technology to accelerate the whole process of testing drugs and getting them to market. Pharsight has developed a system allowing users to optimize clinical trial design by conducting virtual trials before they spend millions testing real drugs on tens of thousands of real people.

Virtual clinical trials allow drugs developers to simulate how drug treatment may affect the general population by inputting information on patient characteristics, drug dosage levels, trial structure and complicating factors arising from other medication. These virtual trials do not eliminate the need for human trials but they do mean that broad conclusions can often be made more quickly and with a much smaller sample of patients. They can also reduce the need to put children, pregnant women and the elderly at risk by exposing them to largely unknown and potentially dangerous drugs.

While virtual trials are new to the pharmaceuticals industry, they are not unlike other forms of simulation software already common to other industries like autos, aerospace, finance and mineral extraction. Whatever the area of business, the goals of simulating real scenarios remain much the same: to predict the viability of business propositions or to reduce costly problems which may arise during product development or production. For drugs makers, the greatest advantage virtual trials offer is not in cutting development costs, but in shortening time to market and lengthening the period a product can earn big sales. (Source: *Information Strategy*, 3 (1) February 1998)

Predictions of the next big things in PC computing

The PC world has reached a plateau. The last year has had no major new software or hardware changes, and many of us were actually using the same versions of things we had a year ago. Windows 95 has been out now for two years without any major upgrades; we are all using Microsoft Word or WordPerfect, and Netscape or Internet Explorer. Even the things we are doing on the Web this year are virtually the same as they were a year ago, though perhaps a bit more refined and polished.

The next big thing in computing will not have anything to do with the above. However, the successful commercialization of useful speech recognition, new display technology, wireless networking, and really cheap home computers will completely change computing as we know it. Until we see some of these developments, most innovations in the industry will continue to be mere variations on existing themes: the same computers and applications, running faster and faster, with more colours, but not actually doing anything fundamentally different.

Speech Recognition is probably the new technology most likely to happen in the near future. Lots of development is going on and we are very close to having low cost Speech Recognition available in the consumer market. Those who will benefit from it first, and most, are the manually and visually disabled. A system that can intelligently process commands, as well as record text, will be a boon for those unable to use a mouse or keyboard, for whom any type of mechanical input is just not practical, or who just cannot read a computer screen. (Source: *Online*, January/February 1998)

Coming soon ... the disposable desktop computer

New personal computers are becoming obsolete faster and faster with every passing year. If the trend continues, a PC purchased as we celebrate the millennium could be good for just six months' use.

This sobering analysis comes from Livingston Rental, a company in west London that leases PCs to businesses across Europe. Livingston tracks the speed at which rented equipment is returned by customers who want a newer model. The trend is inexorable, with the useful life of a PC used in business falling by two to three months each year. Three years ago, when PCs with Intel 486 chips were top of the range, their rental life was around 17 months. Machines based around early Pentium chips running at 133 megahertz, which dominated the market in 1996, lasted, a little over 14 months. Last year, machines with 166-MHz Pentium chips were unwanted after 11 months and had been replaced by Pentiums running at 200 MHz. The newest PCs run at 300 MHz. Livingston's data show that the lag between a new PC being introduced and the peak demand for rentals is also decreasing.

Fred Round, chief executive of Britain's Radio, Electrical and Television Retailers' Association, says that the spiral of accelerating obsolescence of PCs is a serious issue. "Renting will soon be essential to a retail dealer's survival", he says.

There is a silver lining, however. Businesses do not need to worry too much about protecting their current PCs form the "millennium timebomb" of software that will not cope with the date shift to 1 January 2000, says Barry Watts, Livingston's business development consultant: "Why bother buying software to try and make today's PCs handle the millennium date change? They will be on the scrap heap anyway." (Source: *New Scientist*, 17 January 1998)

1999 to see "plethora" of ICs using VSI spec

The first ICs designed using specifications from the virtual socket interface (VSI) alliance will appear next year.

Launched in September 1996, the VSI alliance promised to transform the way ICs are designed. It would allow designers to mix and match intellectual property and cores from multiple sources. Chip design would become as easy as designing a PCB full of standard logic, alliance members claimed.

Last year the VSI looked at the problems and started to develop specifications. In May, specifications from the mixed

signal and implementation/verification working groups are expected.

The VSI is now working to ensure that people adopt the standards. Companies including Fujitsu have designed chips using the specifications. (Extracted from *Electronics Weekly*, 15 April 1998)

Network computing

A recent study undertaken by International Data Corporation (IDC) predicted that the business market for "thin client" devices will reach 6.8 million units by 2002. It also revealed, however, that most computer users are confused about the network computer (NC). The survey had to be repeated, as 25 per cent of the respondents to the first study indicated they were employing NCs, when in fact they were using networked PCs. Those selling NCs will have to make the precise nature of the devices much clearer if they are to make any progress.

Significantly, however, of the 97 (out of 270) enterprises using genuine NCs, 73 per cent indicated they had purchased them as PC replacements, and 80 per cent of respondents believed NCs would lower the total cost of ownership. Only 25 per cent of respondents said that *Java* was a major factor in the decision to purchase, and 34 per cent replied to the effect that it exerted no influence at all on the decision. (Source: *Communications International*, May 1998)

Chip change as PC tide ebbs

The state of the semiconductor industry is so dire that something has to snap. "The industry is completely out of money this year", says Jean-Philippe Dauvin, president of World Semiconductor Trade Statistics.

The market is expected to contract again this year to $134 billion compared to 1995's $150 billion. The 1998 DRAM market is expected to decline to $14.5 billion compared to 1995's $40 billion. Even the microprocessor market is expected to be flat this year.

"The Asian crisis has had a disastrous effect", says Dauvin, "in the first half of 1998 there was a 27 per cent drop in demand for equipment. There's a disastrous export trend from Japan to Asia and a collapse of the Japanese market."

Japan's semiconductor market—which represented 40 per cent of the world market ten years ago—was running at only 20 per cent of the world market in the first quarter of 1998.

When consumers get fast access to the Internet, they will no longer need a powerful PC because they will be able to use other peoples' memory and processing power.

This will drive a sea-change in the semiconductor market, reckons Dauvin. The PC tide that ran so strongly is already ebbing and the next tide will be digital consumer—mobile phones, automotive, DVD, set-top box, energy management and smartcard.

As the equipment market transforms, massive adjustments will have to be made within the semiconductor industry.

In May, the Japanese electronics majors announced the most horrendous year-end results with profits down by between 80 and 96 per cent and with Mitsubishi Electric in loss. They blame the collapsed DRAM price caused by the overcapacity which followed the slowing PC market.

With the PC market slowing and a perception that Internet-type applications may not require the steeply escalating DRAM content designed to speed up the use of larger and larger programmes, DRAM may never recover its former importance in the world semiconductor industry. From representing around 25 per cent of the industry in 1995, DRAM will drop to little over 10 per cent this year.

Motorola has announced 15,000 job losses with more to follow. Intel has announced 3,000 losses. National Semiconductor announced 1,400 job losses and a financial loss for the year of almost $100 million.

Leading PC companies Packard-Bell, Compaq and HP have given profits warnings. All of them blame the same thing—the softening PC market and a move to a consumer market.

That move does not favour Intel, the Americans, the Japanese, the Koreans or the Taiwanese. But it does favour the Europeans.

Mobile communications, automotive electronics, smart-cards, energy management, set-top boxes and DVDs—the full panoply of the digital consumer boom—are European strengths.

So what is going to happen to the semiconductor companies? "There will be an extremely severe consolidation process", predicts Dauvin. He does not think this will happen during the slump, but when the market turns in 1999/2000. (Extracted from *Electronics Weekly*, 17 June 1998)

Market for semiconductor precursor materials forecast to reach $931 million

The semiconductor industry has been and will continue to be, a driving force in the economics of the world. Coupled with its end-use product revenues, it already represents nearly 5 per cent of the world's total output of goods and services. Continued worldwide technical advancement has become dependent on the continued forward march of the semiconductor industry. The element silicon (Si) has so dominated the industry that the term is often used interchangeable with semiconductor. It has been said that the material simply did not offer the potential of some outstanding alternatives. Despite this, and in the face of a current market downturn, silicon continues to thrive. Chip sales and material use continue to climb, and silicon continues to dominate as the material of choice.

According to a soon-to-be-released Business Communications Company, Inc. study, "GB-206-Semiconductor, Building Block Materials: Growing Markets for Material Precursors", the total market for materials and devices was valued at $510 million in 1996 and is expected to grow to $931 million in 2002, representing an average annual growth rate (AAGR) of 10.5 per cent.

BCC points out that silicon remains in a class by itself, and the principal single crystal wafer material precursor polycrystalline silicon dominates the total sales in the available market. Polysilicon is forecast to grow to $655 million in 2002 and was valued at $430 million in 1996, creating an AAGR of 7.3 per cent.

Compound semiconductor substrate precursors include all of the principal III-V and II-VI semiconductor substrate precursor materials, including semiconducting as well as semi-insulating (SI) gallium arsenide (GaAs) and indium phosphide (InP), gallium phosphide (GaP), indium and gallium antimonide (InSb, GaSb), cadium telluride (CdTe), and zinc selenide (ZnSe). The pure metal precursors for these substrates in total will generate an 11.9 per cent AAGR. They were valued at $39.9 million in 1996 and should reach $78.2 million by 2002.

BCC concludes that the segment seeing the strongest growth is that for epitaxial precursor materials in the fabrication of compound semiconductor devices. BCC forecasts growth of over 30 per cent AAGR through 2002, with revenues set to approach $200 million. In 1996, they were valued at $40.7 million. (Source: *Chemical Engineering World*, vol. XXXIII, No.1, January 1998)

Company news

Shrinking discs

In 1999 IBM will launch a miniature hard disc drive with a platter the size of a thumbnail. It can hold up to 340 megabytes of data. The Microdrive is less than 50 millimetres square and 0.5 millimetres thick, and plugs into flashcard slots. It could be used to store entire telephone directories in cellphones, 30 minutes of video in camcorders or vast maps in hand-held GPS navigation devices. (Source: *New Scientist*, 12 September 1998)

Motorola doubles Indian investments

The Motorola Semiconductor Sector will establish a $50 million VLSI design centre in Gurgaon, near New Delhi, India. The facility is expected to employ at least 40 engineers and technicians by the end of the year. This move doubles the company's investments in India. The design centre will work with other similar Motorola establishments worldwide to develop products for wireless markets. According to company sources, the design facility will take advantage of India's software and design talent pool. Already, engineers at Bangalore's Motorola India Electronics Ltd. have developed software for cellular base stations and ground control software for Iridium, the Motorola-led global personal communication system. (Reprinted with permission from *Semiconductor International Magazine*, July 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

IBM to expand custom chip business

IBM (East Fishkill, NY) announced it will spend more than $100 million on several major new initiatives to increase its position in the custom microchip business. The investment centres on the addition of more than 24 chip cores to the company's portfolio. The company estimates that the custom chip industry will increase from $21 billion this year to $52 billion in 2002.

The new cores will allow IBM to build chips for use in a variety of products from digital cameras and set-top-boxes to high-end computing systems. A new core that provides full compatibility with a Texas Instruments' (TI, Dallas, TX) TMS320C54X DSP digital signal processor, a component used in millions of cell phones and other communications devices is significant.

This announcement came on the heels of other recent additions to IBM's logic technology, including Sun Microsystem's (Palo Alto, CA) Pico-Java core for building Java-capable chips and ARM's (Cambridge, UK) ARM7TDMI core, used widely in communications devices. The acquisition of CommQuest (Encinitas, CA) also enhanced IBM's ability to provide wireless communications solutions. (Reprinted with permission from *Semiconductor International Magazine*, August 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

IBM hits SOI high

IBM claims that a 15-year development effort to make silicon-on-insulator (SOI) technology into a practical reality has paid off and will lead to significantly faster chips using less power.

SOI offers faster chip performance because it is a more efficient insulator which prevents electron leaks. IBM claims it has built SOI chips with 35 per cent more performance while requiring just one third of the power of a conventionally built chip.

IBM says that SOI-based chips will first be used in mobile electronics applications where performance and battery power are key considerations, but SOI manufacturing processes will be extended to mainstream microprocessors used in servers and large computers. SOI technology has been explored by other companies but had been considered too expensive for most applications. IBM's first SOI-based chips will be out at the beginning of 1999. (Source: *Electronics Weekly*, 12 August 1998)

IBM improves chip performance

Consumer electronics, mainframes, and servers will be the beneficiaries of several chip initiatives from IBM Corp. One approach combines silicon with germanium, a highly efficient conductor that could pare power consumption of portable devices, such as cell phones, by as much as 50 per cent. Easy to work with, the silicon germanium chip presents the additional advantage of being cheaper than competing high-speed circuit technologies such as gallium arsenide, says Paul Cunningham, product line manager for silicon germanium, Beacon, NY. Best of all, silicon germanium chips are made with the same tools as silicon chips.

In another chip enhancement approach, IBM will use "silicon-on-insulator" (SOI) technology to boost the performance of mainframes and servers by as much as 35 per cent. Because the concept also pares power consumption by a third, the innovation could benefit battery-powered devices. The gains are made possible by depositing a layer of insulating material on the silicon wafers, thus permitting closer placement of transistors and a more efficient flow of electrical current. IBM is now producing the silicon germanium chips at its Advanced Semiconductor Technology Center in East Fishkill, NY, and Burlington, VT. SOI chip production is scheduled for Burlington early in 1999. (Source: *Industry Week*, 17 August 1998)

IMEC looks into MPEG-4 hardware

Hardware for the emerging MPEG-4 audio-visual compression standard is being developed at IMEC, the Belgian electronics research institute.

The chip development is part of IMEC's work with the implementation study group of the MPEG-4 committee.

No date has been set for manufacture as Borman has yet to find semiconductor partners. The MPEG-4 standard will be completed by November 1999.

Other compression research carried out by IMEC includes a wavelet encoder for the European Space Agency. (Source: *Electronics Weekly*, 27 May 1998)

Philips and Cypress unveil latest CPLDs

New complex programmable logic devices (CPLDs) are being launched by Cypress Semiconductor and Philips Semiconductors.

Cypress announced a CPLD family ranging from 32 macrocells to 512 macrocells, while Philips has announced a 960 macrocell chip with propagation delays of only 6 ns.

Philips' SRAM-based Cool-Runner 960 CPLD is, claims Philips, the largest CPLD in the industry with twelve modules of eighty macrocells each. It has a 36-wide logic input structure that connects to configurable registers. It is specifically positioned for high-speed state machine and control logic applications.

Philips says that it achieves the density and speed performance off a 3 V operating voltage by use of its patented interconnect technology which it calls Global ZIA (zero-power interconnect array).

The chip is packaged in a 492-pin ball grid array with 384 signal pin capability. It is manufactured using 0.35 µm technology and five metal layers. Target date for production of the CoolRunner 960 is August. Pricing is $98 each for quantities over 25,000.

Cypess' CPLD family, called Ultra37000, has propagation delays of 5 ns for the 32 macrocell device and 7.5 ns for the 256 macrocell device. (Source: *Electronics Weekly*, 20 May 1998)

BT in joint network chip plan

BT and Korea Telecom are to collaborate in the development of a neural network chip for solving optimization problems in communication networks.

The device is based on the universally reconstructable artificial neural network (URAN), a chip developed by Dr. Il-Song Han of Korea Telecom. He has been working with BT on a version that implements Hopfield neural networks. (Source: *Electronics Weekly*, 14 January 1998)

IBM continues to top patent league

IBM has topped the charts for the fifth year running by receiving the highest number of US patents in 1997. With 1,724 patents granted, IBM easily beats Canon into second place. The top ten places are dominated by Japan and the US, with seven being Japanese companies. Of IBM's patents, more than 50 were issued for its copper interconnect technology for ICs, while over 800 were software or network computing related.

US patents issued in 1997

IBM	1,724
Canon	1,378
NEC	1,095
Motorola	1,058
Fujitsu	903

(Source: *IFI/Plenum Data*)

Two join in Risc SH development

SGS-Thomson and Hitachi are to jointly develop 64-bit embedded processors based on Hitachi's Super H (SH) Risc architecture.

As a result, SGS-Thomson has abandoned its own 64-bit Chameleon processor. Instead the aptly named architecture will be incorporated as part of the SH-5.

The details of the SH-5 architecture will be revealed in late 1998.

The two companies are investing and recruiting for design centres in Bristol and San Jose, CA.

The SH-5 is expected to be backward compatible with SGS-Thomson's previous ST products. A key application for SH-5 will be speech recognition and translation. (Extracted from *Electronics Weekly*, 17 December 1997)

New turn in DVD-RAM spec battle

The DVD Forum led by Toshiba, Matsushita and Hitachi has agreed on a new DVD-RAM specification. It combines the best features of the previous DVD Forum proposal with that of DVD+RW promoted by the Sony/Philips/Hewlett-Packard team.

According to Nick Sundby from Hitachi, neither existing format met the requirements of the Forum. However, the Sony/Philips/HP faction is determined to sell its own format (DVD+RW) despite its incompatibility with other DVD equipment and despite the companies' presence in the DVD Forum. This has caused the Forum to rebel against the name DVD+RW and force Sony/Philips/HP to rename it to phase-change/read-write (PC-RW).

Meanwhile, six of the ten companies holding patents on the initial DVD technology will start a joint licensing operation different to the one established earlier by Sony, Philips and Pioneer. The programme's objective, as before, is to act as a one-stop-shop for DVD technology to new parties, but now it will be operated by Toshiba. (Source: *Electronics World*, January 1998)

Game over for Microsoft?

There are several signs that Microsoft Corp., the world's unchallenged leader in personal computing software for business, is starting to lose some of the monopolistic grip it has had on the industry for nearly two decades. The most obvious red flag, of course, is the challenge the software giant faces at the hands of the US Government. The Justice Department reopened its investigation of the software firm last fall "to determine whether Microsoft is illegally extending or preserving its monopoly in operating systems", according to a Justice spokesperson.

Besides the Justice investigation, which experts speculate may now threaten Microsoft's next big product—Windows 98 and its integrated browser—there is the Congressional inquiry.

Also likely to chip away at Microsoft's hegemony, software industry experts say, is an industry-wide sea change favouring more economical network computing. Personal computers and the associated software are simply too costly to upgrade and maintain, many users claim.

As if those challenges were not formidable enough, Microsoft also faces serious assaults on its dominance from other quarters. These include:

* Java, Sun Microsystems Inc.'s popular Web-based operating system. Java by itself has the capability over time to dominate the Internet-intensive landscape of 21st-century computing, ultimately eroding the need for PC-based operating systems. It could take a decade, but like global warming the trend toward Java-centric computing can not be denied.
* The failure of Microsoft's own Windows NT system to support large numbers of corporate users, especially those trying to access big corporate databases.
* The growing backlash on the part of corporate buyers against having to purchase new PC hardware and software every two or three years.

But almost no one envisions Microsoft losing its dominance in PC software anytime soon, although the software giant may find itself having to share some markets with competitors. (Extracted from *Industry Week*, 20 April 1998)

NEC out to quash dumping charges

NEC is offering remote access to its Tokyo-based supercomputer to avoid charges of dumping supercomputers illegally in overseas markets. Customers can now buy time on its high end SX-4 Model 32 for $100 an hour.

The system's 32 processing units give the machine a total processing performance of 64 billion calculations a second. NEC expects customers with large data modelling requirements, such as weather systems and dynamic flow analysis, to use the service.

NEC ran into trouble last year when it was accused of dumping supercomputers in US markets. To get around such charges, NEC hopes that overseas customers will exploit high speed links to send data to its supercomputers based in Japan.

It also plans to offer additional services such as technical consulting and programming through its overseas subsidiaries. (Source: *Electronics Weekly*, 22 April 1998)

Inmarsat to offer 64kbit/s data uplinks for satellites

Inmarsat is to offer 64kbit/s data uplinks to its satellites in 1999.

Inmarsat is the only organization to offer a near-global telecommunication service, serving marine and airborne subscribers as well as land-based users in remote areas.

Terminals for the service, says Inmarsat, will weigh only 4 kg.

The introduction of 64kbit/s data could be timely. Currently the organization only offers a few kilobits per second, very similar to that Iridium plans to provide its handset users early in 1999.

While Inmarsat and Iridium see little overlap in their userbases, the higher rate will give Inmarsat a clear differentiator in the satellite data market. (Source: *Electronics Weekly*, 6 May 1998)

IBM to use SiGe process on one-chip GSM solution

Single-chip GSM mobile phones based on silicon germanium (SiGe) have moved a step closer with IBM's acquisition of CommQuest.

The San Diego-based wireless communication chip design house already has a two-chip GSM solution. IBM has developed an SiGe process which allows RF and logic circuits to be produced on the one chip using a process very similar to that for silicon. However, unlike CommQuest, IBM does not have a product.

IBM will adapt CommQuest's building blocks to its SiGe process immediately, but the single-chip phone is still some way off.

IBM is marketing CommQuest's existing product line, including its triple band GSM chipset which has yet to be revealed. This will allow a single phone to operate in Europe and the US. (Source: *Electronics Weekly*, 18 February 1998).

Ferro fab plan

Siemens is reported to be constructing a dedicated ferroelectric memory fab in Germany. Half a dozen semiconductor companies have decided that the technology is now sufficiently developed to go commercial.

Because the materials involved in manufacturing ferroelectric memories are detrimental to CMOS manufacturing lines, it is necessary to have a separate production line to make ferroelectric devices.

Hitachi and Rohm are already supplying customers with FRAM.

Only one company in the word is in volume production of ferroelectric RAMs—Rohm of Japan—which makes them in quantities of around a million a month for a single customer.

Rohm has solved the problems associated with humidity and temperature testing. The company is making one device—a 16k serial memory which replaces serial EEPROM.

Rohm started off with the ferroelectric technology pioneered by Ramtron and Symetrix but then developed its own which it calls FFRAM (Floating-gate Ferroelectric RAM).

Others reported to be building fab lines for volume ferro production this year are Matsushita, Motorola and Hyundai. (Extracted from *Electronics Weekly*, 11 March 1998)

$15 Pentium reflects cost fall

Declining microprocessor manufacturing costs have been highlighted with news that Taiwan Semiconductor Manufacturing Company (TSMC) will make Cyrix-designed microprocessors for National Semiconductor at $14.80 a piece.

This contrasts with the manufacturing costs of microprocessors published by the US industry newsletter *Microprocessor Report* which quotes anything from $45 to $85 for the cost of assembled, tested, Intel-architecture micros.

The TSMC price is thought to be for bare die. With packages costing between $7 and $8, and with test adding a few dollars more, the discrepancy between industry-led estimates and the prices quoted by the Taiwanese is difficult to explain.

Moreover, industry sources reckon that Intel's fabs are now so efficient, following Craig Barrett's manufacturing revolution, that the company can manufacture a bare Pentium processor die for $10 to $12.

With Pentiums costing up to $800, that explains why Intel is the world's fourth most valuable company by stock market valuation, and closing on third place Coca Cola.

Meanwhile rivals are unable to match Intel's production capabilities. National is reported to have commissioned over 10 per cent of the 1998 Intel-architecture PC market—ten million units—from TSMC, for a price of $148 million, and is lining up more capacity at Chartered Semiconductor of Singapore and Tower Semiconductor of Israel before it starts using its own fab in Portland, ME.

AMD has arranged foundry support from IBM after it is reported to have failed to produce enough of its top-of-the-range K6 clone to supply it to anyone other than Compaq. IBM also makes Cyrix-designed chips on a foundry basis for National. (Source: *Electronics Weekly*, 4 March 1998)

Russian technology surfaces in the Valley

A technique for thinning wafers based on Russian defence technology has been commercialized by a Silicon Valley start-up company. Called Tru-Si Technologies of Sunnyvale, the company uses an aggressive plasma developed at the University of Zelenograd near Moscow for destroying chemical and bacteriological weapons.

Using a chamber which exploits the Bernoulli effect to suspend wafers without physical contact, Tru-Si's machines thins wafers using an isotropic dry etch process to 100 μm. The aim is to get down to 25 μm.

Tru-Si also plans to use the technology in flat panel displays and CVD systems. (Source: *Electronics Weekly*, 8 April 1998)

Six sign fibre deal

Six companies have signed a multi-source agreement for the next generation of fibre-optic transceivers.

"The establishment of uniform package sizes and pinouts from multiple component suppliers will lower equipment costs," said an industry analyst. "Previous limited attempts at standardization, such as FDDI and fibre-channel modules, have contributed to fibre-optic market growth. This new agreement is broader."

The companies include divisions of AMP, Hewlett-Packard, Lucent Technologies, Nortel, Siemens and Sumitomo.

The deal covers "half-width" transceivers, 13.6 mm wide, which are being designed to double the number of devices that can be fitted on to a PCB. Today's standard is 25.4 mm. (Source: *Electronics Weekly*, 1 April 1998)

BT close to completing SDH-based European commuications network

BT has announced that it is in the final stages of its long term strategy to provide the largest single European communications network.

The company will install 7,000 km of fibre, linking its network to those of six partners in Italy, Belgium, France, Switzerland, the Netherlands and Germany. The network will be based on the latest synchronous digital hierarchy (SDH) technology, providing broadband communications and delivering 160 Gbit/s.

BT says that the network will be centrally managed from its European headquarters in Amsterdam and will consist of 32,000 km of fibre. The network will lead to cost savings for the company and its partners.

BT has also unveiled plans to install an optical fibre broadband communications network in Tokyo in 1999. The UK operator has applied to the Japanese Government for a licence to offer international voice and data services to Japanese businesses. (Source: *Electronics Weekly*, 17 June 1998)

E-mail parcel delivery

United Parcel Service (UPS) and other delivery companies now offer a more secure way to deliver electronic messages and important electronic documents over the Internet, reports PC Magazine Online. How it works: UPS Online Dossier (*www.exchange.ups.com*) double-encrypts documents using digital certificates to verify identities as well as document delivery confirmation, tracking, user insurance, and third-party validation. Based on a container receipt, a Dox—a digital box containing text, images, and video—is encoded and authenticated then transmitted over the Internet. Users pay on a per-use basis; the software is free at *www.netdox.com*. E-Parcel (*www.eparcel.com*), a division of Mitsubishi, offers another solution. Using digital signatures to authenticate and record senders' and recipients' identities, the service allows a user to track digital media files in real time and tailors delivery to the recipient's system configuration, memory, and bandwidth availability. (Source: *Communications of the ACM*, vol. 41, No. 5, May 1998)

E. APPLICATIONS

Commercialization of optical control material for optical data communications

Hoya Corp. has acquired a bright outlook to commercialize an optical control material that utilizes the photon in place of the electron which is indispensable for the development of advanced optical data communications equipment. This optical control material is designed to replace the semiconductor currently used as the ultracompact arithmetic processing unit (MPU) or memory, and enables data processing at a speed that is 100-1,000 times faster than existing semiconductors. The widespread use of data processing and communications equipment utilizing the photon is expected to come about in the years 2010-2020, but a big step forward has been achieved through the development of this control through the development of this control material that is essential and indispensable for the development of advanced photon-based data processing and communications equipment.

The newly developed material is a composite material in which titanium oxide undergoes dispersed vapour deposition of gold particles with a diameter of several dozen nanometers, and is produced by combining the laser optical irradiation and vacuum vapour deposition techniques. The company plans to distribute samples of the new material within the year.

The new material refractive index is changed with the light intensity, so by controlling the light, it performs the same actions as a semiconductor, and can be used with a light intensity of 1 kW/cm², about the same as that of a semiconductor laser. Up till now, a light source with a high output of 100 kW/cm² had been necessary, so material used in home equipment had been difficult, but this is now possible, and the refractive index change is about 100 times greater.

Semiconductors consisting primarily of silicon are limited to a processing speed of 1-10 Gbit/s, but using the new optically-controlled material provides a speed of 1 Tbit/s that is over 100-1,000 times faster. Data processing and communications equipment utilizing light feature a considerable improved data processing speed and communications volume to enable the transmission and reception of large quantities of animated images and high-speed processing, raising the probability of the optically-controlled material being used in the future in place of conventional types of electronic personal computer.

At present, the optical fibre has been commercialized as a means for optical transmission, but there is a delay in the development of optically-oriented components and equipment which actually serve to transmit and receive data, so that data processing is presently suppressed to the level of electronic equipment. When optical equipment comes into wide use and light concentrators are provided in general households, power consumption will be reduced and is anticipated to permit substantial energy conservation and reduction of exhaust gas emission.

In Japan, the New Energy and Industrial Technology Development Organization (NEDO) is implementing a project to develop basic technologies with the cooperation of industrial, governmental and academical circles commercializing advanced systems including the optical computer. Even in the United States, organizations such as the University of Arizona are rushing the development of ancillary materials but at present, research is primarily centred on the optical fibre. Further details from Hoya Corporation, General Affairs Dept., 2-7-5, Nakaochiai, Shinjuku-ku, Tokyo 161-8525. Tel.: +81-3-3952-1160; Fax: +81-3-3952-1314 (Source: *JETRO*, June 1998)

Canon's all-in-one home office: the Veg-O-Matic of computing

Canon has launched a fax, copier and printer in one machine. The Canon MultiPASS L6000 is a great space saver that does not compromise on printing, faxing or scanning quality. The L6000 is built around a sturdy, 600-dot-per-inch black-and-white laser printer. It delivers crisp, professional text and graphics at six pages per minute when it is printing from your computer, and high-quality plain-paper faxes when it answers the phone. Designed to occupy as little desk space as possible, the L6000 has a footprint only 15 inches square.

Setting up the L6000 is straight forward, which is not always the case with these complicated machines. The unit comes with a CD that helps you get the scanner in working order. One nice scanner feature is that it comes with software that lets you turn a scanned document into digital text that you can paste into another document or spreadsheet.

As a fax machine, the L6000 works well. Besides handling regular old paper faxing, you can also fax word-processing, spreadsheet, or graphics files directly from your computer screen. Like most fax machines, the L6000 will automatically answer the phone and print incoming faxes. An auto-detect feature can sort out voice calls and pass them through to an answering machine. The L6000 is a fairly slow scanner, but its high resolution up to 600 dpi makes it remarkably accurate. It translated printed documents into computer text with only a few errors, and turned colour

photographs into sharp, grayscale images. (Source: *Fortune*, 27 April 1998)

New smart card

Conventional smartcards within a cellphone normally store up to 200 names and numbers. Using the keypad for this purpose is so cumbersome, however, that few users bother to store more than a limited number.

A smart card due to be launched in the UK shortly may change this. It will permit numbers to be programmed into a cellphone by inserting the cards in a PC's floppy disc drive. The cards are mounted in a shell—resembling a standard 3.5" floppy—which also features a battery-powered chip. Software on the computer can be used to write to the chip as though it were a normal floppy disc.

SmartDisk, which is marketing the new cards, also intends to use the system to communicate with flash memory cards from Toshiba and Samsung used in digital cameras. This will enable pictures to be transferred to a computer for editing. (Source: *New Scientist*, 4 April 1998)

Fantastic plastic

Plastic could soon form the heart of the "wired" home. According to American researchers, data for everything from multichannel digital television to the Internet could be channelled through cheap and easily fitted plastic optical fibres—and all because of an effect that makes the substance useless for precision optics.

Unlike glass, plastic optics such as fibres and lenses contain tiny imperfections that scatter light rays. So most optical fibres used for communications are made of glass. To carry high-speed signals over long distances, optical fibres must have such tiny cores that there is only one path light pulses can take. However, these tiny cores make long-distance fibres hard to connect, so larger-core fibres are used for short links within buildings.

Plastic fibres could be made with larger cores and would be easier to handle, but were thought to be of limited use because of high power losses due to the material's inbuilt imperfections and the limited transmission speeds caused by scattering of the signals within the fibre. But now Anthony Garito working at the University of Pennsylvania in Philadelphia, and a separate group at Bell Labs in Murray Hill, NJ, have both shown that large-core plastic fibres can transmit high-speed signals better than expected.

The transmission speed of a fibre—measured in megabits per second—is limited by the degree to which lights spreads out within it: late-arriving parts of a signal distort the received pulse. Scattering limits speed because another pulse cannot be sent until the last one has stopped bouncing around in the fibre. In glass, the pulses spread in linear fashion with distance.

However, Garito reports that scattering in plastic fibres has a curious effect: it couples the light paths together, so that pulses spread only in proportion to the square root of the fibre's length. The result is that a digital pulse can travel 10 times as far through a plastic fibre before it spreads out as much as it does in an equivalent glass fibre.

This finding suddenly makes plastic fibre attractive for the next generation of home and office cabling, which could carry digital television and Internet signals at up to 1,000 megabits per second. Garito says that large-core plastic fibres are attractive for the "Firewire" standards being developed by the computer and consumer electronics industries for home video editing and transmission.

Many computers can now take a digital video from a Firewire output on a camcorder straight into a computer for editing. A home wired with plastic fibre could carry broadcast quality pictures from a digital camera monitoring a baby, say. Similarly, high-quality neighbourhood watch video signals could be transmitted around a wired neighbourhood. (Source: *New Scientist*, 29 August 1998)

Power boost

Drivers in the next millennium will be able to download sophisticated software designed to improve their car's performance. Two electronics companies have joined forces to make this possible by developing control chips for car engines that will be able to run large, complex computer programs at high speeds.

Until now, the chips that regulate a modern car engine have been slow, and they have not been able to run programs bigger than a few kilobytes. This has limited their capabilities to basic tasks. Motorola, which has half the market for car chips, is planning to combine its copper-based chip interconnection technology with instantly programmable "flash" memory chips from Advanced Micro Devices (AMD). This will allow the two companies to make engine control chips with enough memory to monitor exhaust emissions, for example, at more than 1,000 megahertz, four times the speed of today's Pentium processors.

Using copper for interconnections linking the transistors on a chip cuts their resistance, allowing the chip to work much faster than those with conventional aluminium connections. Copper also prevents overheating, which can be a problem with aluminium connections.

This technology will be combined with AMD's expertise with flash memory, a type of chip that can hold data even when its power supply is switched off. AMD expects it will soon be able to squeeze between 15 to 20 million transistors on one chip. This will allow a single chip to store large programs of several megabytes.

The added chip power may lead to engine management software that could easily be updated to meet the latest environmental legislation. Tighter controls on peak emission of hydrocarbons, for example, could be met by using the software to tweak the engine's tuning. (Source: *New Scientist*, 29 August 1998)

Ceravision adopts FED technology from RAL

Ceravision, a small company located at the Rutherford Appleton Laboratory (RAL, Oxon, UK), is to use a novel field emission display (FED) technology to produce large, cost-effective displays. A proprietary ceramic material will be used as the substrate of each display module. Within the next 18 months, ceravision expects to produce 40-inch diagonal displays with a thickness of the order of 2 mm at a target price of $2,800 (about two thirds of the cost of current flat screen displays).

The use of a ceramic material instead of a conventional glass substrate brings important advantages. Unlike glass, the ceramic material can be drilled to form via holes for making interconnects in multilayer electronic circuitry, whereas conventional displays must have all their connections along the edges of the glass plate, making the display design difficult. In addition, square panels of this ceramic can be butted together to produce large seamless displays, whereas the joining of glass panels always results in irregular visible seams at their junctions. Ceramic plates are far easier to handle than fragile glass plates during manufacture, thus reducing costs.

Ceravision intends to produce its screens by joining together 4-inch ceramic tiles that resemble bathroom tiles. For example, three ceramic panels can be joined to form an automobile dashboard display, four panels to form a laptop

computer screen and 12 panels to form a display to replace the cathode ray tube of a desktop computer. The tiles can be processed on standard 150-mm silicon wafer lines. After the panels have been joined, they are sealed in an evacuated enclosure. Ceravision also plans very large displays.

The main focus of the current work at Ceravision is the development of a manufacturing technology that will complement the FED technology perfected by CMF. (Extracted with permission from *Semiconductor International Magazine*, July 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Toshiba develops environmentally friendly transistor package

Toshiba (Tokyo, Japan) has announced the development of an easily recyclable transistor package. The package is made from polyphenylene sulphide (PPS), a thermoplastic optimized for precision moulding and high-temperature operation. It does not require the use of a bromine flame retardant.

Most packages are made of epoxy, a thermoset compound that melts only at high temperatures. Reuse or recycling of waste epoxy from the moulding process is impractical, and incineration of used epoxy is also difficult because of the chemical treatment it receives to retard burning at high temperatures. Most used epoxy packaging ends up as landfill.

Thermoplastics melt and can be moulded easily, but they are also highly viscous. They can deform and break bond wires, and they have poor adhesion. Toshiba, along with Idemitsu Materials (Tokyo, Japan), chose PPS for its high heat resistance and low flammability, and engineered it for packaging applications. It has a lower viscosity for damage-free moulding, it is said to be unaffected by the heat from soldering operations and to be viable in high humidity conditions. The company claims that use of the material causes no increase in production costs, and that use of recycled packages does not affect device reliability.

The company plans to use the package with power transistors initially, with samples available in October. Mass production is slated for January 1999. (Reprinted with permission from *Semiconductor International Magazine*, July 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

FLCs introduced for miniature displays

Displaytech (Longmont, CO) recently introduced its ferroelectric liquid crystal (FLC) technology for projection displays. Most flat panel displays are made by fabricating thin film transistors (TFTs) on a piece of glass that is the size of the display. The FLC displays are made by sandwiching a layer of ferroelectric material between a regular CMOS chip and a piece of cover glass.

One advantage of this design is that an actual silicon device is used to drive the display, rather than polysilicon circuitry that is deposited onto the display. The backplane can be made using well-understood 0.8 μm CMOS technology. In addition to making it more reliable, it also uses standard CMOS voltages. Driving it is just like driving a write-only memory with 0 V and 5 V. The cover glass is coated with a transparent electrode that is held at 2.5 V. The field applied to the FLC layer is ±2.5 V/μm.

The display works as a switchable quarter-wave plate. The FLC material reflects polarized light in one of two optical states. In one state, the material reflects the incoming light with no change in the polarization. In the other state, the light is reflected with a 90° rotation in its polarization.

External polarizing optics are used to change the reflected light into light or dark pixels.

The display is illuminated using light-emitting diodes (LEDs) of three different colours, rather than a white light source. The LEDs are lit in succession, and are synchronized to the display drivers. The image is actually a succession of red, green and blue images that time average into a full image. The switching speed of the FLC material makes this possible.

Since each LED is on only when needed, no colour filters are required, and power efficiency is minimized. The whitepoint of the display can be adjusted over a wide range by adjusting the relative brightnesses of the LEDs. Greyscale images are accomplished using pulse width modulation; pixels are held in the on-state for a fraction of the cycle that corresponds to the greyscale value.

Every pixel in the display produces all the primary colours. The subpixels, or colour triads, required in typical LCD displays are not needed. This can produce a sharper image, because the colours are not separated within a pixel.

The small size of the display is also considered an advantage from a yield and cost perspective. A smaller die leads to a smaller probability of having a killer defect as well as more die per wafer.

The FLC display can be used in magnified displays, such as cellular phones, games, personal TVs or headmounted displays. They can also be used for projection displays, such as projectors and large screen TVs. Its use in an application is determined by lighting and optics, rather than by the display element itself. VGA format FLC displays are now available. XGA and SXGA displays will be available later in 1998. (Reprinted with permission from *Semiconductor International Magazine*, July 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Decreasing the release of PFCs

SEMATECH (Austin, TX) and Praxair (Danbury, CT) are attacking the PFC environmental issues on all fronts—employing recovery, recycling and reuse. Work at Texas Instruments in Dallas, TX, indicates that dramatic reductions in PFC emissions may be possible.

As of February 1998, 22 semiconductor manufacturers had signed a voluntary agreement with the US Evironmental Protection Agency to reduce the total amount of global warming compounds emitted into the atmosphere. The goal of the Memorandum of Understanding is to emit less than 1995 levels by the year 2000—a substantial undertaking as emissions tend to increase by 25 per cent annually. A recent meeting in Kyoto, Japan, led to an agreement by the United States to reduce overall greenhouse gas emissions by the year 2012 to at least 7 per cent below 1990 levels of 0.2 million metric tons of carbon equivalent.

Economic data indicate that abatement may prove best for small PFC users (<7,500 lb/yr (3,500 kg/yr) PFCs purchased), addresses the needs of medium-sized users (7,500-15,000 lb/yr (3,500-7,000 kg/yr)) and recycling is the best solution for large semiconductor fabs purchasing >15,000 pounds of PFCs per year.

Abatement techniques include catalytic, combustion, microwave and plasma technologies. Concerns associated with point-of-use abatement techniques include costs to purchase and maintain the equipment, costs to treat the additional fluoride waste generated by the systems, significant water requirement and needs to additionally treat byproducts such as CO_2, CH_4, HF and NO_x. For these

reasons, POU abatement may only prove economically feasible for small-scale users.

To allow high capture efficiencies and maximum concentration of greenhouse gases, PFC exhaust must be pretreated to remove particles and water-soluble components. Capture techniques include carbon adsorption, cryogenic absorption, membrane technologies and pressure swing adsorption. Under optimized conditions, membrane technology has enabled 95 per cent recovery and 95 per cent nitrogen rejection ratio for CF_4 and C_2F_6. Unfortunately, other chemicals typically present in the exhaust stream, such as CHF_3 and NF_3, are not recovered at the same efficiencies because of the nature of the molecules. In addition, the concentration of the product mix, particularly if it is high in nitrogen content, will increase disposal costs.

The most promising solution for reducing PFC emissions in large fabs in gas recycling. Mike Mocella of DuPont has reported the feasibility of recycling C_2F_6 at a cost commensurate with the composition of the captured PFC mixture provided.

SEMATECH is currently evaluating a state-of-the-art cryogenic capture and recycling facility. Its performance relies on the effectiveness of the pretreatment system to remove contaminants using, in this case, co-current and countercurrent water scrubbers with caustic injection to remove COF_2 (carbonyl fluoride), SiF_4 (silicon tetrafluoride), TEOS and corrosive materials. Molecular sieve absorber columns are used to remove CO_2 and H_2O. The PFCs are then continuously absorbed in a wash fluid while the diluent gases (primarily nitrogen) are vented. The wash liquid is transferred to a stripping column that separates the cryogenic wash fluid from the PFCs. The PFC mixture is stored in a tank until it reaches sufficient quantity to separate the gases using a distillation column. Purification techniques are designed to yield gases of starting material quality, which will be tested, bottled in cylinders and reused.

Following the evaluation of the cryogenic systems' ability to pretreat the PFC waste will be SEMATECH's evaluation of capture and recovery efficiencies. The advanced system is expected to have >99 per cent capture efficiency and >99 per cent concentration efficiency, which will qualify it for proposed tax incentives in the US for recycling systems.

The elimination of PFC use altogether depends on the use of alternative chemistries for etching oxide and nitride films from wafers and process chambers. (Reprinted with permission from *Semiconductor International Magazine*, July 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Light emitting polymer displays

Light emitting polymers (LEPs) were first discovered in 1989, following work at the Cavendish Laboratory, Cambridge University. Potentially, these could form the basis for a new generation of display devices which overcome the limitations encountered when using LCDs and gas plasma displays. Cambridge Display Technology (CDT) was formed in 1992 to exploit this potential, and has since licensed the technology to Philips, Seiko-Epson and Uniax, among others.

LEPs are applied to a single sheet of glass or plastic backing. The backing sheet need not be flat, and Philips predicts LEPs could also be used for room lighting.

CDT and Seiko-Epson unveiled the first prototype LEP television screen in February this year. This monochrome device, with a 500 mm diagonal, was a mere 2 mm thick. Unlike LCD screens, there were no restrictions on the viewing angle and no blurring when displaying rapid motion. The two companies plan to have a full-sized, 16 million colour display available by October this year. (Source: *Personal Computer World*, July 1998)

Price and convenience make DVD-equipped PCs an attractive option

It was a year ago that the first DVD-ROM drives hit the shelves, soon after the debut of DVD-Video drives. The latter are set-top boxes to play movies that provide better-quality video than new cassettes played back or VCRs or even laser discs. The few DVD-ROM titles that are available have clearly shown the advantage over CD-ROM drives for a simple reason. A single DVD-ROM disc can accommodate the equivalent of seven CD-ROM discs, and can provide about the same response time as the best CD-ROM drives. DVD-ROM drives are ideal for multivolume databases like MEDLINE, BIOSIS, or subsets of UMI's page-image databases. They are also perfect for suites of databases, like the Microsoft Encarta 98 Reference Suite.

The first DVD-ROM upgrade kits immediately caused problems for the few who bought them a year ago in May. There are two problems. One was that the drives of these first-generation kits did not play back CD-ROM discs. It discouraged not only potential buyers but also the dealers, who do not shy away from adding some hype to a new product.

The breakthrough to really sell DVD-ROM technology seems to have finally arrived, however, with the launch of new PCs equipped with a built-in second-generation DVD-ROM drive in the Pentium II (or equivalent) models. In April came the avalanche of integrated, leading-edge products from big name players, like Compaq, Dell, Gateway, and Micron, which sell both to home users and to businesses. Each of them has at least two or three Pentium II PC configurations with built-in DVD-ROM drive and MPEG-2/Dolby decoder card as the base unit. Some offer the DVD-ROM drive as an option for other models. (Source: *Information Today*, 15 (6) June 1998)

Digital imaging

Digital imaging technology has already replaced the human eye in a wide variety of industrial image processing tasks. As the technology continues to evolve, this process will continue and move into new areas.

Sira Electro-optics Division is currently developing a module that can emulate the eye of a fighter pilot in a piece of equipment it is building for the Defence Evaluation Research Agency (DERA). Sira's "artificial eye" is being designed to go one better than even the best trained pilot. It will not only see what the pilot is seeing through their helmet-mounted display, it will also provide an objective evaluation of the quality of the image the pilot is viewing.

Helmet-mounted displays are increasingly being used by pilots of military aircraft. They present before the eyes of the pilot conventional instrument data which traditionally would have been displayed on a control panel or "head-up" display; and they can also display external images, such as those produced by infra-red thermal imagers and image intensifiers.

DERA has a requirement to determine objectively and consistently the performance of these displays before procurement and during active service life. Currently the performance specifications of individual head-up displays vary enormously. Without objective data it is impossible to know precisely what the pilot will see or was seeing.

Sira's problem was to create a piece of equipment that could not only simulate the pilot's view but could also measure the effect of the pilot moving his eyes as well as any misalignment between the pilot's eyes and the helmet-mounted display. The contract research and development company's solution was to design a compact image analyser that could not only be operated inside a helmet but could also be moved around to simulate all the pilot's possible fields of view.

This meant creating an artificial electronic version of a real eye. Sira's image analyser module has an entrance pupil which can be positioned where the pilot's pupil would normally be and a CCD camera instead of a retina. The module's optical system forms a real image from the virtual image of the test pattern generated by the test piece in the focal plane of the camera.

An optical and mechanical arrangement allows the device to view an image at any specified position in the image field of the test piece. The image analysis module is just one of several that make up the complete test facility which has been designed to test both complete helmet-mounted systems and individual components. Its modular format allows the facility to be used in a number of different configurations for carrying out tests of various complexities from measuring astigmatism in lenses to evaluating image intensifiers and video display units. (Source: *Engineering*, April 1998)

Epson puts ARM into European GSM phone

Seiko-Epson is to develop GSM cellular phones for the European market based on a low-voltage ARM processor.

The Japanese semiconductor firm is the latest licensee of Advanced Risc Machines' ARM7TDMI processor.

Epson will use a normal semiconductor process initially, but will shift to its proprietary low voltage "Energy Saving" process.

Its 0.9V process, developed for wristwatch ICs, dramatically cuts power consumption. Used in mobile phones it will extend standby and talk times by up to four times compared with today's leading handsets.

The ARM7 in the low voltage process will be used by Epson in other products. These could include digital cameras and other multimedia products.

Seiko's latest product, the Ruputer computer-in-a-watch, went on sale in Japan in June.

The ARM7TDMI features the Thumb instruction set which packs 32-bit instructions into 16-bit memory, thereby reducing the flash memory required. The 16-bit code is decompressed during program execution with no time penalty. (Source: *Electronics Weekly*, 17 June 1998 (http://www.electronicsweekly.co.uk/))

Zinc-air battery triples operating time

US firm Electric Fuel has announced zinc-air disposable batteries for mobile phones which it claims will triple or quadruple operating times over currently available rechargeable batteries.

The company is making the batteries as clip-in replacements for standard rechargeable packs.

Electric Fuel says that the batteries contain 17 Wh of energy and weigh 20 and 40 per cent less than competing rechargeables at 70 g. Other performance parameters include a gravimetric energy density of 210 Wh/kg and volumetric energy of 210 Wh/l.

Materials are said to be similar to those used in common alkaline batteries but with no lithium or cadmium. (Source: *Electronics Weekly*, 17 June 1998 (http://www.electronicsweekly.co.uk/))

Sensor technology

Researchers at the Institute of Chemical and Biological Sensing at Münster University have developed a new sensor that can detect whether a road is dry, offering good road-holding characteristics, wet, or covered in ice. The sensor is mounted on the bumper or in the headlight and beams infrared light onto the road. The light reflected back from the road surface is directed through glass-fibre conductors to silicon detectors that measure the light's intensity roughly 100 times a second. Because infrared light is absorbed by water molecules, the intensity of the reflected light depends on the state of the road. If it is weak, because ice crystals are absorbing the infrared light, the detector emits a warning. It also warns of aquaplaning in the same way. However, because the sensor can only look one metre ahead, any warning would be too late for the driver. As a result, the anti-skid detector immediately adjusts the vehicle's antilock braking system (ABS) to suit road conditions and prevent sudden braking. (Source: *Deutschland*, No. 3, June 1998)

Telecommunications

CeBIT '98, the world's largest computer and information technology fair, broke all previous attendance records. A total of 670,000 visitors came to Hanover to try out new software and hardware, to find out about electronic commerce or network computing, and to see innovative products from the information and telecommunications technology sectors. Siemens world-premiered a "fingertip mobile phone". To activate the telephone, you simply have to put your finger into a special cavity that conceals a microchip with 65,000 sensor elements. This detector scans the unique details of the user's fingertip and transmits the image to a remote computer as a digital file. The computer then compares the data received with a stored fingerprint image. This process makes PIN numbers superfluous. The mobile phone is still only a prototype, but because the sensors could be produced at low cost, Siemens believes this technology sill soon be making a breakthrough—not only in mobile phones, but also in cash dispensers and credit card readers. (Source: *Deutschland*, No. 3, June 1998)

Electronic nose for faster infection detection

Infection detecting applications for smell sensor technology from the UK's Aromascan could lead to a tie-up with medical companies.

Manchester's Withington Hospital has been using Aromascan's technology since before it was formed as a separate company. Through the collaboration, it has been discovered that volatile chemicals given off by bacteria can be detected and used to diagnose infection.

Infection in burns, and the bacteria that cause skin ulcers in the elderly have also been detected, as well as an infection that some now think may be a cause of late-term miscarriages in pregnancy.

A hospital at the University of Pennsylvania also has an Aromascan machine and is using it to detect pneumonia by sensing the breath of intensive care patients.

Work is being carried out using the company's laboratory-based machines, but eventually a hand-held unit may be taken to the patient. (Source: *Electronics World*, January 1998)

Laser revives an ancient lighthouse keeper

A statute that may have guarded the ancient lighthouse called Pharos of Alexandria will be reconstructed with the help of a sophisticated imaging system. Until it was finally destroyed in 1480, the lighthouse was considered one of the Seven Wonders of the World.

Last year, Jean-Yves Empereur of the Centre for Alexandrian Studies brought up pieces of the statue from the harbour at Alexandria. To try to reassemble them, researchers used an imaging system developed by French power company Electricité de France. The device scans an object using laser light, which is reflected back to a camera. This recorded 700,000 points on the pieces of the statue. The data were manipulated by computer to find the best fit for the blocks, so restorers can get it right the first time. The 7-metre statue is due to go on display in Paris. (Source: *New Scientist*, 28 March 1998)

Longer life smartcard

De La Rue Card Systems has produced what it claims to be the world's most secure and robust smartcard. It will be used in identity and driving licence schemes worldwide.

Called Fortas, the card will glow brightly when exposed to UV light if any attempt has been made to tamper with the photograph or text. Other security features include a 2-mm wide banknote style thread which incorporates a holographic image.

The card material contains an IC which allows several different identification schemes, such as national identification and driving licence, to be combined securely on a single card. (Source: *Electronics Weekly*, 6 May 1998)

Notepad digitally records written text as Cross links up with IBM

A notepad that digitally records handwritten text has been unveiled by US pen manufacturer Cross. The pad is being aimed at business users who do not want to use a laptop, particularly during meetings.

Cross has teamed up with IBM to produce the Cross-Pad device. It uses a special adapted pen which writes on any A4-sized pad with up to 50 sheets. This is the maximum thickness the RF portion of the pen can transmit through. The sensors underneath then use the data to record the pen's contact with the pad.

An internal 1Mbit flash memory stores up to 50 pages of single-spaced text or 100 pages of loose notes and sketches. These are downloaded to a PC via a standard serial port.

Software, developed by IBM at its T. J. Watson research lab, allows blocks of text to be recognized.

The text and images can be cut and pasted into any word processor package. Battery life of the CrossPad is said to be measured in months.

The company plans to make the CrossPad available outside of North America in autumn. The US list price is $399. (Source: *Electronics Weekly*, 29 April 1998)

Could your pot plants catch burglars?

If you want to protect your house against burglars, you do not need a guard dog—just a few house plants. Like many other common objects, plants can be turned into sensors for burglar alarms simply by connecting them to an electrical circuit, says Hal Philipp, a former IBM researcher based in Southampton.

House plants can act as a capacitor—accumulating an electrical charge and then discharging it.

The burglar alarm works by monitoring the capacitance of the plant. If a burglar walks past the plant, its capacitance changes and the alarm goes off.

The capacitance sensor is normally charged and discharged many times to establish an average reference level. This allows engineers to tune the alarm to ignore harmless changes in capacitance—such as those caused by

changes in humidity—and react only to the distinctive changes in capacitance that are caused by intruders creeping past the plant.

Philipp has developed the electronics needed for the alarm to ignore background noise, but still respond to small changes in capacitance. He has formed a company, Quantum Research, to produce a commercial version of the alarm.

Although several house plants can be wired up to trigger a central alarm, Philipp has also developed a single-chip version of the sensor, which enables each plant to have its own, independent alarm.

Most objects can hold a charge, and Philipp says almost anything can be a sensor. He expects his technique to be particularly useful for protecting works of arts in museums, where visitors are inclined to ignore the "do not touch" notices. Anyone touching a valuable statue or painting would immediately trigger an alarm. (Source: *New Scientist*, 25 April 1998)

New technology to make telecom networks more efficient

Telephone networks today are centrally controlled. Vast programs oversee everything from how calls are routed through networks to who should be billed. This all worked well when networks were small and traffic light. But in recent years traffic has grown so dramatically that some networks are starting to creak under the strain. What telecom designers need is a way to make networks self-sufficient, so they no longer need an all-seeing controller.

A number of these designers now believe the solution lies in artificial ants, tiny programs that roam around networks behaving much like their living counterparts. Two researchers at BT's laboratories at Martlesham in Suffolk have devised a system based on software ants that reroute calls away from heavily congested nodes: the computers that switch calls from one branch of a network to another. The ants have a degree of control over these computers and can, for example, instruct nodes to send them to other nodes on the network.

To begin with, a large program rather like a queen ant wanders randomly from node to node, measuring the traffic at each point. When it comes across heavy congestion, it moves to the node that is generating most of the traffic, called the source node, and spawns a smaller program, a worker ant. Each node has a routing table that lists which of its neighbouring nodes a call should be sent to next in order for it to reach its destination. It also keeps a record of how much spare capacity exists on the links to its neighbours. (Source: *New Scientist*, 24 January 1998)

Cidco's iPhone

Cidco's iPhone is a piece of technology for people who want to send and receive e-mail or browse the Web without giving up a big chunk of their desktop-or bank account for a full-fledged PC. On the outside, iPhone looks just like a conventional telephone. But if you push on a door at the bottom, out slides a tiny keyboard. When you touch the darkened front panel, a touch-sensitive 7.4-inch screen lights up with icons for retrieving e-mail and accessing the World Wide Web.

Touch the e-mail icon, and iPhone downloads your mail from a server at Cidco. A few seconds later, a list of messages appears on the screen. The clear screen, four scrolling keys, and intuitive touch menu make reading easy. Surfing the Web is surprisingly pleasurable, given that you are working with a device about a sixth the size of a PC and monitor. The backlit monochrome display approximates a

standard 640-by-480-pixel computer screen. Web content gets downloaded surprisingly fast, thanks to proprietary compression software. The iPhone also supports Caller ID and keeps a rolling log of calls received.

The iPhone's browser will not run the Java applets that let Web providers run animations, and it also has problems displaying some pages that use frames to divide their content. However, it does integrate voice and computing nicely in a single device. (Source: *Fortune*, 12 January 1998)

Internet teacher helps deaf children

Deaf children in the US will soon be able to learn written English with the help of an Internet program that translates text into American Sign Language (ASL). When users key in text, a three-dimensional computer-generated figure called Mona articulates the words in sign language.

For children brought up to communicate in ASL, English is a foreign language. Mona can help them to learn to read and write by confirming the meaning of the words they have typed.

Mona performs arm and hand movements at a rate of three signs per second and can also perform lifelike facial gestures to indicate a question.

Helena Charlton of Britain's Royal National Institute for Deaf People says Mona could be "interesting". But it would only be useful to children in Britain if it was taught British Sign Language, which is quite different from ASL.

RNID has itself just launched a pilot project to give deaf people access to sign language interpreters via videophones in places such as doctors' surgeries. The aim is to help people in situations where they would otherwise need a sign-language interpreter just for a brief chat. (Source: *New Scientist*, 25 July 1998)

All channels open

Digital terrestrial TV has had an Achilles heel: ordinary video recorders cannot tape one programme while you are watching another. But a group of electronics companies claims to have solved the problem with a VCR that can record several digital channels at once on the same VHS tape.

Digital TV will rely on a set-top box to decode the channels fed from a rooftop aerial, and sends only the one you have chosen to the TV set. An ordinary VCR will only record that channel.

But in the digital terrestrial TV scheme proposed for Europe, the channels are broadcast in bundles called multiplexes, which can contain five or six channels jumbled up in a single data stream running at 24 megabits per second.

This opens up the possibility of tapping the signal before it reaches the set-top decoder and recording the data for a whole multiplex—whether or not the set-top decoder is sending any channels from this multiplex for you to watch on your TV. The breakthrough came with the announcement of a digital VCR that is capable of recording data fast enough to do this.

The Japanese Victor Company (JVC) has worked with Hitachi, Panasonic and the Dutch company Philips to upgrade the standard for an emerging video recorder format called Data-VHS (D-VHS). The new video recorders will now be able to record broadcast bit streams at a maximum speed of 28-2 megabits per second, which is double the data rate that was originally planned by the group of companies.

The new video recorder will be able to record either one high-definition television programme, of the type planned for the US, or several standard-resolution programmes running simultaneously. A whole weekend's worth of TV could also be taped.

To watch the programmes, the recorded data stream will have to be played back through the set-top decoder, as if the signal was being received over the air from a live broadcast. (Source: *New Scientist*, 25 July 1998)

Roke Manor develops clever mine detector

Roke Manor Research has developed a prototype motion-powered mine detector, designed to be operated with minimal training.

Its A4-sized printed circuit detector head has a full-sized single-turn field coil and a figure-of-eight detector coil. While the demonstrator is configured to measure permeability of the ground—to detect mines with some metal—a similar system is under development to discriminate between plastic mines and other non-metallic objects. Roke is looking to develop the product commercially.

The research centre, in collaboration with Hitachi and DSP specialist Ensigma, has also unveiled two Digital Audio Broadcasting (DAB) modules. Its Gold Pack single-board evaluation DAB receiver is suitable for receiver development.

The second DAB receiver is a credit card-sized module aimed at hi-fi tuners and PC applications. (Source: *Electronics Weekly*, 15 July 1998)

Smuggling chips

A briefcase full of microchips can be worth more than one packed with gold, and is much easier to carry. Lucent Technologies of New Jersey believes it can stop the chip smugglers and prevent chips from being filched. Every high-value chip will have a small non-volatile flash memory built in. Before the chip leaves the factory, this memory will be programmed with a password. If the chips are stolen, the thief will not have the password, which will only be issued to legitimate owners. (Source: *New Scientist*, 17 January 1998)

Make do and mend

Two researchers in Tennessee have shown again that one person's trash is another's treasure. They have built a serviceable supercomputer by lashing together a few dozen PCs containing the Intel 486 processor.

In 1996, computer scientist Forrest Hoffman and landscape ecologist Will Hargrove of Oak Ridge National Laboratory's environmental science department asked the lab's managers for funding to buy 16 state-of-the-art Pentium PCs to build a "Beowulf" supercomputer. A Beowulf consists of multiple PCs linked together, and it attacks difficult calculations by dividing them up and delegating these more manageable tasks to the smaller processors.

Their request was denied. At the lab's swap shop and by pestering colleagues, the researchers scavenged the necessary networking equipment and a motley collection of 486 PCs, which are now regarded as obsolete.

In a vacant lab, and during their spare time, they assembled the Stone Souper computer. The name comes from the Stone Soup fable, in which a hungry soldier claims he will make soup from a stone, then convinces people to donate enough "extra" ingredients to make a real soup.

Eight months later, the Stone Souper has grown into a sprawling collection of 56 linked computers, and can perform 1-5 billion floating-point operations per second. That is not enough for truly mammoth computational tasks, such as modelling the flow of electromagnetic radiation in space, but it is more than adequate for Hargrove's project: showing how conditions for plant growth vary across the US on maps with a resolution of one square kilometre.

When the researchers have expanded the Stone Souper to their goal of 64 PCs, the machine will be able to incorporate 10 variables influencing plant growth, including temperature, rainfall and soil chemistry.

Since its components were essentially free, Stone Souper may set a new record for another popular computer benchmark: the ratio of performance to price. (Source: *New Scientist*, 17 January 1998)

Artificial sensors

The human tongue can distinguish between a dazzling array of subtle flavours using a combination of just four elements of taste: sweet, sour, salty and bitter. Each element is detected by one of the four types of taste buds located on the tongue. Now researchers at the University of Texas in Austin have designed an electronic tongue that works along the same lines.

Using chemical sensors, they have demonstrated that the electronic tongue can "taste" different solutions. The team attached four well-known chemical sensors to minute beads made of polyethylene glycol and polystyrene. The beads were placed in micro-machined wells on a silicon wafer.

The sensors respond to chemical stimuli by changing colour, so the wafer was placed between a light source and an image sensor. The responses were monitored as red, green and blue light channels from each well. The first device they built was designed to detect calcium and cerium ions, acidity and the simple sugars. Each sensor responded differently to the various conditions and purple under basic conditions and responded to different combinations of the four artificial taste elements with unique combinations of red, green and blue, enabling the device to analyse several different chemical components simultaneously.

The researchers plan to replace the numerous tests carried out on a blood sample with a single test. (Source: *New Scientist*, 18 July 1998)

Beacons guide blind around town

Elderly, visually impaired and blind people may soon benefit from an electronic system being developed at Edinburgh's Napier University. The auditory location finder (ALF) uses beacons placed around towns to transmit information to a user's earpiece. Information ranges from street names and proximity to road crossings, to the nearest bus stop or post office.

Distress calls to family, wardens or the emergency services can also be made using the ALF.

A research council grant will fund the project over the next two years. The university's Transport Research Institute is running the project in collaboration with the Royal National Institute for the Blind. (Source: *Electronics Weekly*, 3 June 1998)

It's a goal!

Live broadcasts of football matches over the Internet are now possible, thanks to a technique that uses radar to keep track of the players, but the matches will not look like conventional television. Each will be a three-dimensional computer animation, with every player represented by a computerized figure in team colours who will run about the pitch exactly as the real player does. The player's gestures, expression and posture will not be represented. The European Football Championships, to be held in Belgium and Holland in 2000, could be the first to use the Israeli-developed system by Orad Hi Tec Systems.

The system, called Sportrack, uses a transponder about half the size of a credit card sewn into the shirt of every player and official. There will also be one inside the ball. The

transponder receives microwave radiation from a transmitter a few dozen metres from the pitch and transmits it to two receivers, allowing a computer to calculate the transponder's position. Since each player's tag is unique and shifts the frequency of the microwaves by a particular amount, the computer knows where everyone is on the field at all times. The system creates a 3D model of the players for transmission over the Internet.

Sportrack also lends itself to creating action replays from different camera angles. Currently, its commentators can only rotate camera angles within a 3D still frame. Alternatively, a short animation can be laboriously produced some time after the event. But online spectators will eventually be able to choose the referee's view of a controversial decision, or the views that different players had. Orad expects to market the system in mid-1999. The 3D mimicry of the action requires less bandwidth than transmitting TV pictures, making it more suitable for webcasting. But how rights to Net sports broadcasts will be separated from TV rights is unknown and soccer's ruling body may need some convincing over the use of the transponder in the ball.

The exposure of players and officials to microwave emissions for 90 minutes will also be a concern. Orad believes the system is safe, saying that the transmitter's 10-milliwatt power output is tiny compared with the 700 milliwatts of cell-phones.

The safety of football grounds is overseen by local authorities. But they take advice on electromagnetic radiation from the National Radiological Protection Board. (Source: *New Scientist*, 28 February 1998)

Looking to the future

Architect, a laser 3D imaging and modelling system now commercially available, eschews old photogrammetry methods of modelling and surveying to produce geometrically accurate computer images and models of plant or structures. The system, developed by the vision systems group of UK Robotics in Manchester, has been initially tailored for the nuclear and chemical industries, whose installations are characterized by complex piping and vessels. In fact, the first system is now in service with BNFL, a participant in the associated R&D effort.

The system consists of a mobile laser scanner connected to a PC or Unix-based workstation containing a powerful graphics package. Over recent years, laser sensors have developed into small, fast and rugged devices, which have a high resolution and are able to function in a wide range of environments. Computing performance, which was previously a major limitation when analysing range images, has been increasing almost exponentially, making the practicality of producing CAD models increasingly attractive.

The mobile laser scanner offers a wide field of view and can capture high resolution images rapidly. These images can then undergo interpretation before being merged together, combined with known CAD parts and downloaded into a CAD package. The available ambient lighting has little effect on the system. The system is also compatible with several different laser heads, which will allow the system to take advantage of developments in laser technology.

Another innovation is the inclusion of a CAD "kernel" to help make the system compatible with the multiplicity of CAD systems available on the market today. By integrating the ACIS kernel into the product, Architect has been made compatible with 60 or 70 different CAD systems at one stroke. Translators are available off-the-shelf for other common CAD systems, so that compatibility rises to 80 to

90 per cent of current CAD systems. This not only allows the system to verify new plant and buildings, but also to build a model from a piece of physical plant for which no documentation exists.

Producing a comprehensive model of a cluttered piece of plant inevitably requires scanning to be carried out from several different viewpoints. The chosen method has been to mount the camera on a precision pan-tilt mechanism to produce several overlapping images at differing orientations. The approach is interactive, giving the operator a 3D workspace in which they can "fly" around. In this way, it is easy to see which areas have not been adequately scanned.

The strategy for choosing new viewpoints is currently under control of the operator. However, in a bid to increase the automation of Architect, a machine-based strategy is being investigated. (Source: *Engineering*, January 1998)

Toshiba's notebook has MMX

Toshiba's sub-notebook PC, the Libretto, has been upgraded to run a 166 MHz Pentium with MMX technology.

With the dimensions of a paperback book, the Libretto 100CT resembles a Tardis in its level of integration. Included are an 800 x 480 pixel 7.1 inch active matrix LCD with 16 million colours, 2 Gbyte hard drive, 32 Mbyte memory and two PC Card slots.

Unlike other handheld PCs, the Libretto runs Windows 95 and full Windows applications rather than the cut-down CE version. Battery life is claimed to be three hours. (Source: *Electronics Weekly*, 18 February 1998)

Vision system tracks car thieves

An artificial intelligence system that can identify the suspicious movements of car thieves is undergoing a six-month trial in the UK.

The integrated traffic and pedestrian model-based vision system combines a vehicle tracking system from Reading University with one that tracks humans from Leeds University.

The system, comprising a Unix workstation and a domestic video camera, works by building a model from observing people's behaviour in a car park over several hours.

The speed of approach and the distance of a person from a car is measured and added to others to build up a probability distribution model. This is then compared with the behaviour of an individual entering the car park and assessed to see if it matches. (Source: *Electronics Weekly*, 15 April 1998)

Wristwatch is also a PC

Japanese watchmaker Seiko Instruments has developed a wristwatch that doubles as a PC.

Called the Ruputer, two models will be launched in Japan first. The watch features a tiny LCD display of 62 pixels by 102, an infra-red port and 512 kbyte of ROM and up to 2 Mbyte of memory.

Seiko says that the Ruputer will have a 16-bit microprocessor and run Microsoft's Windows 95 operating system. Users will be able to swap information with other Ruputers, and transfer files using the infra-red port. The two models will be available for $285 and $360. (Source: *Electronics Weekly*, 15 April 1998)

Low-cost solar-powered lighting system

A low-cost solar-powered lighting system designed to operate independently of cable-supplied electricity could find use in remote landing strips or for street lighting in developing nations. Built by Sunset Lighting, South Wales,

UK, the lamps use monocrystalline silicon solar cells wrapped in tough, laminated acrylic fibres and housed in a glass-reinforced plastic enclosure. Energy from the solar cells go to a sealed battery. Gases generated by the battery are converted into water to maintain battery electrolyte level and eliminate periodic maintenance. Other features include a solid-state inverter that converts battery output into 240 Vac to light a sodium-zenon lamp and a battery management control module that prevents overcharging. (Source: *Machine Design*, 16 April 1998)

Tiny turbine to power laptops

Sometime around 2000, say inventors at the Massachusetts Institute of Technology's gas-turbine lab, engines the size of shirt buttons could begin to replace 10-to 20-watt batteries in handheld computers, cell phones, and camcorders. Lab director Alan H. Epstein predicts that an engine-driven power pack could be made about 25 per cent smaller than today's lithium batteries, and could run twice as long between rechargings.

The MIT invention resembles a jet engine, with a 2-mm-long combustion chamber, a 4-mm turbine wheel, and a tiny generator. The engine runs on butane and tanks come in different sizes. One the size of a laptop battery pack could deliver 20 hours of computer use.

So far, only the combustion chamber and the wheel have been tested. Over the next five years, Epstein believes, output of these tiny engines will soar to 100 watts. (Source: *Business Week*, 13 July 1998)

Welsh plant uses 1,540 photo cells

Solar cells on the roof of Ford Motor Co.'s Bridgend Engine Plant in South Wales provide power equivalent to what the facility's lighting system uses. The installation, funded jointly by Ford, the European Union, and the U K's Department of Trade & Industry, is capable of providing a peak output of approximately 100 kw. Each solar unit measures 9 metres by 4.5 metres. Only 8 per cent of the roof is covered by the cells. Ford estimates that the installation is expected to save the discharge of a potential 4,000 tons of CO_2 from conventional power stations over the 30-year lifespan of the plant. (Source: *Industry Week*, 18 May 1998)

A caddy that never gets tired

Golfers can now look forward to a new buddy on the links: a robotic golf caddy. Using a digital map of the course and satellite signals, the autonomous robot, developed and patented by GolfPro International in Santa Clara, CA, navigates fairways, following the golfer around the course, carrying clubs, responding to voice commands, and avoiding hazards. The robot also calculates the distance to the hole and follows golf etiquette. (Source: *Communications of the ACM*, vol. 41, No. 5, May 1998)

First virtual reality training simulator for high-performance forestry machinery

NEC Corporation (NEC), on commission from Japan's Forestry Agency and The Forestry Mechanization Society, has developed a high performance virtual reality-based simulator for training operators of tree-felling and logging equipment.

The simulator, which reflects the performance of the equipment in actual forest conditions, is the first of its kind in the world. It will be installed at The Forestry Agency's technical training center in March, with operators being trained on the simulator from May.

Centred around several computers and peripheral devices, the system uses a physics model to reflect the

structural elements of trees and the equipment used, conducting power calculations and processing in real-time. Using two three-dimensional projectors and a large-sized screen (2.4 metres wide, 3.6 metres tall), the simulator enables:

- The free selection, through the use of virtual reality technology, of the training environment
- The accurate simulation of all tasks, from the most basic to the most complex, in tree-felling and logging operations, boosting workers' experience and skill levels
- The standardization and systemization of a group training curriculum
- The promotion of safety by freeing training from the limitations of the weather and risks involved with inexperienced operators on heavy machinery, as well as
- The further conservation of valuable timber stocks.

Operators wear three-dimensional glasses, and see their work on tree-felling and processing equipment as if they were in an actual forest operating the machinery. An instructor can oversee the operator's performance joining the simulation if necessary, all while displaying it to the class. A microphone connected to the instructor is fitted to each device allowing full interaction between the trainee and instructor in all aspects of the equipment.

With fewer recruits to the industry and the ageing of the existing workforce, it is becoming more difficult to recruit and keep workers in the timber industry. In an effort to invigorate the industry, The Forestry Agency is promoting mechanization and, particularly in heavily forested regions of Japan, the development and introduction of high-performance machinery.

NEC believes this simulator will prove indispensable to the industry, and sees additional possibilities for the technology in other applications such as for machinery operators in various public and industrial roles. The company is now planning for these further business opportunities.

Further information: Mr. Aston Bridgman, NEC Corporation, 5-7-1, Shiba, Minato-ku, Tokyo 108-01. Tel.: +81-3-3798-6511; Fax: +81-3-3457-7249 (Source: *Science & Technology in Japan*, No. 62, 1998)

Access control

Biometric technology is the basis of new, lower cost access-control systems developed by Recognition Systems Inc., Campbell, CA. Based on three-dimensional readings of the size and shape of a person's hand, the reader can determine identity in less than a second, the company says. Readers can serve as standalone systems or be networked into complex systems with hundreds of access points. The devices can be quickly and easily added to existing card-based access control systems, it adds. The company also offers readers designed for documenting time and attendance. User-definable function keys can be used to collect additional data. (Source: *Industry Week*, 6 July 1998)

Smart card development

The development of increasingly powerful chips in small packages is affecting the development of smart cards in just the same way as it is conventional computer chips. Smart card companies are currently working to develop general purpose card systems with the ability to accept applications from different service providers on the same card. For example, a bank access card might also be able to accept programs to run loyalty bonus schemes from particular retailers, or be able to manage Internet access and store the addresses of important or frequently accessed websites.

The Java programming language is one approach that is seen by many as the way forward for multi-application cards, a standardized system that will allow cards from different manufacturers to accept programs from a variety of sources. The Java language was developed for powerful 32-bit desktop computing platforms, however, and fitting enough processing power into a tiny card is a challenge for developers. The establishment of a standard is also far from complete, while Java thrives on its promise of interoperability and standardization, other manufacturers have already developed card-based operating systems for multi-application cards.

As well as technological limitations, there are also consumer acceptability questions to be answered before the use of multi-function smart cards becomes widespread. However secure the data access system of a smart card, the security process will still be invisible to the card user, who will have to rely on the card supplier's claims about the fraud resistance of the system. Similar problems have delayed the uptake of Internet-based electronic commerce systems and it is unclear whether people will be happy about handing a card that contains personal medical and financial information to an insurance company, for example.

Another important issue is that of who owns the information stored on the card.

The development of a significant infrastructure of smart card readers is another factor that will encourage or delay their widespread application. The incorporation of card reader drivers into the Microsoft Windows operating system is imminent, along with the inclusion of reading hardware in many new PCs. Automated teller machines in banks are being fitted with the facilities to read smart cards as well as traditional magnetic swipe cards, but the inclusion of smart card readers in point-of-sale equipment and domestic telephone systems awaits the acceptance of a standardized scheme. It may be some time before the contents of your wallet are replaced by a chip smaller than a fingernail. (Extracted from *Engineering*, January 1998)

Inexpensive system integrating photovoltaic power generation module and roof

Hirai Engineering Corp. has commercialized an extremely inexpensive system that integrates a photovoltaic power generation module and its ancillary roof through the world's first TH-type standard specifications, and is based on standardization of the photovoltaic cell module.

Four types of modules are used in combination for compatibility with all kinds of roofs, so due to mass production and reduced fabrication cost, the investment cost has been decreased to less than one-half that of the least expensive conventional system. A system with an output of 4 kW can be assembled at a cost of about ¥1,800,000 that can be depreciated in about 7 years. This photovoltaic power generation module of versatile specifications was devised based on experience gained through roofing business. It is comprised of cells of four sizes, which are five or six 10-cm^2 cells arranged vertically, and eight or nine cells arranged laterally.

The configuration of the aluminium support frame is changed flexibly in conformance with the roof size, so there is no need to fabricate the roof to the necessary size through independent production. Rain drainage of the roof system uses the labyrinth to prevent infiltration of rain water by capillary action and surface tension, and comprises a waterproof structure equipped with triple and quadruple lines of rain water drainage grooves.

The roof system for photovoltaic power generation is lined along the inner lower part of the module with fireproof

iron plates, and the system has already been approved as a fireproof structure by Japan's Ministry of International Trade and Industry and the Ministry of Construction. The structural members all consist of light-weight aluminium, the assembled portions are provided with spaces and fixed in position securely with bolts to render the structure proof even against large earthquakes. In addition, the structure is highly resistant even against strong winds of 70 m/sec. The system can be mounted into position by the knock-down assembling method indicated in the catalogue, and there is absolutely no need for work on the roof, so it can be assembled with ease by the home carpentry method.

With the cooperation of construction material manufacturers, technology and performance demonstrations have already been completed, and more than 130 patents and other industrial property rights have been acquired in Japan, as well as in Europe and the United States. An AC module incorporating an inverter to convert DC power into AC power has already been completed, and the preparation of a franchise chain is already under way.

Sales representatives will be licensed to engage in the manufacture and procurement of necessary material such as the cells and support frames, and to accept orders from homes and enterprises desiring to install the photovoltaic power generation system.

Further details from: Hirai Engineering Corporation, Public Relations Department, 4-22-10, Kitakasai, Edogawa-ku, Tokyo, 134-0081. Tel.: +81-3-3680-4176-7; Fax: +81-3-3680-5212. (Source: *JETRO*, April 1998)

A boost to battery power

Improvements in primary (disposable) cells are making them a viable option where once only rechargeable cells could cope.

Primary cells, particularly alkaline and zinc-chloride types, are well suited for use in low consumption portable equipment—test meters are a prime example—where the load matches the cell characteristics well.

However, these chemistries fall down in high-drain applications where high internal impedance limits output current and dramatically reduces capacity. For example, a D-size alkaline cell has a capacity of 18 Ah at 50 mA load, which drops below 5 Ah at 2 A load.

Where high current is needed in portable equipment, rechargeable chemistries—nickel cadmium (NiCd), nickel metal hydride and sometimes lithium ion—are employed. These have lower absolute capacities, but they are far less affected by drain current. A 5 Ah D-size NiCd has almost the same capacity at 50 mA and 5 A drain.

Motivated by emerging consumer applications including GSM phones, digital cameras and Mini-Disk players, Energizer and Duracell have produced a new generation of primary cells with much-improved high current performance.

Both Energizer and Duracell have concentrated on their AA and AAA-size cells, these being the most popular in their native US market.

The improvements have been twofold. The amount of active material in the cells has been increased and attention has been paid to the sources of internal resistance. As a result, Energizer's latest AA cell is claimed to have twice the capacity of its counterpart of two years ago, and much improved voltage hold-up at high current.

Power-hungry devices like portable signal generators can now reasonably be supplied from primary cells, or at least have an option to use them when their internal rechargeable runs flat at an awkward moment.

Duracell has chosen to market its high performance alkaline cells separately from its standard alkalines under its "Ultra" banner. Energizer's tack is to turn over all its production capacity to its new design which will carry an "Advanced Formula" logo.

Replacing secondary cells with primary cells still carries with it the additional environmental impact of throwing cells away and the increased cost of continual replacement, but it allows field users to get their equipment back in service with a simple trip to the local supermarket. (Source: *Electronics Weekly*, 24 June 1998)

F. SOFTWARE

Filtered news services: solutions in search of your problem?

A number of Internet-based services are available which offer filtered news delivered to the desktop. For some users, however, they simply increase the user's sense of information overload, without actually supporting them in their work tasks. Some services are deficient both as regards sources and filtering, and fail to establish a connection with the business application.

Suppliers vary in their definitions of what constitute the "essential" sources, and the quality of the sources used is only partially reflected in the services' pricing. They also utilize different mechanisms for filtering, again of varying degrees of efficacy. Most filtering depends on either a "bucket" approach—the supplier employs a mechanical or human-influenced process to sort news items into categories —or keyword search profiles, often with not very robust search syntax. Both methods may be subject to limitations, and may result in news feeds which do not provide a precise match to users' needs.

Examples of standalone services relying on searches defined by the end-user include Dow Jones' Custom Clips, Inquisit (from the company of the same name), Knight-Ridder's NewsHound and Scoop's ScoopDirect. Services depending on pre-sorted categories include AirMedia, ClariNet's ClariAlert, Individual's HeadsUp and NewsPage, InfoBeat, Netscape's In-box Direct, NewsAlert and PointCast's Business Network.

A three-step process of evaluation, prior to purchase, is suggested. Firstly, the attributes of tasks undertaken by existing or potential users of the service should be determined. Secondly, these should be compared with the key attributes of the news services. Thirdly, other sources of information relevant to the given application should be identified.

Task attributes include frequency, duration, level of analysis required, the extent to which its completion depends on information derived from an external source and how often such information is used. Clearly, the nature and mix of these attributes will vary according to the job function. A number of primary applications will emerge from this analysis: competitive, industry and technical intelligence, amongst others.

The key attributes of the filtering services include the medium (the way in which the information is delivered), sources, filtering mechanism, price and licensing options, delivery and update frequencies, the period of coverage, ease of use, the extent to which the material can be integrated with other applications such as groupware, and information presentation.

Possible alternative sources include subject-oriented online databases, focused newsletters (whether electronic or print), internal collections of information and Internet-based sources such as Web pages, mailing list discussion groups and Usenet news groups.

Finally, the products under consideration should be "mapped" to their potential users. Those requiring essential competitive intelligence, for example, will be primarily concerned about the breadth and depth of the sources used by the service. Users of technical intelligence are more likely to require additional input from alternative sources. Above all, however, the question must be asked: would the proposed service meet a real need which could not be satisfied by other means? (Source: *Online*, 22 (2) March/April 1998)

From client/server to intranet

Just as the mainframe is not dead, client/server architectures are still with us. Client/server, however, has not been without its problems. A recent survey suggested that only 16 per cent of client/server projects had been completed on time and within budget. Another study reported that only 40 per cent of respondents believed that the investment had been worthwhile.

Client/server is a two-tier architecture, with functions shared between client and server. An intranet introduces a third layer: the Web server. Mounted on the server, this software acts as a gateway to the application logic and the data. The client machine employs a Web browser to access the Web server. As a result, the intranet offers an easy to use, lowest common denominator of communications and collaborative working systems to a large number of people at modest cost.

A lot of mistakes have been made in implementing client/server systems, and it is important not to repeat them when introducing an intranet. Firstly, it should be borne in mind that an intranet can be built on the back of an existing client/server infrastructure, and can be used to access legacy systems: it is not necessary to start ripping out the old to make way for the new. Secondly, intranet applications are scalable: they can start small, and grow later. A pilot scheme can be evaluated, and if judged a success, can have additional content migrated to it at a later date.

The first step is to identify a likely area for deployment. This could perhaps be the company newsletter, benefits

handbook or competitive sales information. It is important, however, to choose an application where the costs of conventional production—such as printing, binding and distribution—are well-understood, so that comparisons can be made with the cost of the new arrangements. The next step is to identify the content source or author, and determine how the material is to be converted to an HTML page, and by whom. This might be by the original author, or a centralized department. After the third stage, implementation, audits should reveal whether the new system represents an improvement on the old.

Web servers do, however, raise a number of organizational issues. These include privacy, currency, performance and security.

Web site log files, for instance, by tracking who has visited which page, have the potential to cause breaches of privacy. Although intranets have the capability of being updated at frequent intervals to ensure their currency, this is no guarantee that they will be so updated. If it is to have enduring value, however, the site must be generally perceived to contain current information, and a commitment must be made to ensuring that this is the case. Depending on the application, performance may be an issue. Intranets are file-oriented, and this can cause problems with high volume transaction-oriented systems. Checks need to be made to ensure that adequate bandwidth is available to cope with the increased traffic. Finally, security should be a major concern. Access to some material should only be extended to those within the company who are authorized to view it. (Source: *Information Management and Computer Security*, 6 (1) 1998)

Microsoft's SQL Server 7.0

Microsoft's SQL Server 7.0 (currently undergoing beta testing) is the latest version of the company's RDBMS (relational database management system) product. When the product is released later this year, however, it will comprise not only an improved RDBMS, but also the tools needed to construct a data warehouse, including an OLAP server (codenamed "Plato"), data transformation facility and a data cube service.

Since data warehousing tools are normally priced in the tens of thousands of pounds bracket, these additional capabilities are no doubt causing some concern at Oracle, Red Brick, Cognos and IBM. On the other hand, much of the difficulty and cost of establishing a warehouse arises out of its complexity, and these problems are not going to disappear overnight so far as the average user is concerned.

The original product was not developed in-house, but purchased from Sybase. It has always suffered from flawed scalability and query optimization. The latest version, however, has been completely rewritten in-house, and is claimed to be considerably faster. It is also claimed to be easier to use. More than twenty-five wizards will be available for such tasks as updating from previous versions, creating databases, importing and exporting data, index enhancement and configuring replication. Internally, it uses OLE DB for linking the query processor and the database, which means that it can also query any data in an OLE DB-enabled application.

Although it will run under both NT and Windows 95/98—the latter capability meaning that it could be run as a standalone product—it is not intended as a replacement for Access. Integration between the two database products, however, has been tightened. (Source: *Information Week*, (26) 1-14 April 1998)

Imaging joins the mainstream of computing

The merging of technologies makes it difficult to distinguish between imaging and document management. An image is just one particular type of document which has to be managed like any other document. Ongoing standardization and unambiguous definition by standards bodies like the Open Document Management API (ODMA) have contributed to a better integration of imaging into an overall architecture.

Unfortunately, ODMA has its pitfalls since it is a standard that every one of its members had to agree on. To achieve this they had to reach compromises. Despite today's common standards it is not yet possible for customers to easily use different software components from different vendors. However, suppliers are able to incorporate certain components into their products. The Verity full text search engine, for example, can be found in document management products from various suppliers.

Imaging software is no longer available only from dedicated document management vendors. Scanner suppliers deliver imaging capability with their hardware that can be integrated into existing document management systems. Imaging is even becoming part of the operating system rather than an additional software layer, for example, Microsoft is shipping Windows 95 with a scan and view components from Eastman Software. All suppliers are also riding the Web wave. Although this adds almost no new functionality, it does have some technical advantages making it possible to use very simple client hardware and software.

Mergers and acquisitions have resulted in a market structure with just a few major vendors operating on a worldwide scale. These vendors will find their customers among larger organizations who can afford the research and development costs of multi-platform, open and extendible applications with complete competitive functionality. However, there are still many local suppliers serving local markets meeting the imaging needs of smaller organizations by focusing more on consultancy and supporting the implementation of standard applications rather than developing and selling their own systems. They also often use the facilities for customization to develop special extensions on top of the standard applications which they then sell under their own label.

The leading imaging vendors are all offering enterprise-wide document management solutions but the companies that have put document management onto every desktop are still rare. There have been successful implementations on a departmental scale but making document management available to all document users in an organization still poses a challenge. Over the coming years new products will be released with enhanced client and server functionality. The market leaders are close on each other's heels in introducing a component-based, open and adjustable architecture.

In installing imaging systems, IT managers need to ask how the new system will fit into the existing IT infrastructure and what kind of support is available during implementation and operation. Other important factors are the support that the product provides for migration from the old to the new systems and the availability of system administration tools. (Source: *Document World*, 3 (2) April/May 1998)

How to sell goods and services from your (Web) site

Those contemplating selling goods or services via the Net would be well-advised to consider a few points first.

If it is a new business, the would-be entrepreneur should ask whether he or she has the experience and temperament required to run a commercial operation. If it is an existing business, its strengths and weaknesses should be reviewed.

If the proposition still appeals, the pros and cons of electronic commerce (e-commerce) should be examined. Entry costs can be modest, but the disadvantages should be looked at. Is the business suited to this medium? The obvious candidates for successful e-commerce are products which are familiar and easy to understand. Novel or complex products are less likely to succeed. Next, the target market should be considered—Net users are predominantly young, affluent and male. Is the product likely to be of interest to such a market? If so, can it be delivered easily? Does the organization have the right (motivated) staff who can process the orders?

As in the case of any business venture, it is essential to have a clearly stated and realistic set of objectives, as well as a view of how success is going to be measured against those objectives. The risks and costs associated with the project must be evaluated.

Starting completely from scratch offers certain advantages over attempting to graft e-commerce onto an existing operation. Establishing businesses should seriously consider the creation of a new, separate venture specifically dedicated to electronic trading.

Once the decision is made to proceed, there are three approaches from which to choose: create a partnership with an ISP, rent space in a virtual shopping centre, or undertake the whole operation in-house. (Source: *Internet Magazine*, April 1998)

Upgraded website keeps the millennium bug from bugging

Free software that assesses "millennium bug" problems is only one of many features on the new and improved NIST Year 2000 World Wide Web page located at http://www.nist.gov/y2k. NIST's information Technology Laboratory recently redesigned the page, making it easier to navigate and more comprehensive in the services it offers. For example, new documents are now added on a regular basis to ensure timely information. Perhaps most importantly for the weary Web traveller, the page includes links to a selective list of outstanding and informative Year 2000 Web sites run by industry and government groups.

NIST has developed a variety of programmes to help both small and large companies in the Year 2000 conversion process. The projects are part of a larger effort coordinated by the President's Council on the Year 2000 Conversion. (Source: *NIST Update*, 31 August 1998)

A new dawn (XML—extensible markup language)

A Web search using a limited number of keywords may well result in 10,000 hits—and probably most of them will be irrelevant to the enquiry. Part of the problem can be attributed to HTML, which today is used for purposes for which it was never originally intended.

XML (extensible markup language), however, promises to make the Web "smarter". The addition of machine-readable data regarding the structure and content of pages will enable search engines to function much more effectively than at present, producing a smaller number of precisely relevant hits. In addition, XML will make possible new languages which permit musical notation, and mathematical and chemical symbols, to be sent across the Web as easily as conventional text. Readers will be able to manipulate the data contained in such documents in any way they see fit. Most importantly of all, XML may be one of the factors which

helps electronic commerce to finally take off, making Internet-based EDI (electronic data interchange) a practical proposition.

Whereas HTML provides only very limited information about a document, XML provides a considerable amount of metadata. It can, for instance, describe the subject of the document, so that the search engine can decide whether it is relevant to a particular enquiry. The use of RDFs (resource description frameworks) allows information about a Web page to be stored as if in a structured database, further aiding a search engine to pinpoint exactly the material required. XML also permits Web pages to be used in a more sophisticated manner than previously possible. An example of this is the way in which an XML application, Xlink, enables links to be made to a specific section of a document rather than simply to the document as a whole. (Source: *New Scientist* (2136) 30 May 1998).

Translation technologies pushing forward global commerce

Two of the more interesting exhibitors at Internet World UK Spring 98 were Lernout and Hauspie, and Globalink. Lernout and Hauspie unveiled its latest speech and translation technology, demonstrating a range of Internet-enabled products. These included Coronado, which it claims is the industry's first multilingual intelligent search and translation tool; an e-mail reader code-named Popeye, which allows users to access, retrieve and send e-mail via a telephone, and StreamTalk for Java, enabling Web browser integration of voice and music.

Coronado is intended to provide fast, accurate and comprehensive Internet search and language translation as well as content management. It is scheduled to begin providing translation for English, German, Spanish and French in an attempt to dramatically simplify and increase access to Web Content for non-English speakers. The product has been designed for use by large businesses, academic institutions and researchers, and other big players in global markets.

Paris-based Globalink has developed a suite of translation software, ranging from simple document translation tools to services tailored to SMEs or larger businesses, or those translating weighty documents. Its Intranet Translator is a clever application that provides machine translation to multiple network workstations from a server-based engine and data set, thus removing the overhead of having the translation engine and data on every workstation. In addition, for a monthly subscription, Globalink provides real-time machine translation of a company's site which is good enough to give foreign customers visiting the site the gist of the information in their native language. (Source: *Interactive Media International*, 12 (6) June 1998)

Savings from data entry engineering

Creating a database entails investing a lot of time and effort into data entry and verification. "Data entry engineering" (DEE), however, can assist in controlling the entire process so that data quality is maximized and the cost contained within reasonable limits.

Most libraries cannot afford exhaustive data verification procedures, but they can at least improve the quality of input by making it as straightforward as possible. Using good equipment in a pleasant working environment can do much to reduce the incidence of error, and subsequent remedial work. Another aid to good keyboarding is to employ the best available "entry engine", customized if necessary to meet the institution's peculiar requirements. Yet another, is careful

design of the database structure—unnecessary additional fields can cause confusion, and needlessly increase the workload.

The data to be input should be analysed before work begins. What is the source material, and what can be done to mark it up beforehand to make the task of input easier? The markup can identify items to be indexed and the controlled vocabulary or natural language terms to be employed, as well as drawing attention to keywords in the text.

Analysis should also extend to the input process itself. It is probably better to separate data entry from other tasks, such as indexing and entry checking. The task can also be greatly simplified by the use of automated aids, such as relational table look-up of abbreviations or controlled vocabulary terms. Use can be made of macro keys for translations, formatting and conversions, as well as default entry functions wherever practicable. (Source: *Database*, 21 (3) June/July 1998)

The mobile intranet

The Global System for Mobile Communications (GSM) network was designed to take both voice and data. Despite this, by 1997 only 2 per cent of GSM revenues were being generated by data communications.

This slow take-up can be attributed to three main causes. Proprietary notebook-to-phone links have tended to make the GSM cards expensive. To eliminate this constraint, software modems are now being developed which emulate the phones of leading suppliers. Secondly, until fairly recently, users have had to carry both a phone and a computer. This issue is being addressed by PC Cards incorporating a complete GSM phone, or by integrated devices such as Nokia's 9000 Communicator and Nortel's Network Phone. Thirdly, and possibly most importantly, current transfer rates of only 9.6 kbps place restrictions on mobile data communications.

One of the more successful non-voice applications, however, has been the Short Message Service (SMS), a pager-like facility for carrying brief text messages. SMS enables users to receive items of up to 160 characters, as well as e-mails, on a mobile phone. Network operators are pinning their hopes on enhanced versions of this service, normally referred to as "smart messaging". Real expansion of the market, however, is only likely to occur if operators can offer higher bandwidth on demand and if there is better integration between mobile communications networks and corporate information systems. The reference point for quality of service remains the fixed network.

An ambitious initiative—not likely to come to fruition until 2002 or 2003—aims to address the limitations of the present network and systems based on it. The Universal Mobile Telecommunications System (UMTS) will give mobile users the same level of functionality they enjoy at the desktop. It will support both circuit- and packet-switched services, a variety of mixed-media traffic types and at least 144 kbps for data transfer, as well as up to 2 Mbps for stationary office settings.

One of the key elements of the next generation GSM network will be the WAP (wireless application protocol). This will enable interactive information to be delivered to mobile devices. Various suppliers—including Nokia, Motorola and Ericsson—have been offering different versions of this, but the specification is now being managed by an industry consortium. The standard will also be applicable to other services, such as GPRS (general packet radio service), expected to be available within the next two years.

The programming model for WAP closely resembles that for the Web, and indeed all content can be hosted on standard Web servers, using CGI and Java. Not only can WAP be used to add value to mobile phone services, therefore, it can provide mobile workers with secure, wireless access to corporate information systems over the Internet (the "mobile intranet"). For the next few years at least, WAP and Java are likely to be complementary technologies, with the former used for non-graphical applications and the latter for more sophisticated Web browsing devices.

The appearance of more intelligent WAP- and Java-enabled devices over the next few years, therefore, may be sufficient to ensure that wireless data networks finally become reality. (Source: *Byte*, May 1998)

ADONIS; National Library for the Blind

The news that Elsevier Science have bought out all the shares of ADONIS BV from their partners Blackwell Science and Springer-Verlag brings to an end a consortium that dates from the 1970s. ADONIS was set up when a group of STM publishers became concerned that document delivery operations were eroding the market for conventional publishing. The original concept was that STM journals could be stored on videodiscs and demands met by means of laser print-outs. A royalty charge, built in to the cost of each transaction, could then go to the original publisher. CD-ROM replaced video discs when the service was launched commercially.

In January 1997 ADONIS broke new ground in launching an electronic publishing service in which initially 400 individual titles would be published for purchase by users on CD-ROM. The new service was to be based on electronic input instead of the scanned input from printed material used in the document delivery operation, thus achieving better quality than in the document delivery operation. Reports indicate however that the new service got off to a slow start during 1997.

Meanwhile a new system based on scanning is claimed to have revolutionized Braille book production at the National Library for the Blind (NLB) in the UK. It enables Braille editions to be produced from normal printed books in a matter of weeks compared to the year or more taken by conventional methods. The NLB runs a general lending service for the blind and visually impaired sending out 1,000 volumes a day. (Source: *FID News Bulletin*, 48 (1) 1998)

E-mail and Internet options for small businesses

For a single user business e-mail and Internet access can be accommodated with one standard telephone line, an inexpensive dial-up account with an Internet Service Provider (ISP) and the software included with most operating systems. There are hundreds of ISPs to choose from. Some, such as AOL, offer unique content while others only provide Internet access services. A good idea in choosing an ISP is to make a short list of possible providers then try their support lines and select the one which comes across as the most helpful.

Assuming you already have a telephone line, you will need a modem to connect to an ISP. Most speeds are currently in transition to a new standard. The top speed is 56,000 bits per second. Unfortunately 56 Kbps modems operate at their maximum speed only for downloads. When sending files they will only upload at 33.6 Kbps. If you are going to send or upload plenty of large files you will be better off with ISDN, which runs at 64 Kbps both ways. Another good reason to consider ISDN is that you get two lines. If you run a home office you will probably need at

least one extra telephone line so you can have Internet access and still have a line free for incoming calls.

There are dozens of ways to set up both e-mail and Web access for a networked group. You are likely to be running a peer network where one of the computers acts as a gateway to the Internet but it is also worth considering a proper dedicated network server even for a small network of between five and ten people. You will pay more but will gain reliability, security and performance. (Source: *Personal Computer World*, August 1998)

A graphics file format for the future

There have been at least a good dozen bitmapped image formats developed since the advent of microcomputers, and at least as many for vector image formats. The problems with the former have been that enlarging or reducing the original image size distorts it, and bitmapped images tend to be large at high resolution and high colour density. A typical picture of 1,024-by-768 resolution using a 24-bit colour palette is fairly standard today and it takes about 2.3 MB.

To reduce the information highway traffic jams, compressed formats (GIF and JPEG) are used instead of the original bitmapped images such as BMP, DIB and TIFF. GIF and JPEG compressors are far more effective than any diet clinic in trimming the fat, but they come with a loss of quality, especially in the GIF format. GIF also has the limitation of supporting only 256-colour depth. This is acceptable for run-of-the-mill images but not for art collections, product catalogues, and high-quality photographs. JPEG has become the more popular format (except for line-art images) not only because of its higher quality but also because of the financial and legal implications of the patented technology used for GIF compression.

FlashPix was developed about two years ago, and what makes it the most helpful universal format of the future are the recent developments in application and system software that support the format, including the ability to view FlashPix images (whose extension is FPX) using a Web browser (with or without the help of plug-ins and Java applets), the ability to create FPX images inexpensively, and the ability to convert images from other formats into FlashPix format. (Source: *Information Today*, 15 (7) July/August 1998)

The limits of power

Windows applications are currently rooted in 16-bit DOS, limiting the scope for running multiple applications simultaneously. Intel's BeOS, by contrast, offers true multitasking and multithreaded capabilities, and also offers support for multiple processors. Unfortunately, it is aimed at multimedia developers only—there is no likelihood of it replacing Windows. The mass of users must await Windows NT 6.0, due some time in 2000.

In the meantime, one solution, according to Intel, is to use large amounts of processing power and memory to overcome the limitations inherent in the current version of Windows. This is the justification advanced for purchasing the latest high-performance chips such as Intel's 400 Mhz Xeon. Another possible reason for doing so is that with the appearance of CD-R and DVD read/write systems, computers will increasingly be used to create documents with multimedia content. Such documents will require powerful PCs. (Source: *Personal Computer World*, September 1998)

Extending ERP (enterprise resource planning)

A new trend is evident: organizations which had invested in ERP (enterprise resource planning) software for internal use are now connecting their systems to those of their supply-chain partners. Supply-chain management is the latest watchword. According to Benchmarking Partners, the value of the supply-chain software market will grow from $900 million in 1997 to nearly $2,500 million within two years.

An example of how these products can be used is provided by Colgate-Palmolive, which has a pilot programme to connect its ERP systems (supplied by SAP) to the Internet. By this means, it advises its key suppliers of its manufacturing production schedules and inventory levels, enabling them to replenish stocks without a request having to be made by Colgate. The result is a shorter replenishment cycle and a reduction in inventory costs. Another company investing in the technology is Bristol-Myers Squibb, which hopes to reduce its costs by $1,500 million a year.

ERP systems are also being used to improve links with customers. Gauging customer demand accurately is difficult, but with Internet-enabled systems, both business and consumer customers can specify and order online what they require, when they need it. The supplier can manufacture to order, not for stock. In another pilot scheme, Nabisco is creating such links with major US retailers to undertake collaborative forecasts.

The constraints on the adoption of such techniques are those of organizational culture and concerns for security. Nonetheless, expectations are high that such reservations will be overcome, and ERP system suppliers are briskly announcing new software releases and new strategic alliances with other software suppliers which will enable them to address the market. (Source: *Information Week* (34) 22 July-14 August 1998)

Straight talking (Windows 98)

The upgrade program for Windows 98 is almost fully automated. After checking to see whether the PC can support the upgrade, it copies the program files across from the CD-ROM to the hard disc, and converts the registry (the electronic index which Windows uses to keep track of the programs and devices used with the PC).

If, however, the registry includes incorrect entries, the conversion process fails. When Win98 attempts to run a plug-and-play check against the unconverted registry, the installation process fails and the computer crashes. Although users are supposed to have the option of reverting to their Win95 system, a crash before completion of the upgrade means that the necessary recovery files are not present.

Depending on the PC's configuration, a number of other difficulties may be encountered during setup. Some remedies are available, but power users are advised to exercise caution. (Source: *Personal Computer World*, September 1998)

Full text services: the view of the agent

Over the past two years Blackwell's Information Services (BIS), like many other subscription agents, has developed tools for delivering and adding value to full text services. These new tools, such as Blackwell's Electronic Journal Navigator, deliver electronic journal content from a wide variety of different publishers to organizations throughout the world. These tools will do many things for the customer although most of these services are still in their infancy. In effect, what they all offer the organization is a

single source for full text content, a means of searching simply across many publishers' offerings and a mechanism for purchasing such disparate content. Shortly we are also likely to see links to secondary services.

Publishers traditionally market to researchers, agents to libraries. That is changing because the agents' full text services will deliver all publishers' journals and electronic services directly to the end user and provide a huge wealth of information and market reach. Agents' systems will do this because they will be an institutional purchase and as such they will be rolled out to all within the organization so that there is one standard way of accessing journal literature electronically which can be properly supported internally, and by the single external supplier, the agent. The information specialists can then train the users and ensure that appropriate content is available to all. This will not stop individuals going to publishers' sites, nor would agents or libraries wish to stop this, but it does give a single backbone service across the site. (Source: *Serials*, 11 (2) July 1998)

Internet computer virus protection policy

Computer viruses have dramatically increased in complexity over the years. The first viruses were static programs that copied themselves from program to program or diskette to diskette. The viruses that exist today are much more complex. They not only spread via the previous ways, but now also via e-mail and the Internet. Also a second breed of viruses has been developed in the shape of Internet viruses. They are the new threat that the computer industry needs to fight against and that computers need to be aware of.

The threat of computer viruses on LANS and PCs is still great. New viruses are being created readily. The PC virus that is most infecting computers today is the Macro virus. Macro viruses are a new wave of viruses that started to appear in 1995 and they are now the most prevalent computer viruses in the world. Macro viruses attach themselves to word processor documents and spreadsheets. They spread fast due to the growing use of e-mail attachments.

Viruses can pose a threat to the security of programs and data on computing systems. They can spread without the intent of the people who spread them. Today's viruses are spreading in new ways on the Internet, via e-mail, FTP and now by ActiveX and Java applets. This means that just browsing the Internet makes the computer vulnerable to viral infection. The use of anti-virus software to protect against viruses is not enough. An effective virus protection policy should combine the three Ps: people, products and procedures. (Source: *Information Management and Computer Security*, 6 (2) 1998)

Identifying effectiveness criteria for Internet payment systems

Despite the increasing commercialization of the Web, generally accepted and trusted payment mechanisms continue to be conspicuous by their absence. This is not to say that attempts to develop such mechanisms have not been made. Indeed, considerable attention has been given to the creation of Internet payment systems (IPS). Since 1996, more than thirty IPS proposals have been published on the Web. As yet, however, no single, uniform method of handling financial transactions over the Net has been universally adopted.

A number of issues need to be addressed if an IPS is to gain widespread acceptance. Security and privacy are two obvious considerations, but there may be others.

Current IPS proposals tend to fall under one or more of a number of categories. These include: third-party or clearing house systems, credit and/or smart card arrangements,

systems based on secure Web servers, and those employing electronic tokens.

An example of a system falling under the first heading is that operated by First Virtual Holding, which involves the presentation of a VirtualPIN (rather than credit card details) via ordinary e-mail to the clearing house. In the second category, MasterCard and Visa International have jointly produced a specification for secure electronic transactions (SET), which employs digital signatures and public key cryptography. The Mondex card is an example of an electronic cash smart card. NetMarket is an example of a company handling transactions using a secure Web server, while DigiCash is one of the leading operators of a token-based electronic cash facility.

In order to determine IPS effectiveness criteria, a Delphi survey involving 19 organizations and individuals was undertaken via e-mail. The survey comprised two successive mailings, and 14 respondents completed the first round questionnaire. Preliminary conclusions from the first round were then circulated to respondents for further refinement.

The first round identified six major groups involved in the operation of IPS. These were: financial institutions, IPS providers, merchants, consumers, regulators and network providers. The second round showed that security and reliability (trustworthiness) were the two more important effectiveness indicators overall, but that different groups placed more importance on some indicators rather than others. Consumers were more concerned with security and privacy, while regulatory bodies were anxious to prevent illegal usage. IPS and network providers regarded consistency as the priority, while merchants wanted systems that were easy to use and otherwise attractive to consumers. (Source: *Internet Research: Electronic Networking Applications and Policy*, 8 (3) 1998)

Turning visual: image search engines on the Web

Searching for text on the Web is straightforward enough: searching for images can be quite a different matter. A number of image search engines, however, do exist and may ease the task. It should be noted that all have at least some limitations. Some display only the picture and URL, without any text, others simply take the user to the site where the image may be found, but offer no further help. Locating the rights owner tends to present particular difficulties at present, although the proposed Dublin Core standard (which includes a metadata field for rights management) may improve matters.

Whereas an internal image database could be searched using captions or fielded data, a search of images embedded in Web pages requires a certain amount of ingenuity. One approach is to look for graphics files as a type, indicated by the HTML tags IMG, SRC and HREF, or the file extensions .GIF or .JPG. Clues as to content may be given by the file name and/or path. Another approach is to seek out captions. The problem here is that even if they do exist, consistent markers (such as the word "Caption" or "Photograph") may not be present. Some engines rely on the HTML tag ALT—which functions as a caption—to locate images.

"AltaVista" bases its searches on the file name and its extension, looking in the HTML, IMG, SRC field for .GIF or .JPG file or directory names which match the search term. No thumbnail images are offered.

"Amazing Picture Machine", from the (US) North Central Regional Technology in Education Consortium (NCRTEC), depends on prior human intervention. Within selected sites rich in pictures, keywords and other descriptive information are assigned to each image.

"HotBot" employs what is effectively a Boolean AND search strategy—the search is of the type "keyword AND file of type .gif". Results are displayed as the site title and opening text, and lead to the calling page, at which point the user may have to search for the image itself.

Yahoo!'s "Image Surfer" offers a directory as well as a search facility. It employs Excalibur's "Internet Spider" to locate and catalogue images, with some human intervention. Keywords are searched for in page titles, directories or file names, as well as in links leading to an image file. Variants (such as plurals) of the character string entered are also found. The results are displayed as thumbnails and text.

"Lycos" uses an approach similar to that adopted by "AltaVista", but looks for the search term in the ALT field as well as in file or directory names. Displays of the search results include both the file name/path and the content of the ALT field.

"Web Places Clip Art Searcher" offers dialogue boxes for "HotBot", "Lycos", "Filez", "Open Text", "Yahoo"! and "Euroseek". Only one box or link can be searched at a time.

Columbia University's experimental "WebSEEK" employs automated agents to seek out and catalogue visual information. To date, over 650,000 pictures have been catalogued. In addition to the techniques used by other packages, it supports pattern recognition and colour attributes searching. (Source: *Online*, 22 (3) May/June 1998)

Visual maps of the World Wide Web: helping the user find the way

In the multidimensional environment of the Internet, there are difficulties in finding intellectual content with many users experiencing the "lost in cyberspace" phenomenon. Software developers have known for a long time that the provision of mental models for the user can improve the interaction between user and system. A useful approach is to provide sufficient information about what the system can do and what it contains (meta-information/metadata) so that the user's cognitive strengths can be accommodated. The advent of the Internet and the World Wide Web provides a number of possibilities for mental modelling which is being called metadata modelling. Over the past three years, there have been several attempts to provide a mapping of Internet sites in a non-virtual format. Maps can be used to provide a visual representation of intellectual organization and depth of coverage. A number of recent attempts are mentioned, notably those using the self-organizing mapping (SOM) technique developed by Kohonen.

It is concluded that visualization techniques hold great promise for helping users build mental models of portions of the Internet. Maps and metaphors create the possibility of communicating large amounts of information to the user. Mapping also provides a means of access to Internet content which is more visual than a list. SOMs are one approach to visualization which use a complex network of computational relationships to model the distance between two resources on the Web. The computing power available over the Internet and the visual resources that can be used provide an opportunity to experiment with a variety of organizational methods and approaches to information. (Source: *Reference Librarian*, 60, 1998)

How to surf and survive

According to a UK survey undertakes by Benchmark Research on behalf of Reuters Business Information, many managers encountered difficulties in managing information. Despite the flood of available material, 38 per cent stated they wasted considerable amounts of time attempting to locate the right information. In addition, 44 per cent believed the cost of collecting information exceeded its value to business.

The Internet was cited by 35 per cent of managers as a major information source. On the other hand, nearly half (48 per cent) thought the Net would be a significant contributor to information overload in the next two years. A quarter of those surveyed avoided information overload simply by ignoring the available material.

Clearly, a better approach is to filter and prioritize information, so as to put it to work. This process, so far as the Net and intranet are concerned, can be simplified by clear, functional site and page design. Good presentation in turn can be aided by the use of the right software tools to develop the site. Products such as "IntraWeb", "Jamba" and "Web Publisher" can be employed to convert existing documents into Web pages, enhanced with multimedia features and interactive applications.

Tools alone, however, are not enough—a systematic approach to displaying information is required. One such methodology is Information Mapping (IMAP), which aims to present facts clearly and concisely in labelled charts, maps and diagrams. It is claimed that mapped materials are up to 30 per cent quicker to read and result in a 10-15 per cent increase in learning and retention. (Source: *Information Management and Technology*, 31 (4) July 1998)

Beginning all over again: where to start a search

Having a good search start is essential in determining how successful the search will turn out to be. The variety of starting options is staggering. Yet each search truly starts in the same place: the searcher's brain. How the searcher analyses the research problem is critical to the starting place. Sometimes the analysis and search planning takes only an instant—often because the research problem is not new. The researcher has already encountered very similar circumstances and knows, almost instinctively, what the correct starting point is.

The macro approach is to find the biggest possible metasearch engine and start there. The micro approach is to go immediately to a bookmarked Web site. There are immediate approaches, including hopping from one search engine to another, using a search engine restricted to Usenet discussion groups, or relying on metasites created by others. Before leaping to the conclusion that one starting point is preferable, keep in mind once again that different research questions dictate different approaches.

If you need an ongoing update on your topic, you will want to look at the various push technologies—PointCast is the most well-known—and the real-time news integration services, such as NewsEDGE. Traditional online hosts still offer current awareness services. Dialog has Alerts, LEXIS-NEXIS has Eclipse, and Dow Jones offers CustomClips. Increasingly, these deliver results into your e-mail box as well as by fax, courier service, and regular mail. For researchers wishing to control their own destiny, you can still manually search the same topic on a daily basis. (Source: *Database*, 22 (3) May/June 1998)

Knowledge management makes it online

Information professionals have been preaching the importance of managing internal knowledge for years, yet it has taken some time for publishers and conference organizers to catch on and deliver knowledge management-related products. This is probably due to knowledge management being perceived as an extension to traditional librarianship, and not a role in itself.

One publisher that seriously tackles knowledge management issues is Knowledge Asset Media, Inc., based in Camden, ME. Its magazine, KMWorld, available both in print and on the Web, offers case study examples of knowledge management and rounds up the latest news and events on a daily basis. KMWorld's content focuses on case study reports and industry analysis. More specifically, it reports cases that illustrate successful business performance using application and content management tools. Industry analyses are drawn from Gartner, Meta, IDC, Delphi, and Doculabs. On the Web, headlines and introductions to 10 main stories are listed down the centre of KMWorld's first page, with a link to the full text provided in each case.

Another company offering a hub of knowledge management-related content on the Web is Quantum Era Enterprises. It publishes a monthly newsletter, Knowledge Inc., in print, from which it draws content for a Web site of the same name. The Knowledge Inc. Web site offers a snapshot of its print counterpart, including several case studies. Companies profiled have included Sun Microsystems, Chevron, and Xerox. Another part of the newsletter looks at key trends, discussing everything from compensation to competitive intelligence. A Q and A section called "Leading Lights" profiles an industry guru, and another page offers some brief ideas and the latest announcements. Manasco's back page commentary can also be read for free at the Knowledge Inc. Web site. (Source: *Information Today*, 15 (6) June 1998)

Message-orientated middleware

A new class of message-orientated middleware is appearing designed to iron out the uncertainties of remote networking. The basic principle behind these messaging products is store and forward or deferred connection, which means that the middleware stores all attempts at communication and sends them in its own time and under its own control, rather than letting the user connect to home base in real time. Separating user events, such as sending a memo or downloading a file, from system events, such as making a connection, allows such middleware to resend messages after a connection is lost. It also enables the user to defer connection until favoured times, such as when phone rates are cheaper.

Messaging middleware allows the user to work entirely off-line, viewing memos, composing queries, adding database updates, completing spreadsheets and then synchronizing this data with the headquarters server during an automated on-line session. If the server is busy, the middleware will keep trying, invisible to the user, until it is free. All log-on formalities are handled automatically by scripts. If the line drops, the middleware automatically reconnects and completes any operations underway. The most sophisticated products, like Xcellenet and Mobile Objects, are completed distributed data management systems that can control the publication of new information and the integrity of remote machine configurations. They typically support subscriptions for each user, which define the parts of the company database that the person is interested in and has access to. Updates and executable files can be sent to users automatically using push technology. (Source: *Byte*, July 1998)

Ears to the wall

Security holes in an e-mail program deemed to be one of the biggest Internet success stories of recent years have made it as popular with hackers as it is with ordinary users.

ICQ, which was created by Tel Aviv-based software company Mirabilis, is an instant mail program that allows groups of people to swap messages via the Internet—without the wait required for normal e-mail. Since the free software was launched in 1996 it has been adopted by over 12 million users, including many businesses.

Security experts say ICQ's runaway success has been achieved at the price of reduced security. They claim the software is vulnerable to a wide range of attacks that allow hackers to impersonate ICQ users, hijack an ICQ account or steal passwords. Many of these security holes can be exploited using programs that are widely available on the Internet.

But Mirabilis argues that ICQ should never be used to exchange confidential or important information. It says that some of the holes exposed will be fixed. (Source: *New Scientist*, 27 June 1998)

Security and Windows 98

Microsoft's new operating system, Windows 98, has the ability to pick up a computer virus by reading e-mail. Up to now, viruses have had great difficulty getting into your computer this way. Though attachments to messages frequently contain malicious programs, these are easily destroyed by antivirus programs that can be set to kick into action whenever attached documents are opened. However Microsoft's moves to integrate its Windows operating system with its Internet browser program are weakening this line of defence.

These changes, which take a big leap forward with Windows 98, give small programs called applets written in the Java language, access to the innards of a PC. Web pages make heavy use of applets to perform tasks such as animating graphics. One virus expert has found that he can send e-mail messages that save applets straight onto the hard drive of the receiving PC. The applets are activated when the computer is next turned on. Anyone using Windows 98 along with Microsoft's popular Outlook Software is vulnerable.

The problem centres on a Windows 98 file called SCR RUN.DLL, which enables the system to run Java applets found on Web pages, hidden in e-mails, or wherever else they turn up. Microsoft could eliminate this vulnerability simply by removing the file from Windows 98, but this would mean that its "active desktop", which allows Internet sites to be accessed by clicking on desktop icons, for example, would not function as advertised. Although malicious Java applets are not yet circulating on the Internet, virus programmers exploit any new opportunities to create mayhem. (Source: *New Scientist*, 2131, 25 April 1998)

Web math made easy

Talking shop on the I-Way will soon be a lot easier for scientists and mathematicians, thanks to a new computer language released last week by the group that sets Web standards (www.w3.org). The language, which should also be a boon to blind scientists, will for the first time allow people to write mathematical formulas in an HTML document.

Until now, formulas had to be presented as images pasted in a document. As a result, to read Los Alamos physics preprints, for example, one has to add a plug-in such as Acrobat to their Web browser, says Robert Miner of the University of Minnesota's Geometry Center.

That will change with the advent of an HTML dialect called Math Markup Language (MathML) developed by the World Wide Web Consortium (W3C), a dues-funded group of companies. MathML has two ways of encoding a formula, says Miner, who helped write it. One, better for high-quality printing, specifies the exact appearance; for example, it might encode "pi squared" as the Greek letter pi with a superscript of 2. The other captures semantic meaning: it encodes "pi squared" as 3.14 multiplied by itself. Formulas made this way

can be understood by screen-reading software. According to W3C, this will allow visually impaired people to work with math "in a way that has never been feasible".

You still need a plug-in for MathML, but two types are available free (as is MathML) at the W3C site. One benefit of MathML is that because formulas are text, not images, documents can be searched or indexed by formula. "I think that will have an enormous impact on the scientific enterprise," says Miner, who hopes most scientists will be using it within a year or two. (Source: *Science*, vol. 280, 17 April 1998)

A marriage made in cyberspace

You can now send an e-mail to anyone in the world—even if they do not own a computer. Thanks to a link-up between the Royal Mail, Britain's postal service, and the software giant Microsoft, you just visit their website, leave your note and off it goes. You do not even need to buy a stamp.

The new service, RelayOne, allows Internet users to send electronic mail from a Microsoft-run website to a Royal Mail office in London. All the sender needs is a computer, an Internet connection and a browser. The Royal Mail prints out the document on A4 paper and delivers it. A one-page letter to any address in the world costs £1.50.

The website also allows you to send any document up to 50 pages long for £5 if it can be read by Windows-compatible software, according to Microsoft's RelayOne program manager, Roland Dunn.

You pay for the service by credit card. Both your financial transaction and the electronic document are encrypted. (Source: *New Scientist*, 18 April 1998)

Builders now have BEES to buzz about

Environmentally sensitive and cash-conscious BEES are ready to help designers and architects plan better buildings. BEES, an acronym for "Building for Environmental and Economic Sustainability", is a software package developed by NIST's Green Buildings Program to identify building products that improve environmental performance with little or no increase in cost. The first version, BEES 1.0, is now available.

BEES 1.0 is based on consensus standards and designed to be practical, flexible, consistent and transparent. The Windows™—based decision support software includes actual environmental and economic performance data for 24 building products. BEES was developed with support from the US Environmental Protection Agency's Environmentally Preferable Purchasing program. The EPP encourages federal agencies to reduce the environmental burdens associated with products and services that they buy, including building products. Refinement and expansion of the software will be done over the next three years under sponsorship of the NIST Green Buildings Program and the EPA EPP program.

BEES runs on a Windows 95™ personal computer with a 486 or higher microprocessor, 32 megabytes or more of RAM, at least 10 megabytes of available disk space and a 3.5-inch floppy diskette drive.

For technical information, contact Barbara C. Lippiatt, B226 Building Research Bldg., NIST, Gaithersburg, MD. 20899-0001. Tel.: (301) 975-6133; e-mail: blippiatt@nist.gov. A fact sheet on BEES 1.0 can be found at http://www.bfrl.nist.gov/oae/bees.html. To purchase BEES 1.0 for $49.99, contact the US Green Building Council, Suite 1001, 90 New Montgomery St., San Francisco, CA 94 105. Tel.: (415) 543-3001; fax: (415) 957-5890;

e-mail: info@usgbc.org, or order directly from the Council's World Wide Web site at http://www.usgbc.org. (Source: *NIST Update*, 27 April 1998)

Encryption algorithms

Cryptographic algorithms become progressively more vulnerable over time, as raw computing power becomes cheaper and new decryption techniques are developed. "Moore's Law" suggests that computer systems become ten times faster (and one tenth as expensive) every five years, meaning that "brute force" attacks previously not feasible because of the time and cost involved cease to be so. The discovery of more subtle techniques—such as differential and linear cryptanalysis, and the number-field sieve—in the early 1990s enabled many formerly secure systems to be broken. As a result, longer keys become essential if security is to be maintained.

Currently, there are many algorithms available, of various types and offering varying degrees of security. Symmetric algorithms use the same key for both encryption and decryption. Blowfish is the fastest, but has a long key-setup time, is not suitable for encrypting small blocks and (because of its large tables) is completely unsuitable for smartcards. Triple-DES, although the slowest, is a good conservative choice.

Public key algorithms have been available since the 1970s. Different keys are used for encryption and decryption, and one cannot be calculated on the basis of the other. At present, 1280-bit keys might give adequate protection against corporate attack, although 1536-bit keys would be necessary to prevent government agencies from decoding the messages. By 2005, however, those key lengths might have to be 1536 and 2048, respectively.

The US National Institute of Standards and Technology (NIST) is currently soliciting algorithms for an Advanced Encryption Standard (AES), to replace DES. AES will have a 128-bit block size and key lengths of 128, 192 and 256 bits. A decision as to which offering to adopt will be made in 1999 and 2000. (Source: *Byte*, May 1998)

Web page design: fiddling with fonts

There are many things that a Web designer can do to give a specific feel to a page. Attributes such as colour, background, graphics, Java, and so forth are under a designer's control. Until recently, however, one attribute has been relatively inflexible: the fonts. This limitation has long been a bone of contention among Web designers. Then, three things happened: standardized fonts, cascading style sheets, and ways to embed fonts that have been developed by both Netscape and Microsoft for their respective browsers.

Embedded and dynamic fonts could fundamentally change the look of the Web forever. Their use permits designers to select specific fonts and control the size, colour, placement, and kerning of type. Microsoft has released a list of recommended free fonts for the Web. Once you have installed the fonts, you can change your preferences to automatically make use of what may be two of the most important fonts: Georgia (serif) and Verdana (sans serif).

Cascading style sheets or CSS may well signal the end of HTML tagging as we know it. Both Netscape and Explorer offer full support for CSS. For font purposes, CSS permits the designer to define the style for a page. While CSS permits the designer to specify a font, it is still dependent on the browser, so the equation is not perfect. The weak link in the chain is that the font is required to be resident in the available fonts for the browser.

Specified fonts can also now travel with a Web page. Unfortunately, Microsoft and Netscape have found different ways to do this. Netscape was first using Bitstream's TrueDoc and now calls the feature Dynamic Fonts. Microsoft's Internet Explorer (IE) uses a new font format called OpenType and calls its process IE4 Font Embedding. (Source: *Information Today*, 15(4) April 1998)

Netscape releases Web source code

Netscape Communications has made available the source code of its Web browser software. The move is unprecedented in the computer industry and is part of a bold attempt to shore up its eroding share of the browser market.

Netscape hopes the move will spur tens of thousands of software developers to create a variety of applications for the Communicator browser.

The company claims wide support for the move from major companies including Adobe, Digital Equipment, Intel, Nippon Telegraph and Telephone and Oracle.

Access to the source code is via Netscape's mozilla.org Web site. Netscape will integrate the resulting developments in future Communicator versions. (Source: *Electronics Weekly*, 8 April 1998)

NIST software makes remote computing a snap

Researchers at the National Institute of Standards and Technology have developed a computer program that may fundamentally alter the way people use the Internet.

WebSubmit allows even novices to tap into the power of remote computers via the World Wide Web and use them to do calculations as if they had direct connections to the machines. The Web currently is used primarily as a way to transmit documents and images or download software. WebSubmit makes it easy for people to use applications software—the computer programs that make calculations and do other chores—on the Web. This could transform the Web from a medium primarily geared toward information exchange to one in which actual computing takes place.

WebSubmit grew out of a seamless computing project at NIST designed to give staff researchers easier access to supercomputers. Many scientists were frustrated by the time required to learn how to use different supercomputers. WebSubmit eliminates much of the difficulty in learning new systems. WebSubmit is being tested internally at NIST, and will be placed in the public domain by the end of the year. (Source: *Tech Beat*, August 1998)

It's life, but not as we know it

Artificial life may be about to make its next big advance. Researchers believe that the digital equivalent of multicellular life will soon evolve in a virtual world spread around the Internet.

Tom Ray, a "digital evolutionist" at Japan's Advanced Telecommunications Research Institute, has since 1991 been running a software package called Tierra, a virtual world in which populations of simple computer programs breed and compete for resources. But none of these digital organisms has evolved into anything as complex as multicellular organisms.

Ray has changed Tierra to make it more likely that complex digital organisms will evolve. The small programs within Tierra have been altered so that they can express only parts of the whole string of data within them, rather than all or nothing. This is a crucial feature of multicellular life because it allows cells to become specialized—although all our cells contain a complete copy of the genome, they

only express the part of it relevant to the job they do in our body.

To create a diverse community of Tierra colonies, Ray is now running Tierra modules on over 100 disparate computers connected via the Internet, giving colonies several habitats to choose from. Ray likens this scenario to an archipelago of islands. At different times of day, the computers running the Tierra modules have varying processor power and memory available—so the organisms have evolutionary pressures to contend with. The organisms are able to interrogate other computers to see which habitat is the most hospitable.

Ray has also seeded the Tierra Web with 960-byte "ancestor" programs containing scrambled instructions for breeding and sensing, like mutations. As a result, he says new generations are getting better at sensing and breeding. (Source: *New Scientist*, 4 July 1998)

Security blanket

Experts in computer security say that a new bill in the US might prevent them from searching for security "holes" in the latest software. They fear they could be sued by disgruntled manufacturers.

The bill, which could be passed within weeks, would enact a World Intellectual Property Organization (WIPO) treaty on electronic copyright protection. This aims to extend copyright law to cover works stored in electronic form, including computer programs.

Critics say the wording of the US law is so loose that it could outlaw any attempt to "crack" the security features of commercial software. As a result, legitimate researchers could become vulnerable to intimidation from big software companies that would rather not have flaws in their products made public.

In an attempt at compromise the Software Publishers Association, which favours the bill, and the Computer and Communications Industry Association, which objects to its wording, agreed that "legitimate" researchers should be exempted from it, but their definition of legitimate is so vague that researchers are still likely to be sued, claims Schneier.

The WIPO treaty has been signed by 51 countries, all of which are obliged to pass laws against cracking copyrighted software. (Source: *New Scientist*, 4 July 1998)

Windows 98 is no recording star

Over five million PC users worldwide could face computer crashes if they upgrade to Windows 98. The Dutch-based electronics company Philips is warning that the software controlling its CD-ROM recorders is currently incompatible with Microsoft's new operating system.

The driver software for Philips's CD-ROM recorder is written by an American company, Adaptec. To use the recorder with Windows 98, a new version of the software, Direct CD 2.0A, is needed. The snag is that version 2.0A is not yet being sold with new recorders.

Adaptec recommends that anyone with a Philips CD-ROM recorder should remove the old version of Direct CD before installing Windows 98. Version 2.0A can be downloaded free from its website at www.adaptec.com. (Source: *New Scientist*, 4 July 1998)

Cyberjustice

A computer program stands accused of practising law without a licence. The software's publisher is being sued by a subcommittee of the Texas Supreme Court under legislation that protects lawyers from unaccredited competitors.

If the subcommittee wins the lawsuit, Parsons Technology of Hiawatha, IA, which markets Quicken Family Lawyer, will be banned from selling its product in Texas. The case may come to trial in December.

Another publisher of self-help legal software, Nolo Press of Berkeley, CA, has been notified that the same subcommittee will hold a hearing next month to determine the legality of its product. Two other producers of legal software are also thought to be under investigation.

The Quicken software can be used to draft documents such as wills and leases. In a section called "Ask Arthur Miller", the famous Harvard lawyer of the same name appears on video and expounds on issues ranging from choosing a lawyer to deciding whether or not you can afford to buy a house.

Mark Ticer, the Dallas lawyer who chairs the Supreme Court subcommittee, insists that it is not singling out software. In 1992, he says, a book written by someone with no legal qualifications was judged to have breached the statute invoked against Parsons Technology. But Ticer argues that the Quicken program may represent a more serious breach.

Nolo's associate publisher, Steve Elias, says he does not see how a computer code can be accused of practicing law. He points out that the software's introductory screen tells its users: "You must use your own judgement and, to the extent you believe appropriate, the assistance of a lawyer." Even if such programs were to be outlawed in Texas, he argues that the ruling would be unenforceable, as the software could still be downloaded from the Internet or ordered from booksellers operating on the Web. (Source: *New Scientist*, 18 July 1998)

One bad applet

Computer makers and anti-virus software companies are teaming up to tackle the next big threat in computer viruses—bad applets. Many websites add animation, forms or other gimmicks to their pages using programs written using Java, ActiveX or Javascript that are downloaded with the page. Most are harmless, but anti-virus companies are starting to see malicious programs on some Web pages.

Some of these simply slow browsers down but others are written specifically to damage a computer, often exploiting security loopholes to steal or corrupt data. Growth of the Internet is giving these malicious programs great scope for destruction.

The International Computer Security Association (ICSA) is setting up the Malicious Mobile Code Consortium to look into the problem, set standards for the products created to tackle bad applets, and educate the public about the dangers.

Although there are only tens of malicious applets compared to the thousands of conventional viruses, the industry does not want to be caught out as it was with macro viruses—programs that can infect documents. These first appeared in summer 1995 but now they are the most prevalent type of virus.

The combination of security loopholes and anti-virus software that cannot catch malicious programs means that the problem could grow quickly, given the vast number of potential users. (Source: *New Scientist*, 18 July 1998)

NEC chip design tool talks in "C"

A chip design tool that starts with a description of the circuit in the "C" software language has been developed by NEC.

Integrated circuits designed using the tool are faster and use less silicon area, the company claims.

Initially for internal use, NEC executives may decide to offer the tool to the company's Asic customers.

The entire hardware and software system is written in C, making it easy to simulate. A synthesis tool then turns the hardware part of the design into logic.

Some extensions to C have been written to allow for features such as parallel operation.

Compared with using traditional behavioural level languages, such as VHDL, the time for this stage of the design is cut by 90 per cent, according to NEC.

A 1.5 Gbit/s network interface card was designed using the tool. Compared with early predictions, chip area was reduced by 40 per cent and speed increased by 30 per cent. (Source: *Electronics Weekly*, 15 July 1998)

TriStrata secures Internet

The US firm TriStrata Security recently introduced an encryption technology aimed at securing Internet data.

The method used for the encryption—or cipher—is over 80 years old and has the enviable attribute of being, at least in mathematical terms, unbreakable.

TriStrata's founder, Dr. John Atalla, has spent the last five years looking at the problems of securing transactions over the Internet. Prior to this he invented the PIN number system used in bank cash machines.

For secure Internet transactions, Atalla has moved away from complex encryption algorithms, such as the public key RSA and the private key DES, and opted for the Vernam cipher.

Vernam forms the basis of TriStrata's random key stream (RKS) technology. It is unbreakable provided the key is not revealed, and with the use of modern computers it can encrypt data at over 30 Mbyte/s.

The permission to encrypt or decrypt a message is via a central server, accessed over the Internet or intranet. That way, a company can have complete control over who is allowed to encrypt/decrypt data.

This central server also generates and distributes the random keys. Given enough time, it could be possible for someone to break the code and get the key, but each key is only used once. By the time someone uncovers the key, it is already useless.

Designated members of the company, the senior management for example, are able to retrieve keys and decrypt messages. This feature makes RKS exempt from the US Government's ban on exporting powerful encryption software. Critics maintain the ban is costing US companies billions of dollars in lost revenues.

The first customer to use RKS is the accountancy firm Price Waterhouse Coopers. (Source: *Electronics Weekly*, 8 July 1998)

Spending spree

Shopping is much the same the world over. As long as you have the correct currency in your purse it is easy to find ways to spend it.

Shopping on the Internet is less straightforward. Every electronic currency comes with special software that must be used when paying with that system. It is as if you had to be fluent in the language of the country you were in before you were allowed to buy anything.

Some companies fear that unless this changes, the growth of Internet commerce will be stifled. Thirty companies have now got together to create an electronic wallet that will be able to handle any and every digital currency. In January the Open Trading Protocol consortium released the specifications for its multi-currency wallet.

The aim is to hide the software associated with the different Internet payment schemes, so that no matter which one is used people will go through precisely the same process when ordering and paying. The idiosyncrasies of each system will be translated so that, to the shopper, everything will look exactly the same.

The wallet is being created using XML—an extension of the more familiar HTML protocol most Web pages are written in. Some Web designers are already using XML to create pages, and the latest versions of Web browsers can make use of it. The wallet will also work with the different security systems the payment schemes employ.

The consortium counts among its members the developers of most of the large electronic payment schemes, such as DigiCash, CyberCash and Mondex.

"There is a need for a standard trading system on the Internet," says a spokesman for Mondex International. "At the moment every time you perform a transaction, you need a different wallet." He says the consortium should make it possible to buy goods over the Internet from all over the world in exactly the same way. (Source: *New Scientist*, 7 February 1998)

China's search fox

Officials from Internet Technologies China (ITC) formally unveiled Sohoo, or "Search Fox" in English (www.sohoo.com.cn), a search engine for the Chinese portion of the Web. The absence of a powerful Chinese-based search engine has made it virtually impossible for Web surfers to sift through thousands of Chinese-language sites for information. ITC chief executive Charles Zhang sees his company's mission as nothing less than the salvation of Chinese culture in the digital age. With China as one of the world's fastest growing computer markets, Zhang expects Sohoo revenues to reach $1 million by year end. (Source: *Communications of the ACM*, vol. 41, No. 4, April 1998)

Breaking the Chinese language barrier

The thousands of variations of intricate Chinese characters has made it impossible to use a standard computer keyboard to type a message in Chinese, in essence keeping one-quarter of the world's population from taking part in the information age. But new technology reaching the Asian market now allows users to write Chinese with a computer faster than doing it by hand. Two products, one from a Chinese company called Zi, works with current-generation PCs and uses a keyboard; another, compatible with higher-end computers and developed by IBM's research lab in Beijing, uses the spoken word. Both applications are to be bundled in some brands of PCs sold in China; other Asian and Western companies are expected to quickly follow what a Chinese-born linguist at Microsoft Research called a "revolution" in software. (Source: *Communications of the ACM*, vol. 41, No. 1, January 1998)

G. COUNTRY NEWS

China

Latest Internet numbers for China

China's Internet users have increased to 620,000 from less than 20,000 five years ago, reports the Xinhua news agency. About 300,000 computers are now wired to the global computer network, Xinhua said, quoting a report by the Data Communication Department of the Ministry of Posts and Telecommunications. More than 60 per cent of Internet users are 20 to 30 years old, Xinhua said, estimating that PC sales in China are expected to top 700,000 units this year. (Source: *Communications of the ACM*, vol. 41, No. 5, May 1998)

World's largest information technology market

China will in the next century become the largest information technology market in the world. It is believed that at the end of October 1997, Chinese computers connected to the Internet had increased to 50,000 from 10,000 at the end of 1996 with dial-in computers connected to Internet reaching 250,000. At present, Internet users in China have reached more than 600,000. China's education and research computer network has been connected to over 200 universities, with the China Science and Technology Network connecting 100 institutes. China's Public Computer Internet Network has covered 31 cities in the country and China Golden Bridge Information Network has opened its stations in 24 provinces, autonomous regions and municipalities. During the 8th and 9th Five-Year Plan periods, computer networks have been gradually connected, with the total number being connected going beyond 1,000. To promote the healthy development of a computer-based information network, China has recently published interim regulations on computer-based information networks and the Internet and an interim management method on registration at the Chinese Internet. (Source: *China Science and Technology Newsletter*, No. 138, 10 January 1998)

IBM strengthens cooperation with Chinese universities

At a ceremony in August 1997, IBM made a donation of S/390 large server equipment to the State Education Commission of China, the largest ever computer equipment donation the Commission has received. IBM reaffirmed that it would continue its efforts to strengthen cooperation with Chinese universities and colleges in the building of information technology to help improve computer skills. The value of the equipment, software, training and supporting service contributed by IBM on this occasion amounted to more than US$ 32 million, which is also IBM's largest single donation for educational purposes.

The donation is a part of the "Cooperative Program Between IBM and Chinese Universities", which began in 1995 when a memorandum of understanding was signed with the State Education Commission. (Extracted from *China Science and Technology Newsletter*, No. 135, 10 December 1997)

Germany

The electronics industry

Add up all the individual products and services supplied by Germany's electronic companies and you have a DM 350 billion-a-year industry, the third largest such market in the world. This industry's leading edge areas are registering double digit rates of order and sales growth. One key indicator is showing that boom times lie ahead for Germany's electronics industry. One key fact details what has unleashed this boom-in-the-making. The amount of new orders on the books of the country's electronics producers is currently running a strong 11 per cent higher than at the same time in 1996. Over the last four years, the industry's productivity (defined as the output per employee) has increased 32 per cent. As the new orders figure shows, this increase has made the industry's products highly saleable on the world's major markets. In 1996, the country's electronics industry proper (not including the software and certain service sectors in the IT sector) had a total turnover of DM 171 billion, accounting for one quarter of Europe's entire output. Of 1996's total, DM 120 billion was exported.

The electronics industry's increase in productivity is a direct result of its massive investment in new manufacturing facilities, equipment and other capital goods—i.e. DM 11.3 billion in 1996. This was the second highest figure in the industry's history and brought the four-year total to DM 41.4 billion.

Large and impressive though the figures for Germany's electronics industry are, they do not comprise its three fastest rising areas. Over the past decade, the highest and most consistent rate of growth in the industry has been recorded by IT software. Software is now a DM 34 billion a year business in Germany. Buoyed by Germany's massive move into the Web, IT start-up and link-up services are outgrowing even the software sector. This area has set to record a 10 per cent

rate of turnover growth in 1997, one which has brought its total volume to DM 17 billion for the year. But that is not all there is to Germany's IT services area. The biggest and fastest growing of them all in the services sector—or in German electronics as a whole—is the communication services area. Largely attributable to the explosively growing use of mobile telephones, the Internet and dedicated data transmission link-ups, this figure is bound to be eclipsed in 1998, when a fourth "turnover booster" is set to ignite the deregulation of the country's market for standard telecommunications services. Experts have predicted that the presence of three further major providers in the standard telephony field will stoke demand for telecom services by a further 15-25 per cent over the first three years. (Extracted from *Deutschland*, No. 1, February 1998)

India

United Kingdom links R&D in India to speed ATM routing

High-speed asynchronous transfer mode (ATM) routers could be the result of joint research being conducted by academic institutions in the UK and in India.

Liverpool John Moores University's School of Electrical Engineering and the MN Regional Engineering College in Allahabad have teamed up to develop an ATM switch to be used by the Indian telecoms industry.

The UK engineers will be using their digital signal processing expertise, while the Indians will be contributing their knowledge of telecommunications. (Source: *Electronics Weekly*, 11 February 1998)

Design rajas

It is well known that India has become a cost-effective place to go to find computer programmers and software engineers. The country now has 12 software technology parks set up next to major towns and cities, and highly experienced programmers can be employed for less than £20,000 per year.

But IT professionals are not the only knowledge workers being sought after. India is also a source of inexpensive design engineering talent. In addition, US- and UK-based chip suppliers can gain other advantages, besides low-cost access to skills, by operating in India.

In the recent past India has also been seen as a great opportunity for telecoms firms and consumer electronics manufacturers eager to expand sales through the development of new markets. Various companies—including GEC-Plessey Telecoms, Motorola and Philips—have dabbled with joint ventures and even invested in factories manufacturing products for the Indian market, but with mixed results.

For the moment, however, the shortage of design engineers in the West makes India a good bet for chip firms planning to increase design capacity.

The presence of several hundred engineering institutions in the country ensures the supply of high quality designers for IC developers setting up in India.

What precipitated the rise of R&D centres in India has been the recent development of an infrastructure within India's cities, particularly Bangalore.

Today India is doing its utmost to encourage inward investment and Bangalore can support the ISDN traffic required to send vast amounts of data to collaborating designers outside of India. (Extracted from *Electronics Weekly*, 21 January 1998)

Ireland

Adding value on the Internet

Five years ago the Electric Paper Company spotted a new niche: producing computer training courses specially for non-technical people. Today, the Dublin firm employs over 10 people and sells its successful CD-ROM training packages to clients around the world, including large organizations like ESB, Hewlett-Packard, Vauxhall and the South African defence forces.

According to Production Director Jonathan Parkes, the four multimedia courses in their "Understanding Technology" series can be used to train anyone, from the Chief Executive down, on everything from mousing to mail-merge, from PCs to the Internet. The Forbairt-supported company recently became the first Irish firm whose products are approved for the European Computer Driving Licence (ECDL), which sets internationally agreed IT competency standards.

Electric Paper wanted to explore how to repackage—or even re-engineer—its existing CD-ROM products so as to be able to deliver them over both company intranets and the external Internet. The firm was also concerned with security, especially protecting the copyright on its products. Finally, they wanted to look at what additional features could be added to exploit the potential of the new technologies.

The system also includes a database that records the class's progress through the course and the various mastery tests. A trainer can access the database at any point and monitor a student's success.

As for security, the current on-line prototypes include an encryption system that both protects the firm's copyrighted course content, and enables the firm to offer short-term rental options: when a customer's time is up their access to the course is withdrawn, unless and until they renew their subscription. Internet connectivity is of course crucial to the course on "Understanding the Internet", so the development team added software modules that enable the student to launch a browser seamlessly from within the course.

Prototypes of the new course packages are now being evaluated by customers using networks, home modems and high-speed ISDN lines. (Source: *Technology Ireland*, March 1998)

Japan

Japanese wafer makers to boost advanced material output

Japanese silicon wafer manufacturers will expand their epitaxial wafer production capacity to meet 64 Mb DRAM chipmaker demands. Sumitomo Sitix Corp. plans to invest more than $840,000 to double production capacity at both its Saga factory, which currently turns out 360,000 chips per year, and its Albuquerque, NM, plant, which produces 840,000. Mitsubishi Materials Corp. will double capacity at its Hokkaido and Oregon plants from the current 840,000 chips per year, and triple it by 1999. Toshiba Ceramics Co. expects to begin commercial production of 200 mm wafers early next year at its Yamaguchi plant—a joint venture with Tokuyama Corp.—at the rate of 960,000 per year. Shin-Etsu Handotai Co., the world's largest wafer producer, will expand output capacity in Japan, the US and Europe by investing $84,000,000 over the next two years to increase its current capacity from 1,200,000 wafers per year to 6,000,000 by March 2000. (Reprinted with permission from *Semiconductor International Magazine*, November 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

Hard choices as DRAM sector plummets

According to Japan's Economic Planning Agency, which tracks the country's leading economic indicators, the Japanese economy has contracted for seven months in a row.

So the Japanese semiconductor companies have to sink or swim by how successfully they can sell in international markets. And international markets for the product they mainly sell—memories—are the worst in living memory. The DRAM market, worth $40 billion in 1995, is expected to hit $14.5 billion this year.

The simple answer for the Japanese is to do what the Americans did in 1985—pull out of DRAM.

In 1984 the Japanese had invested more in DRAM capacity than they were to invest in any year since for more than a decade.

The industry is said to have lost $6 billion that year (when the world market was worth only $30 billion), with the Americans losing $2 billion and the Japanese $4 billion. But, while all the Japanese companies stayed in the DRAM business, all the Americans (Intel, Fairchild, National, AMD, Motorola), except for TI and Micron, pulled out of DRAM.

Beset by ruthless and unremitting cheap competition from Korea and, increasingly, Taiwan, the Japanese semiconductor companies know that in the long run they need to get out of DRAM.

But the Japanese majors have a problem that the Americans do not. Whereas the Americans can pull out of a product area, close the fabs, lay off the people and cut costs—as TI did when it pulled out of DRAM—in the Japanese culture lay-offs are still largely unacceptable.

What makes it worse is the Japanese semiconductor majors have all the infrastructure of companies with annual sales worth from $3-$10 billion. It is difficult to relinquish a third of your revenues while keeping most of your people and infrastructure in place.

However, some experts do not believe the Japanese will waver in their commitment to DRAM. (Extracted from *Electronics Weekly*, 1 July 1998)

Republic of Korea

Korean DRAM meets PC-100

Korea is implementing an aggressive strategy for the PC-100 DRAM market with Samsung planning to have 90 per cent of its production meeting the specification by the end of this year.

LG plans for 80 per cent of its production to meet PC-100 by the year-end, and Hyundai expects that "over 50 per cent" of its DRAM output will be PC-100-compliant in the fourth quarter.

The companies have split three ways between the interface options with Samsung preferring double data rate (DDR), LG plumping for Rambus, and Hyundai favouring SyncLink.

Korea's big three are pursuing the classic semiconductor industry strategy for bad times—to run faster with the technology. (Source: *Electronics Weekly*, 6 May 1998)

Korea software venture supporting centre opens in Silicon Valley

The Korea Software Incubator opened in Silicon Valley (California) in April. The incubator, located in the International Business Incubator (IBI) building in San Jose, is a culmination of the efforts of the Korean Government and software industry to make inroads into the huge American market. The centre is designed to help Korean software venture firms secure a foothold in the American market. It will support small but innovative software firms which have

had difficulty entering the US market for lack of funds and information. Specifically, the incubator will provide one-stop service for Korean firms to take root in the US market. While offering basic infrastructure needed to do business, including office and communications equipment, it will also provide legal, accounting and administrative support. The centre will also supply up-to-date information on technology and market trends and offer marketing and management consulting services. (Source: *Newsreview*, 2 May 1998)

Korea in U-turn on chip plan

Industry sources do not now expect the new Korean Government to pass legislation to force any of the Big Three chip makers to give up their semiconductor divisions.

With semiconductors accounting for ten per cent of South Korea's total exports, it has become a critical national industry. Hyundai and LG have announced ambitious semiconductor output targets for 1998, and Samsung and ASM Lithography have struck a deal, rumoured to be worth over $100 million, for steppers to convert Samsung's fabs to 0.22 µm processing. (Source: *Electronics Weekly*, 4 March 1998)

Mozambique

Mozambique unveils leading edge telemedicine facility

The Prime Minister of Mozambique, H. E. Mr. Pascoal Mocumbi, inaugurated the first telemedicine link of Mozambique and one of the first in Africa on 30 January 1998.

"Telemedicine" refers to the provision of medical services and health care via existing telecommunications-based systems (terrestrial and satellite links). The range of such services, making use of low-cost technology, is very wide, and includes medical consultation, pathology diagnosis, education and emergency services.

The central hospitals of Beira and Maputo will be able to make use of standard low-cost teleradiology equipment which provides support for the exchange and visualization of images including radiographs as well as for transmitting laboratory results or for communication (verbal or written messages). The project has been carried out by a multidisciplinary group of partners including Telecomunicaçoes de Moçambique and a telemedicine equipment vendor—WDS Technologies of Geneva.

Doctors at the hospital of Beira will now be able to refer cases to Maputo for a primary or second opinion. The availability of this new facility will also make it possible to send a medical record of a patient in Beira in order to assess whether hospitalization is required before the transfer of the patient to Maputo, thus minimizing inconveniences and unnecessary costs for patients and hospitals. The establishment of a link between the two sites is also expected to be beneficial for clinical and educational purposes.

The project is the first pilot project in Africa to be launched by the Telecommunication Development Bureau (BDT) of the International Telecommunication Union (ITU) in order to evaluate the potential of information technology to solve some of the developing world's most acute health-care problems. It responds to recommendations of the ITU's World and Regional Telecommunication Development Conferences of Buenos Aires, Abidjan and Beirut. It also follows the adoption of a major ITU report presented at the World Symposium on Telemedicine held in Portugal last year entitled *Telemedicine and Developing Countries*.

The Mozambique project is intended to serve as one of a series of case studies involving the BDT and other partners and as a model for other telemedicine projects to be undertaken by public and private initiatives. The case studies aim at showing the different applications of telecommunication and information technologies for telemedicine and how telemedicine can help overcome some of the serious shortages in health-care services in developing countries.

For further information you may contact: Mr. Leonid Androuchko, Telecommunication Development Bureau, ITU, Tel.: +41 22 730 5433; Fax: +41 22 730 5484, E-mail: androuchko@itu.int. (Source: *News Release*, 30 January 1998)

Switzerland

STM sets up wireless design centre

A design centre for wireless communications chips has been set up by SGS-Thomson Microelectronics (STM) in Geneva. The centre is designing for GSM and code division multiple access (CDMA) mobile phones. "In the GSM market we have been supplying custom solutions including single-chip baseband devices", said a spokesperson. The centre will look to turn these designs into standard products. In the longer term, the centre will also develop chipsets for the UMTS third generation mobile phone standard. (Source: *Electronics Weekly*, 11 March 1998)

United Kingdom

British to investigate silicon carbide

The British Government's Engineering and Physical Sciences Research Council has made a grant of $1 million to a consortium of UK researchers who aim to make the UK work with this material competitive with that of the rest of Europe. The commercial partners are contributing more than $1 million. The main limitation to the use of this material in power devices has been crystal defects that limit the size of high-quality silicon carbide crystals that can be obtained. This limiting size has been considerably increased in the past few years. Mark Johnson of the University of Newcastle is leading the academic work in collaboration with the Defense Evaluation Research Agency (Malvern, UK), Mitel (formerly GEC Plessey Semiconductors), the GEC Alsthom Engineering Research Center, AEA Technology, Samelab and GEC Marconi Materials Technology. ABB leads the European work on silicon carbide for high-power and high-temperature applications in Sweden, but Siemens is also involved in Germany. (Reprinted with permission from *Semiconductor International Magazine*, July 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA)

Upstarts challenge traditional models

A fresh crop of young British information companies are emerging with very different ideas to traditional database vendors. Mondaq, Perfect Information, and City Mutual are all using the Internet to break the mould in their respective fields.

London-based Mondaq has created a free Web database providing advice and guidance from top accountancy and legal firms which has attracted over 85,000 registered users with between 800-2,000 said to be signing up each week. What sets Mondaq apart from established vendors is that it charges publishers to offer information via its database rather than the users for accessing it. Mondaq now also has its own

Website which has over 80,000 registered users, 70 per cent of whom are based in the UK and US.

Perfect Information has teamed up with Internet service provider BusinessNet and networking specialist Cisco to develop what it claims will be the "Amazon.com" of company document delivery. Through a new network called IntraCity, which provides a 622 Mb ATM network throughout the City of London, PI will be able to deliver secure documents at high speed to the intranets and desktop PCs of clients in the City of London. Meanwhile the use of the Internet TCP/IP standard protocol will allow PI to extend its services to occasional users worldwide.

City Mutual is launching a pan-European business intelligence service, which was first developed by its subsidiary VK Europe for the education market. The Web-based Reconnaissance service contains over 120 files on the history and workings of the European Union and Europe, including eastern Europe and the 15 republics of the former Soviet Union. The service offers historical and economic perspectives on the European Union and 52 full country files on European countries, with details on their history, politics and government, economics and business culture, transport, agriculture, environment. (Source: *Information Today*, 15 (5) May 1998)

University opens lab

Queen's University Belfast has opened a DSP intellectual property research centre.

Called DSiP Laboratories, it has been established with funding from the European Regional Development Fund. The activities of the Centre will be overseen by an advisory board comprising representatives from companies including Analog Devices, Integrated Silicon Systems, Nortel, VLSI Technology and Xilinx, as well as representatives from Government research laboratories. (Source: *Electronics Weekly*, 8 April 1998)

UK banks target New Year cards

UK banks will introduce smartcards for credit and debit card use from next year.

The key attraction of using smartcards is the increased security they offer, according to banking industry body the Association for Payment Clearing Services (APACS).

The plan will involve over 104 million cards, a considerable proportion of the expected worldwide smartcard market estimated by Dataquest at over 825 million units in 1999.

However, the national roll-out of the cards has been opposed by the British Retail Consortium (BRC) which wants current trials to continue until all the technical issues are resolved. The group, which represents 90 per cent of the UK retail trade, said that its members will not be involved with smartcards until all issues of concern have been addressed.

It fears that the cards and the associated technology will be costly to introduce and that the financial implications and benefits to retailers and their customers still need to be clarified. (Source: *Electronics Weekly*, 15 July 1998)

EU directive benefits UK databases

UK owners and developers of electronic and non-electronic databases stand to benefit from the creation of a European Union-wide database directive that came into force on 1 January 1998. The database directive prevents an unauthorized extraction of a part or whole of the contents of a database. This will protect the investment of money, time and effort that goes into compiling databases as well as encourage the development of new databases and similar

information products. (Source: *Electronics Weekly*, 14 January 1998)

Chip design centre Alba may put Scotland on top of world

The Government, Scottish Enterprise and Cadence Design Systems have announced the creation of an advanced chip design centre in Livingston, Scotland.

But the project, dubbed Alba, goes much further, with the setting up of degree courses at local universities and an intellectual property (IP) exchange centre.

The design centre will create between 1,800 and 1,900 jobs, giving rise to close to 6,000 jobs in total with a 2:1 ratio of employment creation in the community. Cadence is setting up a leading systems-on-a-chip design centre in Livingston, and will spend several hundred million dollars.

This will be the largest and most important centre in Cadence's chain of design houses called design factories. Other units specialize in digital, RF, analogue and mixed signal design. This means Scotland could become the world's mot important centre for chip design.

Scottish Enterprise hopes the design factory will seed further investment from other companies including start-ups.

In addition to the design facility, an educational centre will be created.

This will be run by four Scottish Universities—Edinburgh, Glasgow, Heriot Watt and Strathclyde.

The Scottish universities will have a masters degree course for system-on-a-chip design in place by the next academic year. This aims to redress the severe shortage of capable chip designers.

Perhaps the most technically exciting and challenging part of the project is the setting up of an IP exchange.

System-on-a-chip ICs are the next stage of miniaturization in electronics, and their design requires IP. It is no longer possible to design from scratch multimillion gate chips with today's time-to-market pressures.

Project Alba hopes designers will register their IP at the exchange. Users of IP would then negotiate with the exchange, leaving the IP companies to get on with designing.

The thorniest issue when transferring IP between companies is the legal one. Since the US is a litigious country, siting the exchange there was out of the question. Scotland was chosen for the converse reason.

IBM will supply the required electronic commerce technology needed for exchanging IP. (www.sli-scotland.org.uk) (Source: *Electronics Weekly*, 17 December 1997)

Last British-owned fab sold

GEC Plessey Semiconductors (GPS, Swindon, England) has been sold to Mitel, a Canadian telecommunications group, for $225 million. This sale of the sixth largest European semiconductor company ends a more than 30-year struggle to develop a significant British-owned semiconductor industry under successive governments. Global competition led to various mergers among GEC, Plessey and Ferranti that finally brought the formation of GPS, whose name will now disappear.

GPS has >2,700 employees and produces chips mainly for the communications, personal computer, media and defense industries. In mixed-signal ASICs it is one of the top 10 manufacturers in the world. It made a pre-tax profit of $11.8 million on sales of $300 million in the year ending April 1997. The acquisition will expand Mitel's existing

semiconductor operations, giving it a 0.35 μm (350 nm) fab processing 200 mm wafers at Roxborough. Mitel has previously been limited to 0.8 μm (80 nm) production, mainly for devices for telecommunications. Last year Mitel acquired ABB Hafo Semiconductors. Reprinted with permission from *Semiconductor International Magazine*, April 1998. Copyright 1998 by Cahners Publishing Co., Des Plaines, IL, USA.

R&D labs promote UK as world chip centre

Five research laboratories are collaborating to promote the UK as a centre for microelectronics research and training.

The Universities of Southampton, Edinburgh and Surrey, the Rutherford Appleton Laboratory and the Defence Evaluation Research Agency plan to coordinate their research and share resources for the production of advanced ICs. The five labs will also set up a virtual fab, that will focus on producing 0.1 μm process CMOS devices.

Training is another key issue for the initiative, known as The Network of Excellence in Silicon Microelectronics (NESM).

The five members of NESM will put together "one of the most comprehensive courses on semiconductors". (Source: *Electronics Weekly*, 25 March 1998)

United States of America

Computer experts urge new federal initiative

Recently, 200 experts from academia, industry, and government gathered in Washington, D.C., to help put together a potential major research initiative: an effort spread among several government agencies to build the next generation of US supercomputers. The National Workshop on Advanced Scientific Computation reached broad agreement that the Government should invest about $1 billion over the next four years to develop a national network of supercomputers for civilian use, together with supporting technology and cutting-edge software.

The ultimate goal would be to construct two 40-teraflop machines by 2003, each of which would be 200 times more powerful than the best supercomputers in universities today. (A teraflop is 1 trillion operations per second.) To allow scientists across the country access to the new machines, workshop participants also agreed to urge the government to bankroll a network of scientific and support centres.

If the proposal is approved, it would provide a civilian counterpart to the Accelerated Strategic Computing Initiative, a 2-year-old DOE project to develop a 100-teraflop machine in the next decade that would be used to model the behaviour of nuclear weapons. Although some universities have constructed high-end computing systems, their machines cannot keep pace with the demands of scientists for faster number-crunching capabilities for tasks such as mapping climate change, simulating combustion systems, or studying a microbe's interaction with its environment. (Extracted from *Science*, vol. 281, 7 August 1998)

No. 1 Industry in the US? Information technology

Sales by the American computing and telecommunications industries have grown by 57 per cent during the 1990s, to $866 billion, making those businesses an increasingly important force in the country's economy, according to a new study.

The field of information technology—often defined as both computing and telecommunications—is the largest American industry, ahead of construction, food products and automotive manufacturing, the study concluded.

The study represents perhaps the most comprehensive statistical portrait to date of what is called "the new economy"—populated by high-technology companies that generate new wealth, new work practices and new challenges in public policy.

It was sponsored by the American Electronics Association, a trade group, and the Nasdaq stock market, which lists the shares of a large number of high-technology companies.

The study, based on Commerce Department data, is titled "Cybernation: The Importance of the High-Technology Industry to the American Economy".

For purposes of the study, telecommunications was grouped with computer hardware and software as a single field mainly because the technologies are so closely linked.

The high-technology sector, the study reports, generated 6.2 per cent of the nation's output of goods and services in 1996 and employed nearly 4.3 million people. Workers in the field earn wages 73 per cent higher than the average wage in the overall private sector, the report shows.

Productivity—or output per worker—in the high-technology field is also growing sharply. From 1990 to 1996, as high-technology revenues increased 57 per cent, to $866 billion, the report said, employment rose 7.2 per cent, to 4.26 million.

The revenue and employment figures in the study were assembled from the Government's statistics, grouped by type of business. The study included sales and jobs data reported by companies in 45 of these industrial groups. (Source: *Herald Tribune*, 19 November 1997.

Industry consortium joins with Government in EUV project

A private industry consortium led by Intel, Advanced Micro Devices and Motorola have joined with the Virtual National Laboratory (VNL)—consisting of three US Department of Energy (DoE) installations: the Lawrence Livermore National Laboratory, Sandia National Laboratories and E. O. Lawrence Berkeley National Laboratory—to launch an advanced lithography research project targeted at increasing computer chip capabilities. The lithography technology being considered, extreme ultraviolet (EUV), could allow the etching of 0.1 µm linewidths, theoretically making microprocessors 100 times more powerful and memory chips capable of storing 1,000 times more information than is presently possible. The group, known as the EUV LLC (Extreme Ultraviolet Limited Liability Company), will invest $250 million in private funding over three years, to develop EUV lithography for the commercial manufacture of computer chips. This is the largest investment ever by private industry in a DoE research project. (Reprinted with permission from *Semiconductor*

International Magazine, November 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

Television censor sensor could appear in US PCs

US PCs may soon be shipped with the controversial V-chip which blocks violent scenes in television programmes.

The US Federal Communications Commission (FCC) says it is looking at federal laws that apply to the V-chip and will issue a ruling on whether PCs should include the IC. Several companies already produce hybrid PC/TV systems, and Gateway 2000 says it is making plans to include the V-chip in its Destination PC/TV system if there is an FCC ruling.

The FCC published a report recommending that the law be applied to PCs. "We believe that the program blocking requirements we are proposing should apply to any television receiver—including PCs—meeting the screen size requirements", it said.

However, many computer and Internet companies oppose any attempt to censor Internet content and have fought against proposed laws that would make it illegal to transmit sexually explicit images.

The V-chip is designed to screen out violent content but it could also be used to filter sexual images. According to a US law, all TVS must carry a V-chip within the next two years.

The V-chip could even become available early next year in special converter boxes attached to televisions. The V-chip relies on TV broadcasters tagging violent shows with codes that enable parents to decide which programmes their children can watch. (Source: *Electronics World*, January 1998)

Postage stamps to go electronic

The US Post Office has approved the first digital postage stamp. Called an electronic indicia, the stamp will initially be trialed in the Washington, D.C. metropolitan area.

The US Post Office hopes to make it easy for business and home users to download postage over the Internet and use their PCs to print postage directly onto envelopes or mail items.

E-Stamp, the company which has developed the SmartStamp technology, has successfully completed a two-year testing phase to ensure the technology is secure.

SmartStamp works by customers purchasing postage on-line and downloading it into the E-Stamp security device, an "electronic vault" that connects to a PC's printer port. As users address envelopes using a word processor, E-Stamp Internet Postage verified the address and prints a SmartStamp, deducting the amount from the vault. (Source: *Electronics Weekly*, 8 April 1998)

H. STANDARDIZATION AND LEGISLATION

Standardization

China blazes the trail for video CDs

For the first time, China is shaping the future of electronics by creating a new world standard. Its video standard has won support from Philips, Sony, Matsushita (Panasonic) and JVC. The International Electrotechnical commission should rubber-stamp the super video CD (SVCD) as a world standard later this year. The format will be used for education, interactive training, movies and karaoke.

Video CD was launched around five years ago. A conventional CD stores around 75 minutes of heavily compressed moving video. Although the discs can be pressed cheaply, at least two are needed for a full-length feature movie, and the quality is no better than VHS tape. Instead, The West has leapfrogged over video CD to DVD, a digital video disc that can store more than two hours of much higher quality video.

But last year the Chinese Government decided to bypass DVDs, which are expensive to press, and improve on video CD. SVCD has borrowed a data-efficiency trick developed for DVD. When video and audio signals are converted into a stream of bits, the data rate varies. When the picture is static and the sound is quiet, the bits stream slowly. When there is a lot of movement and sound, more bits are used.

China's new video CD delivers near broadcast-quality pictures and sound, and can be mass-produced by the hundreds of CD pressing plants now running in China and the Far East. (Source: *New Scientist*, www.newscientist.com, 15 August 1998)

Brochure details valuable standards resource

Now in its 33rd year of operation, the NIST-managed National Center for Standards and Certification Information serves as a referral service and focal point in the US for up-to-date information about standards, technical regulations and conformity assessment programmes—domestic, foreign and international. The centre's staff respond to inquiries, maintain a reference collection of standards and standards-related documents, and operate two telephone hotlines that provide information on proposed foreign technical regulations issued by the World Trade Organization (301-975-4041) and draft European Union/ European Communities standards (301-921-4164).

A new brochure prepared by NIST's Standards Information Program details the services offered by the NCSCI. The document explains how the centre operates, describes the reference collection and guides potential users on the best ways to access the many resources available.

Copies of the brochure may be obtained by sending a self-addressed mailing label to the NSCSI, Bldg. 820, Rm. 164, NIST, Gaithersburg, MD, 20899-0001. Copies also may be requested by calling (301) 975-4040, faxing (301) 926-1559 or sending electronic mail to ncsci@nist.gov. (Source: *NIST Update*, 31 August 1998)

Adoption of the G.Lite networking standard

The Universal ADSL Working Group (UAWG)'s G.Lite networking standard, also known as DSL Lite, is far from the panacea it is portrayed in the popular press. It does provide for the first time a standard way everyone can agree upon to build equipment for ADSL service but still faces hurdles. First the International Telecommunications Union (ITU) has to start blessing the standard for it to truly be accepted by telephone companies. Any market trials or rollouts of G.Lite before then are using prestandard implementations that may not interoperate although the UAWG is conducting its own prestandard interoperability tests.

This lack of a standard will almost certainly keep it out of computer stores while competing technologies are still lurking. These could fracture the phone network in a permanent way or raise costs as equipment providers have to support multiple standards. Technologies like Nortel's EtherLoop and Paradyne's MVL are seizing niche opportunities in places where the need for ADSL today overwhelms the need to wait for a standard implementation. Service providers are also facing a diverse range of customer expectations from the first time to sophisticated PC users.

Despite these hurdles ADSL is rolling out on an unprecedented scale, even though all the services are pre-G.Lite. There are new ADSL chip sets already shipping, such as Alcatel's DynaMiTe chip set, newcomer PairGain's Falcon DMT chip set licensed by Rockwell, and Motorola's CopperGold. These chip sets in turn are allowing second generation central office multiplexers with lower power consumption, less crosstalk, and higher port density than their predecessors. (Source: *Byte*, July 1998)

Wideband CDMA is favourite

Wideband CDMA, the mobile phone protocol being championed by Ericsson and Nokia, looks set to be adopted for the next generation of mobile phone standard in Europe.

A vote of members of the European telecoms standards body (ETSI) at the end of 1997 came down in favour of the W-CDMA digital radio protocol rather than the time-division CDMA alternative that is being championed by Alcatel, Siemens and Nortel.

Motorola has hedged its bets by backing the two leading protocols.

The W-CDMA protocol, which is being adopted in Japan and South Korea, will be integrated into the GSM network infrastructure to support broadband services such as high speed data and video in the next generation of mobile phones known as UTMS. (Source: *Electronics Weekly*, 7 January 1998)

In the open

Eight of the world's largest electronics companies have agreed a common "home network" standard that allows any audio or video device to be linked up. With the audio and video connected to a network, one remote control can work for everything. The eight companies—Grundig, Hitachi, Matsushita, Philips, Sharp, Sony, Thomson and Toshiba—will make the standard "open" so that other manufacturers can make compatible equipment. The move challenges Microsoft's plans to make Windows software the standard for controlling audio and video in the home. (Source: *New Scientist*, 18 April 1998)

ITU approves a standard for transmission systems for interactive cable television services

The ITU Study Group 9 which deals with standards for cable television systems, has approved a landmark standard which will allow transparent bi-directional transfer of Internet Protocol (IP) traffic, between the cable system hub and customer locations over an all-coaxial or hybrid-fibre coax (HFC) cable network.

This standard, designated Recommendation J.112, defines modulation protocols for high-speed bi-directional data transmissions, such as those used for Internet communications. Recommendation J.112 will enhance interactive cable television services providing transmission data rates up to 30 Mbps, and should result in worldwide economies of scale and interoperability benefits.

Over 60 per cent of all households worldwide have a TV and 15 per cent are already cable TV subscribers compared to 40 per cent that have a phone line. Given the phenomenal take-up rate of the Internet which has now over 50 million users, the availability of two-way transmission systems is expected to be a boon for the cable TV industry which already boasts over 200 millions of consumers worldwide. Moreover, cable systems could represent, for developing countries, a promising avenue to leapfrog to broadband networks capable of supporting voice, video, data and Internet services.

Recommendation J.112 includes three annexes which address the unique requirements of the European, North American and Japanese/Asian sectors respectively. (Source: *News Release*, 16 April 1998)

Here at last—a 56k modem standard

A single 56 kbit/s modem technology standard has been finally ratified by the ITU effectively unifying the incompatible K56flex and X2 rival modem technologies.

The standard, called V.90, is being supported by all the major modem manufacturers and the first V.90 modems are expected on store shelves by March. Existing modem users will also be able to upgrade their modems to V.90 through a free software upgrade.

Modem companies are rushing to test their modems against each other to make sure that there are no compatibility problems.

Modem chip companies and modem vendors hope that the V.90 standard will help boost modem sales which have slowed over the past few months as customers postponed purchases until the single standard was available. (Source: *Electronics World*, April 1998)

International charter proposed to regulate Internet

European Union Commissioner Martin Bangemann proposed at a conference on the Global Information Society an international charter that could be used to regulate the Internet. The proposal is an alternative to a government-style regulatory body, on one hand, and uncontrolled, free-market behaviour on the other. While Bangemann believes the international standardization system works well, the danger exists that early standardization can stifle innovation. He suggests a set of common principles for standards bodies and users to apply: (1) Standardize only if necessary, (2) Standards should help to enhance self-regulation, and (3) International standards are the best choice, instead of regional or national standards. (Source: *ASTM Standardization News*, February 1998)

Mobile phone operators move closer to worldwide standard

World mobile phone operators have moved closer to creating a global mobile communications service.

The world's telecoms standards bodies under the guise of the International Telecommunication Union (ITU) have agreed to collaborate to ensure that the next generation of mobile phones will work on all continents of the world. If driven through by the operators this will mean that European handsets conforming to the proposed next generation UMTS standard will operate on networks in North America and Japan.

While the US, Europe and Japan are pursuing different technical standards for future mobile phones, this ITU agreement should ensure that operators support the use of dual standard handsets on their networks.

The move, which is being promoted as the International Mobile Telecommunications 2000 (IMT-2000) initiative, also includes for the first time cordless telephones used to replace fixed line telephone services in homes and offices.

This means that mobile phones will also have to be usable as cordless telephones, such as Europe's DECT standard, in the home.

There are also proposals to increase the data bandwidth of next generation mobile phone systems to let them compete with fixed line services. However, the 2Mbit/s data rate proposed for mobiles falls well short of current fixed-line technologies like ADSL, which operate at up to 6 Mbit/s in one direction. (Source: *Electronics Weekly*, 27 May 1998)

TSB makes ITU-T terminology and newly approved Recommendations available on Internet

On the occasion of World Telecommunication Day (17 May), the Telecommunication Standardization Bureau, which is responsible for, among other things, the preparation and updating of the databases of the Telecommunication Standardization Sector, will launch on the Internet a comprehensive database of terms (with their definitions) and abbreviations relating to standardization.

With over 12,000 definitions and more than 8,000 abbreviations drawn from 35,000 pages of Recommendations currently in force, the database will be available free of charge to the general public. Some 200 new and revised Recommendations are approved every year. Taking 1997 as an example, this represents 14,000 pages of text per language (English, French and Spanish).

With the information revolution proceeding apace, the world telecommunication community has to have access to the very latest information on standardization activities. To cater for this need, three categories of Recommendation have been available on the Internet since March 1998, namely Recommendations in force, newly approved Recommendations and deleted Recommendations.

The posting on the Internet of the newly approved category of Recommendations is in response to the request made to the Director of TSB by the World Telecommunication Standardization Conference (WTSC-96) in its Resolution 1, which states that approved Recommendations should be "available online in at least one working language; with an indication that the Recommendation may not be in its final publication form".

The availability on-line of the deleted category of Recommendations is in response to a request made by the telecommunication Standardization Advisory Group at its last meeting in January 1998. (Source: *ITU News*, April 1998)

Legislation

Free patent information

The European Patent Office (EPO) is following the lead of the US by offering the full text of patents free on the Internet in a plan which will result in a super server that also offers North American and Japanese patents. The EPO project is split into two stages. In the first stage, due for completion by the middle of this year, national Internet servers will be set up in each of the EPO's 18 member states. Each of the national servers will be linked so that users will be able to find related patents from one country to the next. In the second stage, EPO data will be added, including keyword-searchable abstracts in English, along with the full text of patent documents.

What appears on the surface to be good news for information users could leave patent specialists in a technological limbo, according to the author. The EPO said it will limit the search functionality on its Internet service so as to not threaten the business of the on-line hosts. No one is sure, however, whether there will be enough remaining patent revenue to convince the on-line vendors to maintain and develop search tools for specialist searchers.

Officially, the on-line vendors support the EPO's viewpoint, but privately express concern. They argue that the production of patent databases with high-quality abstracting and indexing is an expensive business and can only be commercially viable if the costs are passed on to the information professional community. They would like the EPO to limit its service to a very basic service with links to the hosts offered for those needing more sophisticated searching.

The US in particular is further down the road when it comes to offering patent data on the Internet free of charge. In January last year, IBM launched a free Web service offering information contained in more than 2 million US patents issued in the past 26 years. Searches can be carried out by patent number, keywords, title, inventor, assignee, abstract, claims, attorney/agent, and patent references.

Full images of nearly 1 million US patents issued since 1987 can also be viewed free of charge. IBM launched its service to show off its Internet technology, particularly its DB2 relational database.

The impact on those who based their business on selling patent data was immediate. MicroPatent announced in the same month that it had opened its fee-based Online Gazette to users free of charge. The Online Gazette, which is part of MicroPatent's PatentWEB site, contains fully searchable summary information, which includes abstracts and an exemplary claim, for each of the approximately 2,500 new US patents issued each week. MicroPatent hopes that the free access to the Online Gazette will increase the company's Patent-Images downloading business. (Source: *Information Today*, March 1998)

Copyright code

Union, a committee of 700 European industrial property lawyers, wants the European Commission to clarify the law on patenting computer software. The present law confusingly says that programs "as such" are not patentable. No one knows what this means.

Inventors often describe their software as "systems" to get round the law. One patent examiner admitted: "It is like a camel, difficult to define, but you know it when you see it." Union fears it could take ten years to get all 15 states to change their laws. So it wants the European Patent Office to rule that a computer program cannot be patented because it is already protected by copyright. (Source: *New Scientist*, 9 May 1998)

Digital watermarking: intellectual property protection for the Internet?

Watermarking has been used since the early days of paper making for security, to denote paper quality, or as a subtle promotional technique. There is usually no attempt to hide a watermark and they may be used sometimes to denote document validity. Digital watermarks differ from printed ones because they are usually hidden from the user and can be applied to several different types of media—text, images, and sound. This means that digital watermarks are attractive to people who wish to add security to their products, people such as publishers, music producers, and photographers. Digital watermarking is part of the science of steganography (covered writing). Other relevant terms are data hiding and information hiding. Digital watermarking uses naturally occurring variations of text and images and cannot be seen by the user unless special techniques are employed.

Some major corporations are investigating the use of digital watermarking and developing applications. These include AT&T Research Laboratories; IBM; and NEC Research Institute. In addition, several smaller companies have also entered the field and are selling application software. To be effective, digital watermarks must be incapable of being altered or removed by would-be pirates. It is concluded that digital watermarking shows significant promise as a method of protecting electronic intellectual property that is available on the Internet. Advantages of the technology include copyright protection; finding unauthorized reproduction of images; dissuasion of potential pirates; and generating sales by linking image viewers with company information through the watermark. It should be recognized that watermarking does not prevent unauthorized copying but it enables detection of unauthorized distribution of material. Watermarking is not yet widely accepted, so it remains to be seen if watermarking or another technology will be the final solution to protecting property on the Internet. (Source: *ONLINE*, 22 (4) July/August 1998)

On beyond copyright

It is unusual for authors of articles in scholarly journals to receive any recompense for their work. Many, if not most, authors assign rights in their work to the publisher without taking account of how such material might subsequently appear in other media. Moreover, they often fail to reserve rights to future use in their own classroom or for reserve collections.

Given the development of electronic journals, however, perhaps it is time to look again at such issues as fair use, the relationship between information and intellectual property, copyright and the economic ramifications of the new technology.

Some moves in this direction have already been made. The (US) conference on Fair Use (CONFU) was convened in 1994, charged with developing guidelines for fair use in the context of networked systems. Participants included representatives of the publishing, education and business sectors, as well as authors. Unfortunately, insufficient common ground was discovered to enable them to produce satisfactory guidelines by the time of the final meeting in 1997.

Nonetheless, the forces impelling a thoroughgoing review of copyright remain. Educational institutions are looking for ways to reduce costs and generate income through marketing the intellectual property created by their staff. One possibility, therefore, is that academic authors be required to assign copyright in articles to the institution, rather than the publisher. Publishers, however, are examining how they may recover the expenditure incurred in the development of new publishing mechanisms. In this environment, both parties are resorting to licensing agreements rather than simply relying on copyright legislation. (9 notes. 1 appdx. Selected readings. JB) (Source: *The Serials Librarian*, 33 (1/2) 1998.

Agreement among Internet providers will regulate domain name registration

Internet service providers and telecommunications companies have joined in a pact designed to bring order to the registration of Internet addresses and put together a regulatory structure for the 21st century.

The agreement calls for a worldwide network of cyberspace registrars that would be overseen by two United Nations organizations. It would also implement an arbitration process in the World Intellectual Property Organization (WIPO) Arbitration and Mediation Centre in Geneva to resolve domain-name disputes over trademarks.

The memorandum sets up a new self-governing system for the registration of Internet addresses, to be policed by WIPO. One of the major results will be the ending of the monopoly now held by Network Solutions Inc. (NSI) of the US on the present three generic names .com, .org. and .net.

To ease the pressure on registration, another seven generic domain names will be created:

- .firm (for companies);
- .store (goods for sale);
- .web (World Wide Web activities);
- .arts (culture);
- .rec (recreation);
- .info (information); and
- .nom (individual Web sites).

Initial signatories were the Internet Assigned Numbers Authority (IANA), the Internet Society (ISOC), WIPO, the International Telecommunication Union, and the International Trademark Association (INTA).

Among the major companies which endorsed the plan were Digital Equipment Corporation and MCI. Telecommunications companies singing included France Telecom and Tella of Sweden. (Extracted from *World Intellectual Property Report*, vol. 11, 1997)

I. RECENT PUBLICATIONS

Expert textiles tuition available on-site and on-tap

Significant savings could be made in staff training costs using a unique multimedia CD-ROM launched by the School of Textile Industries at the University of Leeds.

Introduction to Textiles is a versatile and simple to use programme providing more than 70 hours of structured tuition on 82 topics, including:

- Yarn manufacture
- Production of knitted woven and non-woven fabrics
- Basic knitted and woven fabric structures
- Textile dyeing and finishing and fabric printing
- Apparel manufacture
- Textile testing and quality assurance

Its authors believe it will eliminate the need for time-consuming off-site training for staff or expensive consultancy services by providing expert on-site tuition whenever it is required, at a moment's notice.

The programme has been designed to be the most comprehensive educational and training package available in the world of textile and apparel manufacture. The topics are set out in manageable sections and the versatile structure enables the user to study for short periods if necessary without detracting from the overall continuity. A bookmark facility lets the user resume studying at the exact point they left off.

Introduction to Textiles is already used by first-year textiles students at the University of Leeds, and has proved to be a great success. Students have welcomed the opportunity to manage their own learning and improve their understanding of the concepts involved.

The package is already used by several universities and educational institutions worldwide as well as industrial clients such as the major textiles manufacturers Coats Viyella, Unilever Research and the CAPITB group, the national training organization for the clothing sector.

Anyone requiring a fundamental understanding of the processes involved in textiles or apparel manufacture would benefit from the programme. It is easily understood as well as being stimulating and fun to use. The learning process is enhanced by the use of hundreds of quality audio and video sequences, graphics, animations and colour photographs, together with a glossary of terms and bibliography for further reading. Freeze-frame and slow motion facilities allow the user to follow and understand complicated processes or intricate workings of machinery more easily.

Once completed, subjects may be freely browsed, with hypertext links to provide a valuable reference resource.

For further information, contact Mr. Tony Smith, Department of Textile Industries on 0113 33 3801, or Dr. Simon Harlock on 0113 233 3698. Alternatively, contact Joanne Kelly, PR Co-ordinator, University of Leeds Innovations Ltd. on 0113 233 5789.

NIST writes the next chapter in book publishing

A new industry will emerge in the next year as several manufacturers begin selling electronic books. These hybrid products combine features found in books and computers. For example, touch screen technology allows a reader to touch an unfamiliar word to obtain an immediate dictionary definition. Touching the screen elsewhere can make the print larger or smaller. Yet another touch allows a reader to underline a section using a fingertip instead of one of those yellow markers.

Several recent technological advances have converged in a way that makes electronic books both technically and commercially feasible. Electronic book manufacturers expect to take advantage of developments in fields such as video display technology and computer storage capacity. (Source: *TechBeat*, September 1998)

Full text journals on the Web

One profound change created by the Web is that we can at last acknowledge the reality of the electronic journal: either a uniquely electronic entity or an on-line version of an existing printed title. New services are now coming to market that let customers use their PCS and the Web not just to identify, but also retrieve an electronic facsimile of a journal article, with all its complex formatting intact.

The publishers of academic and professional journals in a wide range of subject disciplines can now reach their customers directly using the global reach of the Web, without reliance on the likes of a Dialog or Lexis-Nexis. Although this represents the anticipated evolutionary path of electronic publishing, since the tools of Web server, browser and HTML have become cheap commodities, the rise of the electronic journal may prove problematic as well as beneficial.

What seems clear is that the traditional on-line vendors may not have the licensing deals in place to provide on-demand delivery of journal articles in an as-published format via the Web, despite the self-evident fact that they have the huge advantage of mature, highly structured bibliographic databases. Besides offering cross-file searching and record de-duplication, an on-line supermarket host presents just one

monthly invoice; yet the lack of seamless linkages from citation and abstract directly to an electronic document delivery mechanism leave them exposed to new Web-based electronic journal services. Secondary publishers such as UMI and IAC have begun to attack the territory of on-line vendors, and now the primary publishers are following. (Source: *Managing Information*, 5 (3) April 1998)

New primer helps improve use of electron-beam moiré technique

Engineers and researchers in the area of electronics packaging will want to get a new publication from NIST that describes procedures for the relatively new electron-beam moiré technique which measures submicrometre strains on a local scale in electronic packaging. In particular, it can measure the thermomechanical displacement caused by thermal expansion mismatches among the various materials used in an electronic package.

Measurements of displacements can be used to validate computer models or otherwise contribute to the assessment of the reliability of the packaging. The new publication describes the background, setup and procedures for the electron-beam moiré technique and is intended to give readers enough information so that they can conduct an experiment in their own laboratories. Such experiments would include a scanning electron microscope, access to electron-beam or other type of lithography process, and computers to run the lithography process and aid in reducing and analysing the data.

The publication covers specimen preparation, electron-beam lithography, thermal testing, mechanical testing and analysis of the moiré fields. It also contains, as appendices, nine papers on electron-beam moiré theory and applications by NIST authors. A program disk is included with the publication. (Source: *NIST Update*, 31 August 1998)

Neural Networks—producing dependable systems—selected papers

Neural Networks have the potential to be used in a wide range of industries. The current under utilization of the technology may be due to the lack of proven dependability of these systems. The ways of monitoring and measuring reliability and dependability are increasing, however until these methods are acknowledged as providing proof of dependability, industry will remain reluctant to use the technology, particularly in commercially or safety critical areas. These selected papers focus on dependability. The papers under "Network dependability" studied: are neural network (NN) combinations more reliable?, robust non-linear models through bootstrap aggregated NNs, engineering multiversion reliability, GTM—a validatable alternative to the self-organizing map; and selecting appropriate dependability criteria for NNs. "The practical reality of producing dependable systems" examined, theory building— a constructive approach to modelling NN development processes, the comprehensibility-accuracy compromise in NN validation, verification and validation of an NN flight control system; and certification of NNs. (Leatherhead, 1997, price £90.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

Web inspection for printing and packaging—conference notes

Thorough inspection is the only way of ensuring the quality of products now demanded by consumers. This can only be consistently obtained by using automated inspection techniques. Automated web inspection is tried and tested; it can result in cost, time and energy savings as well as improved quality. This conference looked at the help this technology can provide for the industrial user in the area of printing and packaging. It highlighted both the possibilities and benefits of on-line automatic Web inspection systems including colour systems. These notes look at improving print quality, identifying and classifying faults, high speed colour inspection, reducing inspection times and costs, and integrating Web inspection with the rest of a system. Presentations from distributors, suppliers and system integrators help in deciding how the technology can be used. Whilst speakers from the printing, paper and metals industries discussed the use of variations of the technology, highlighting cross industry similarities. This publication will be of value to managers and directors working in printing and packaging, food and beverages, pharmaceuticals, textiles, manufacturing and metals. (Leatherhead, February 1997, price £50.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

Computer modelling for the procurement and development of IT systems with confidence

Computer modelling is accepted in many engineering disciplines, but is not yet standard practice in IT system development. This report provides a comprehensive analysis of the application of computer modelling to assist in the procurement and development of computer systems and information technology/information systems (IT/IS). It discusses some of the difficulties that may arise, highlighting particular risks. It then looks at some of the more traditional techniques used to reduce such risks. ERA's new approach to the use of computer modelling in this area, and the advances this has made on conventional solutions are presented. The work undertaken and the results obtained in two case studies, one for a procurement system and one for a stores system, are summarized. Conclusions are drawn from this work and other experience gained within the field and recommendations are made for improving the chances of developing a successful IT/IS system within the timescales and budgets allowed. The details of the case studies are included as appendices. (Leatherhead, July 1996, 42 pp., price £85.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@ era.co.uk)

Third generation signal processing and digital video: techniques and implementation

The introduction of modern digital signal processing has overcome many of the disadvantages associated with the earlier developed classical signal processing methods. Significant advances in digital integrated circuit technology have allowed wide-spread uptake in practical applications. Recently, these advances have aided the emergence of a new generation of signal processing techniques. These techniques are based largely on generalization of the classical linear systems approach on signal processing theory and have the potential to provide substantial improvements in a wide range of applications areas. This report summarizes recent developments in the three related fields of evolving signal processing techniques, video compression and electronic implementation technology. The new generation of signal processing techniques which may themselves be classified into advanced deterministic techniques and semi-deterministic/non-deterministic methods are described.

Comparisons where appropriate are made with the more conventional approaches and their advantages and disadvantages are illustrated by case studies. A review of the important area of speech compression is also carried out. Standards established in the field are discussed and the future for video compression is examined. Finally, implementation aspects of the emerging technology are considered. A useful list of references is included. (Leatherhead, May 1996, 110 pp., price £180.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

On-line condition monitoring technology and applications

Condition monitoring is applicable in a wide range of industrial sectors. By monitoring the condition of plant and machinery, maintenance can be scheduled based on its condition rather than on a time-based regime. Production down-time and plant failure are minimized, maintenance costs are reduced and the life of expensive components and plant are maximized. Despite this the uptake of the technology in some areas has been slow. The report reviews existing off-line and on-line condition monitoring technology and its application in a number of key industrial sectors. The relative merits and limitations of various technologies and techniques are presented and the results of a survey are used to examine the current extent of applications. The main condition monitoring techniques, the plant that can be monitored, the types of equipment currently available and approximate equipment costs are summarized in a table. The report then discusses the potential for more advanced on-line condition monitoring using recent developments in the field of neural networks (NN). These new technologies offer substantial benefits over current condition monitoring equipment and could change the way in which condition monitoring is used in the future. The development by ERA of a generic approach to condition monitoring based on NN technology is presented, followed by a practical evaluation of the technology applied to monitoring an industrial process plant. The results show how the NN-based approach can be used to give early warning of rapidly developing impending failures that current technology would miss. The trial system uses multiple parameter information and makes use of the NN ability to learn and adapt solutions to complex data analysis problems. The advanced technology presented in this report will therefore find application in a number of diverse industrial sectors including paper, food, metals, building services, electricity supply and most other process industries. The nature of the technology allows easy transfer of the techniques to different plant and reduces the amount of effort required to interpret condition monitoring information. (Leatherhead, July 1995, 50 pp., price £200.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

Implementing optics in measurement, monitoring and control—practical solutions for industry—selected papers

This report addresses the key concerns of industry relating to the implementation of optics in measurement, monitoring and control processes where their advantages including immunity from electrical noise, no requirement for physical contact and high resolution are significant. These selected papers which include a case study, look at methods of integration of optical technologies with existing electrical,

mechanical and electronic systems. Emphasis is placed on the cost and value added benefits of applying optics. After a brief overview of the application of optics for industrial process monitoring, papers under "On-line condition monitoring of industrial equipment and processes" look at optical fibre sensors (OFS) for conditioning monitoring of electrical distribution plant, application of high performance gas filter correlation to on-line emissions measurements, UV DOA-spectroscopy on stationary sources of pollutants, near-infrared spectroscopy—looking into the process, and OFS for single point and distributed measureands—techniques and commercial prospects. "Safety issues for optics in industrial environments" discusses: intrinsically safe photoelectric sensing, and safety issues of optical technology. "Case study in machine control using vision techniques" deals with the use of structured lighting in machine tool control. "Automating surface and 3-D inspection using optical techniques" reviews: industrially proven methods of 3-D inspection and measurement by machine vision techniques, multi-channel dynamic thresholding optical sensor detects small defects in industrial Web optical inspection, automatic inspection of ceramic tiles, and the automated inspection of lace using machine vision. "Tomorrow's vision—tools, technologies and standards" covers high speed image analysis—image capturing—the choice of recording media, low cost silicon-based integrated optics for sensors and communications, application of Monte Carlo techniques to the assessment of optical systems, and future applications for industrial visual inspection and the need for standardization. (Leatherhead, December 1994, 108 pp., price £65.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

Engineering asset management for utilities, industry and commerce—conference proceedings

These proceedings provide the latest information, in terms of views and case studies, from national and international companies involved with driving forward asset management. They look not only at the day-to-day effects of planning asset management strategies but also follow through to implementation. Papers also look at the benefits and savings that can be achieved with a well planned asset management strategy. (266 pp., price £120.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

Life prediction in polymers

Many of today's plastics only emerged from the laboratory 50 years ago. The stabilizers which prolong their lives dramatically had not been developed. It is not therefore possible to provide longer-term lifetime guarantees, say over 35 years, based on service experience, or of performance tests under simulated conditions before a product is produced and marketed. This report looks at assessing the lifetime of a polymer component at the design stage. (111 pp., price: £185.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

Transmission of software and data to and from remote sites

This report investigates the communication of software and data to/from remote sites. As companies become

geographically diverse, they need to transmit information to distributed equipment around their organization and to equipment in the field. This communication can also be used to reduce costs by centralization of resources and by limiting the necessity for extensive travelling. It also offers faster response to enquiries and problems which may occur. The report looks at communication methods with the remote site and the software implications on the remote application. Other general factors are considered briefly. (95 pp., price: £200.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

The future of liquid crystal and related display materials

This survey focuses on liquid crystal displays (LCDs) and other flat panel displays (FPDs) as key devices in this age of multimedia technology. Related markets including those for applications, parts and materials, and equipment are studied in depth, together with trends among parts and materials producers. The report, translated from Japanese, was prepared from a wide range of specific data gathered by the Fuji Chimera Research Institute. It covers areas that have until now been dealt with only on a cursory level, including pricing and market numbers, projections for LCDs and FPDs. There are over 500 detailed charts and tables. The survey results provide information to further the development of LCD-related business. (187 pp., price £540.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

From concept to completion—a guide to EMC management

The EMC Directive has a direct effect on manufacturers of apparatus. They have to be aware of their responsibilities and obligations under the directive. For manufacturers, an internal EMC code of practice and quality assurance system is needed. This can be referred to in all stages of the design, procurement, production, development and approval stages of the apparatus development life-cycle and beyond. The use of such an approach will ensure that EMC engineering practices are considered throughout the development. The particular approach taken will have to be tailored for each apparatus type and to the apparatus compliance route, from components to finished products, to systems and to installations, but should generally be applicable to variants of a particular apparatus type. This guide provides manufacturers of all types of apparatus with guidance on the interpretation of the EMC Directive, the methods of showing compliance with it and the strategies, frameworks and policies which should be in place. (94 pp., price £85.00)

(For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

The competitive electricity market, differentiation through innovation—conference proceedings

Since privatization the development of competition between the new companies has brought about many significant changes in the way generators and distributors operate their businesses. These proceedings examine companies' response to the market changes, and how investment in new technology has improved in-house efficiency and added value to their customers' businesses. They also study experience gained abroad where different competitive market models have been developed and applied. In 1998, the UK residential and commercial market sector will be opened up to competition. In 2000 prices will be set by competition rather than regulation. The proceedings look at some of the key challenges that will be presented by this next stage in the competitive market. (238 pp., price £95.00) (For further information, contact ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, England. Tel.: +44 (0) 1372 367014; Fax: +44 (0) 1372 377927; e-mail: pub.sales@era.co.uk)

Harnessing IT in government

An international study on IT, government and public sector reform has recently been completed and published as:
'Reinventing Government in the Information Age:
International Practice in IT-Enabled Public Sector Reform' (Routledge 0-415-19037-1)

Chapters identifying successful and unsuccessful management approaches are complemented by a dozen case studies from the US, UK, mainland Europe, Africa, Latin America and the Caribbean. These deal with a wide range of technologies, reform initiatives and IT management techniques, providing best practice recommendations in all cases.

The book will also be of interest to those outside the public sector since it provides a new model for avoiding failure in IT application. This model includes a recognition of the context of developing countries.

Further details and order information from:
http://www.man.ac.uk/idpm/rgia.htm
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