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# **MICROELECTRONICS MONITOR**

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# MICROELECTRONICS MONITOR

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## TO OUR READERS

In the last issue of the *Microelectronics Monitor*, mention was made on the editorial page that UNIDO was in the throes of an in-depth reform process, which we call **UNIDO 2000** – our programme for managed change and improvement. This process is now in its final stages. As part of UNIDO's perspectives for the year 2000 and beyond, a Global Forum on Industry was held in India during October 1995, sponsored by UNIDO and the Government of India, the purpose of which was to review estimates and prospects for industrial growth and of manufactured exports from developing countries during the next decade. Key issues were identified as the consequences of liberalized trade and investment, the crucial role of technology as a determinant of competitiveness and the environmental challenges faced by industry. Solutions were seen in new forms of international partnerships, industrialization as a positive force in employment generation, and the need for a new role for governments as promoters of industrialization. It was noted with concern that while demand for UNIDO services is large, its resources were becoming more limited.

Projections regarding developments in new and generic technologies beyond the year 2000 are difficult to anticipate, primarily because of the extraordinary pace of technological change in these fields. The rapidity of such changes highlights the drive of technological innovations for sustainable competitiveness. Yet such innovations are now at the core of competitive strategies of successful industrial firms, and the new and rapidly evolving generic technologies such as biotechnology, new materials and information technologies offer many opportunities and challenges for broad competitive strategies to engender new products, services, markets and businesses. The pervasive applications of information technologies allow companies in all industrial sectors to re-engineer critical processes, improve overall efficiency and rearchitect their businesses with full participation of clients, suppliers and all internal functions, made possible through electronic networks. Information access, connectivity and portability are now the key to sustainable competitiveness.

A World Bank initiative to define a vision and strategy to assist developing countries in harnessing information and information technology for poverty alleviation and sustainable economic development recognizes the growing importance of information in development. However, most developing countries still have very incomplete information infrastructures. It is estimated that between now and the end of the decade, developing countries need to invest about \$50 billion per year in basic telecommunication facilities, excluding more advanced services and information systems required by businesses to become competitive in regional and global markets. In recent years the World Bank has therefore helped developing countries undertake major telecommunications reforms, including establishing legal and regulatory frameworks, fair business conditions and increasingly open and competitive markets that encourage domestic and private foreign investment. The scope of assistance is now being broadened to include key information systems as well as applications of this emerging infrastructure towards more information-intensive approaches to economic development.

Many of our readers will be interested in knowing that all the *Monitors* will soon be available on the Internet. The UNIDO World Wide Web (WWW) server (<http://www.unido.org>) was opened to public access on 24 November, with some 140 documents available so far. Any document may be located via an integrated full text searching facility. Interaction is made possible by a growing number of on-line forms and clickable e-mail addresses provided in every document. The system has been designed to accommodate by e-mail delivery service at a future stage of development. The next issue of the *Monitor* will include a more detailed description of this system, and it is planned to have a much more extensive portrayal in an up-coming issue.

This issue of the *Microelectronics Monitor* also offers a survey on parallel processing. Resulting from technological advances over the last few years, this type of processing is gaining momentum and with the constantly decreasing price of hardware, accompanied by the increase of processing power, this technology will soon become a major issue in information technology. This article will be followed in coming issues of the *Monitor* by papers presenting achievements of selected developing countries on the topic of parallel processing.

Konrad Fialkowski  
Scientific Editor

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## A. SPECIAL ARTICLE

### TRENDS IN SOFTWARE ENGINEERING FOR PARALLEL PROCESSING

by

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#### 1. Introduction

The increasing importance of parallel processing caused by its rapid growth encouraged development of standards in parallel programming languages and tools. Yet there is no evidence of convergence of the supported paradigms to a single model. In this paper, we review two currently most popular models for parallel program design: data parallelism and message passing. We also discuss the relevant developments in object oriented programming techniques as well as in client-server distributed/parallel processing. The declining share of the parallel processing market held by traditional supercomputers and the waning popularity of SIMD machines, together with the increasing role of clusters of workstations, created the conditions for a rapid spread of parallel machines in government and industry. The price of entry into parallel processing significantly decreased making abundant opportunities for new enterprises in software industry in this area. The paper reviews these developments and also discusses changes in supporting areas of software engineering for high performance distributed computing. Finally, the article reviews the perspectives and impact of the changing parallel computing industry on information processing at international and national levels.

#### 2. Trends in Architectural Design

Recent events, such as the filing for Chapter 11 bankruptcy by the Thinking Machine Corporation in August 1994, the discontinuation of manufacturing and sale of KSR supercomputers by Kendall Square Research in September 1994, and the disappearance of Cray Computer this year, raised the question of how secure is the future of the parallel computing industry.

It is important to realize that currently, computing constitutes a small fraction of the overall information technology industry. In 1994, the the overall USA information technology products were likely to be worth about \$500 billion.[5] This value is a middle point of two estimates. The first estimate was provided by the US Department of Commerce and was based on data from the US Bureau of the Census. It values shipments for the information technology industry at \$421 billion for 1993. This number includes computers, storage related devices, terminals and peripherals, packaged software, computer software manufacturing, data processing, information services, facilities managements and other services, and telecommunication equipment and services. However, this number omits revenue from equipment rentals, fees for after-sale service and mark-ups in the product distribution channel, as well as office equipment.

The Computer and Business Equipment Manufacturers Association (CBEMA) values the world-wide 1993 revenue of the US information technology industry at \$602 billion. This number includes office equipment and larger revenues for information technology hardware and telecommunications equipment than the numbers provided by the Department of Commerce.

In the United States, the total revenues of parallel computer hardware manufacturers were estimated at about \$1 billion in 1993. Out of it, about \$400 million was received by manufacturers of massively parallel machines. Even with services and software revenues, the parallel computer industry was about 0.5 per cent of the US information technology industry. Such a small percentage of the overall market indicates a narrow user base that can be easily saturated with new products. In addition, parallel computing has been highly dependent on government policies; institutions and government-supported universities traditionally constituted more than 50 per cent of all users.

The end of the Cold War and the associated shift of governmental spending in the United States drastically changed the market for parallel machines and supercomputers. As a result, companies relying solely on the manufacturing of parallel machines have suffered the most. At the same time, companies for which parallel computing manufacturing is only a part of the product line (e.g., IBM Corp., Silicon Graphics Inc., Intel Supercomputing) have persevered, and others (most notably Hitachi and NEC in Japan) have entered or expanded their presence in the parallel systems market.

Predictions about a lasting impact of the current changes on the parallel computing industry vary widely. Some see in the recent bankruptcy protection requests the beginning of the end of parallel computing based on massive parallelism. Others argue that it is just an end of a beginning. In the first camp is Gordon Bell, the founder of several computer companies and the sponsor of the yearly Gordon Bell Awards for the fastest parallel computer.[1] Mr. Bell believes that the latest threat to the very existence of the industry comes from standard workstations and fast, low-latency networks based on ATM. These networks, according to Bell, like massively parallel machines, offer size scalability (smooth transition from fewer to more processors). However, unlike parallel machines, they also support generational scalability (from previous to future hardware generations) and space scalability (from multiple nodes in a box to computers in multiple rooms to geographical regions). The most important capability offered by these networks is application compatibility with workstations and multiprocessor servers.

This is a capability which massively parallel computers sorely lack. According to Bell, the weaknesses of massively parallel machines stem from the following two factors:

1. Parallel architectures are best suited to highly-tuned, course-grained, and or data parallel problems;
2. Every new generation of parallel architectures differs from the previous one, forcing the users to redevelop their applications.

Bell sees the future of parallel processing networked workstations and shared-memory multiprocessors.

In a rebuttal to Bell's criticism, James Cownie from Meiko [4] cited the reasons why networked workstations are not an answer in many environments. The most important reason is the need for data security and availability. For a large commercial organization, security of data and its accessibility to those who need it are crucial. The solution is a single, central repository. However, the central repository could use some components as workstations to amortize the cost of their development. The natural solution is to use multiple processors compatible with the workstations. High performance requires a small physical size because the speed of light limits the performance of highly distributed machines (to keep the latency of communication below one micron, the distance between computers must be kept below 300 m). Switching technology cannot be based on ATM's in such a repository, because ATM switches are an order of magnitude slower and more costly than proprietary switching technology. According to Cownie, the only alternative is a massively parallel machine.

A similar point is raised by Philip Carnelley and William Cappelli of Ovum Ltd.[2] They underline that effective manipulation of large amounts of data is crucial for companies in maintaining a competitive advantage in the market. The complex applications in manufacturing, commerce, travel and entertainment require a sophisticated database support that demands enormous computing power. The costs of hardware and application development restricted parallel processing to niche applications such as scientific computing, weather forecasting, etc. Yet only parallel computing can meet the current challenge of information processing and, in response to those needs, parallel processing has entered the commercial mainstream. Parallel computers built from standard components (e.g., shared-memory, like Sequent, or distributed memory, like IBM SP2) can run powerful parallel relational databases. Such systems can process data extremely quickly, are reasonably priced, and are impressively scalable. Today, most of the commercial uses focus on data repository. Carnelley and Cappelli predict the future applications of parallel systems will transform operational systems, decision support systems, and multimedia applications, and in the process, will provide an enormous impetus for the parallel computing industry.

Ken Kennedy from Rice University [8] underlines that part of the difficulty in making parallel computing widespread and popular was the lack of standards in parallel programming interfaces. As discussed later in this article, such standards have been developed and are gaining widespread acceptance.

The optimistic views on the future of parallel processing are supported by an exponential growth in the usage of parallel supercomputers at the NSF Supercomputing Centers in the USA (see table 1).

**Table 1. Supercomputing Usage at NSF Centers in US**

Fiscal Year	Active Users	Usage in Normalized CPU Hours
1986	1,358	29,485
1987	3,326	95,752
1988	5,069	121,615
1989	5,975	165,950
1990	7,364	250,628
1991	7,887	361,037
1992	8,758	398,932
1993	7,730	910,088
1994	7,431	2,249,562

(Source: National Research Council [5], 1995)

Some analysts see the exponential growth of revenues for massively parallel computers in the near future. Terry Bennet, director of technical systems research for Infor-Corp in Beaverton, Oregon, was quoted in [11] as saying that the industry is currently in a "lag" where traditional vector supercomputers are fading out while other approaches are maturing. Bennet predicts that by 1996 there should be a reasonable upswing in the high-performance computing business and the market will continue to grow over \$4.5 billion in 1998. The strong sales of relative newcomers to the market, IBM Corp. with its SP series and Silicon Graphics Inc. with the Challenger computer, agree with Bennet's prediction.

Steve Wallach of Convex [12] argues that parallel processing has been becoming ubiquitous on all levels of computing technology. In microprocessor design, super-scalar techniques—executing multiple instructions at the same time—are now a standard. Multiprocessor file servers are in the process of becoming a standard. The continuing increase in the semiconductor density (see table 2) will naturally lead to multiple processors on one semiconductor die. If a standard 64-bit RISC microprocessor has 1-2 million transistors (without cache), what else (other than creating a multiprocessor chip) can be done with transistors when 100 million and 1 billion transistors become available? Widespread use will drive the costs of such a chip down and will therefore make massively parallel computing cost effective.

The case against supercomputing and massively parallel computers is often based on the difference in speed with which the performance of microprocessors and other CPU's grew (see figure 1, which was based on [7]). However, the CPU performance gains are of one of two kinds:

1. Architectural advances: bit-parallel memory and arithmetic, cache, interleaved memory, instruction lookahead, instruction pipelining, multiple functional units, pipelined functional units and data pipelining.



Table 2. Semiconductor Technology Trends

	1992	1995	1998	2001	2004	2007
Feature size (micron)	.5	.35	.25	.18	.12	.1
Gates per chip	300 K	800 K	2 M	5 M	10 M	20 M
Bits per chip in DRAM	16 M	64 M	256 M	1 G	4 G	16 G
Microprocessor chip size in square mm	250	400	600	800	1,000	1,250
Memory (DRAM) chip size in square mm	132	200	320	500	700	1,000
Wafer diameter in mm	200	200	200-400	200-400	200-400	200-400

(Source: *Semiconductor Industry Association*, March 1993).

2. Pure hardware advances, basically improvement in instruction cycle time, which is costly and limited by the physics of propagating signals through a medium and dissipating heat generated by transistor operation.

Microprocessors only relatively recently started to use architectural advances, whereas supercomputer CPU's used some of them before the 1970s. Consequently, performance improvement resulting from some of the architectural advances is not seen in the plot for supercomputer CPU improvements. However, the pure hardware advances are based on advances in technology, which are increasingly costly. For example, the capital cost of a semiconductor fabrication line is growing rapidly with improvements in wafer and features sizes (see figure 2).

This capital cost can be much more easily amortized if the chips produced are used not only in supercomputers or parallel computers, but also in all other lines of computers. Another reason for using stock hardware in building parallel machines is the constantly improving performance of microprocessors. As shown in figure 3, designing a specialized processor for parallel processing, which has a 10-fold performance advantage over the current uniprocessor design, gives the designers just four years of speed superiority. After that time, the improvements in general microprocessor design will nullify any initial performance advantage. Perhaps this is the reason why all three companies mentioned at the beginning of this section as getting out of the parallel processing manufacturing were using custom design chips in their products. On the other hand, the most recently successful parallel hardware manufacturers (IBM Corp. and Silicon Graphics, Inc.) use the standard CPU chips designed for them in their main line of workstations.

### 3. Importance of Memory

Technology is behind yet another phenomenon important for design and programming of parallel machines. There is a clear trend of DRAM speed improvements lagging behind the processor speed improvements

(see figure 4). In the last 12 years, the CPU speed increased several hundred times, whereas the speed of DRAM chips merely doubled. Both chips are produced by the same technology, however; the advancement in technology for DRAM chips is used to increase RAM density, not speed.

To mask the difference in speed between the processor and memory, modern processors use caching systems, often two level caches. A cache trades capacity for speed. During program execution, the most recently referenced fragment of the memory is kept in the cache and data are retrieved from it. Each time data needed by the processor are already in cache, the access is done at (roughly) processor speed. Such an access is called a cache hit. When the data are not available in cache, cache miss happens, and a bucket of data (equal in size to the cache line) that contains the needed data is moved from a slow memory to cache. The access to data is slow in such a case. The cache miss ratio (or in other words the percentage of cache misses over all data accesses) dictates the resultant speed of processing. The bigger the difference in speed between the memory and the processor, the lower the cache-miss ratio must be for the processor to work at near capacity (see figure 5).

In general, the cache miss ratio can be improved only by increasing the size of cache. Consequently, an increase in difference between performance of processor and memory is compensated by an increase in the cache size.

A multiprocessor brings not only multiple power of the CPU's together, but also improves memory capacity and performance, thanks to multiple cache capacity. As a result, a multiprocessor consisting of  $n$  processors may perform faster than  $n$  times the speed of a single processor for some applications. In such cases, the multiprocessor achieves super-linear speedup. It should be noted that the improved cache miss ratios of component processors of a multiprocessor must provide performance improvement that exceeds the overhead of parallel execution (such as load imbalance, not all processors having the same amount of work, and communication overhead, delayed access to non-local data), so cases of super-linear speedup are rare.

Figure 1. Trends in microprocessors and Mainframe CPU Performance Growth

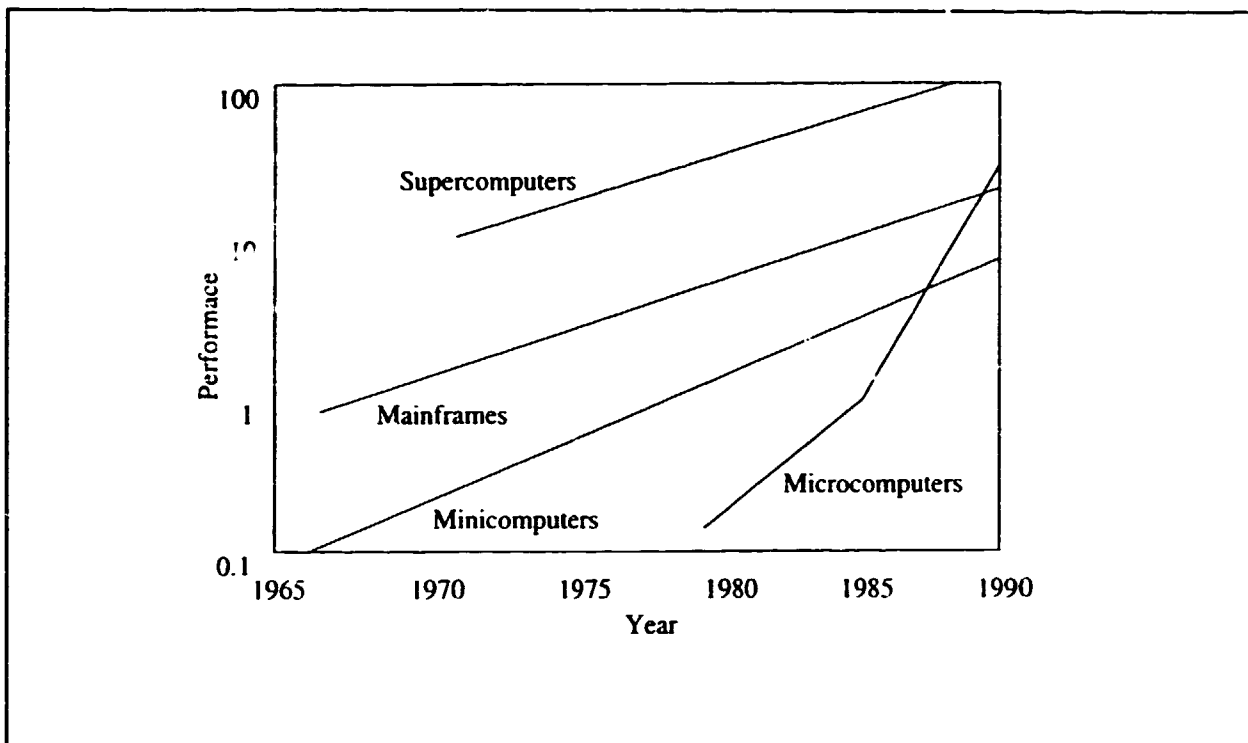


Figure 2. Semiconductor fabrication line capital cost per thousand wafers per week. Feature size is measured in microns. (Source: [7])

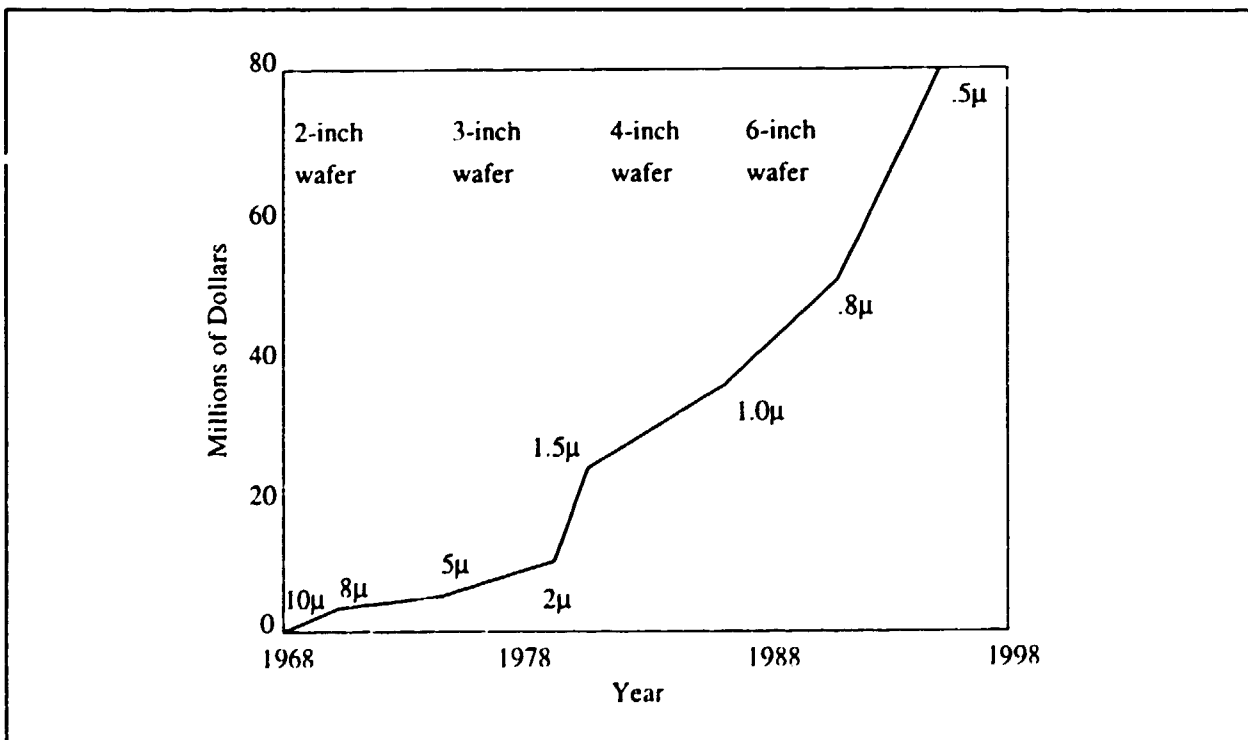


Figure 3. Performance window of opportunity for custom design chips

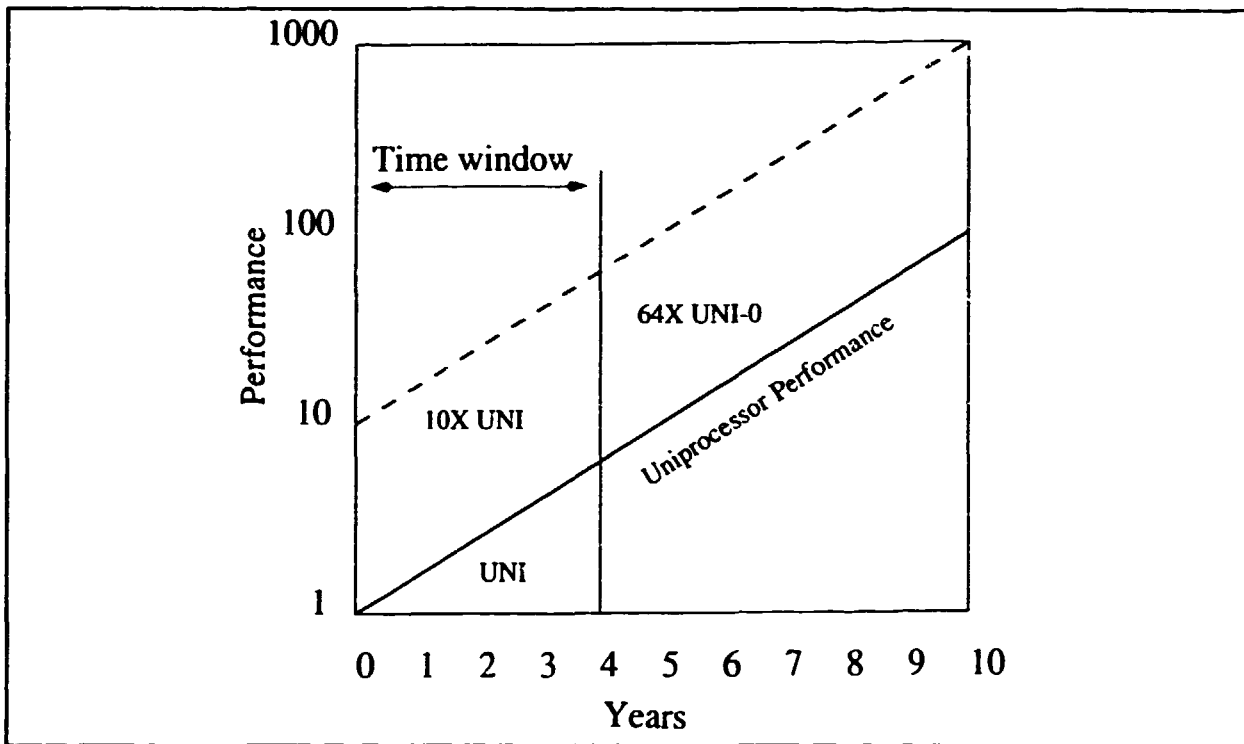


Figure 4. Trends in DRAM and processor cycle time: [7]

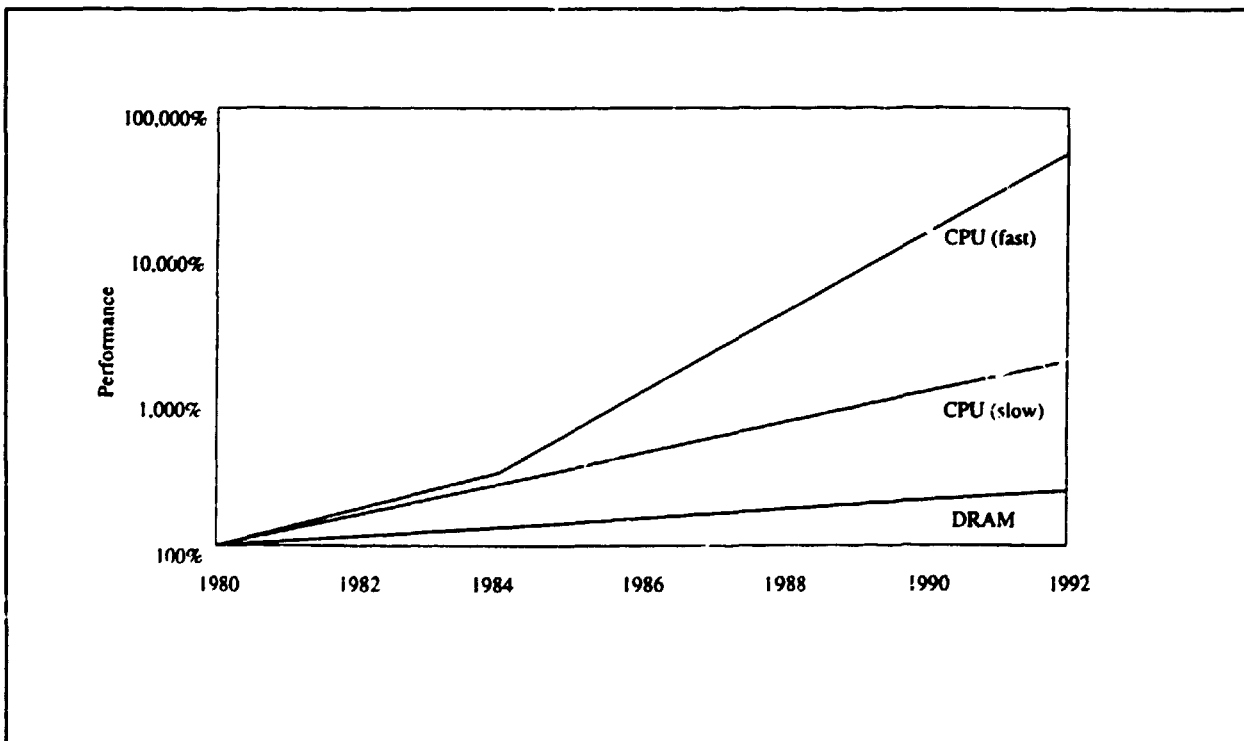
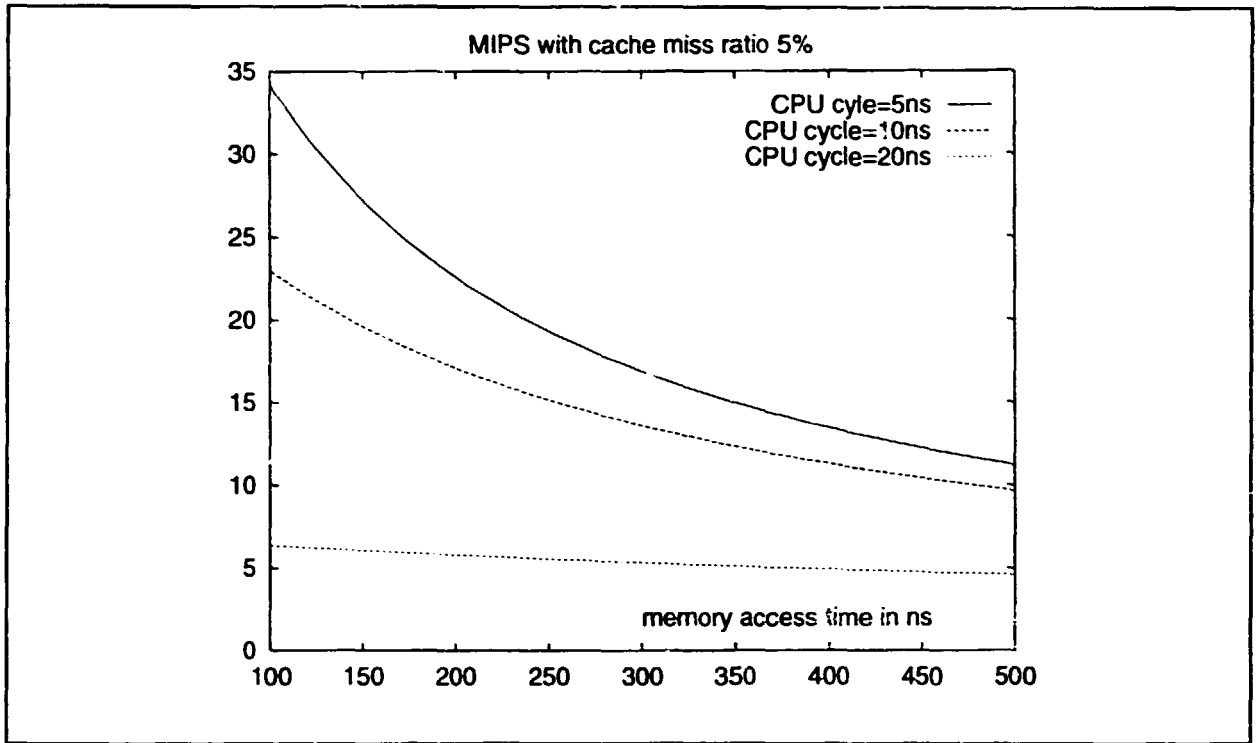


Figure 5. Effects of memory-access tie on speed of processing



However, in all applications, the impact of the extended memory of the parallel computer versus its single processor counterpart can be significant.

David Wood and Mark Hill discuss in [14] the concept of a costup and show that large memories can make parallel computing cost-effective even with modest speedups. Let  $s(p)$  denote the speedup of a program when executed on  $p$  processors, i.e.,

$$s(p) = \frac{1/\text{time}(p)}{1/\text{time}(1)} = \frac{\text{time}(1)}{\text{time}(p)}$$

The speedup is linear when  $s(p) = p$ , super-linear when  $s(p) > p$ , and sublinear (the most often case) when  $s(p) < p$ . Let  $c(p)$  denote cost of  $p$ -processor machine. The cost-performance of such a machine,  $\text{costperf}(p)$  is then  $c(p) \cdot \text{time}(p)$ . If a parallel machine is to achieve better cost-performance than a uniprocessor, then  $\text{costperf}(p) < \text{costperf}(1)$ , which leads to the following conclusion (see [14]):

$p$ -processor parallel computing is more cost-effective than uniprocessor computing whenever  $s(p) > c(p)$ .

The point is that often  $c(p) < p$  because processors in the multiprocessor may have less memory each than the uniprocessor. The authors provide an example of SGI systems. As of July 1994, a uniprocessor Challenge DM cost:

$$\text{cost}(1,m) = \$38,400 + \$100 \cdot m$$

where  $m$  is memory size measured in Mbytes. The comparable  $p$ -processor, SGI Challenge XL, cost:

$$\text{cost}(p,a,m) = \$81,600 + \$20,000 \cdot p + \$100 \cdot a \cdot m$$

where  $a > 1$  is the factor of the memory overlap on different processors. By substitution, David Wood and Mark Hill obtained the following formula for SGI machines:

$$c(p,a,m) = (2.125 + 0.521 \cdot p + 0.0026 \cdot a \cdot m) / (1 + 0.0026 \cdot m)$$

Figure 6 illustrates costups with SGI prices under the assumption that  $a = 2$ , i.e. that the parallel implementation requires twice the memory of the uniprocessor program. Different lines correspond to different number of processors  $p$ . The data support the assertion that parallel computing can be cost effective at speedups much less than  $p$  for large but practical memory sizes. Wood and Hill conclude that more than one processor might be needed to effectively utilize sufficiently large memories.

In the closing of this section, it should be noted that several different architectural approaches to parallel processing are slowly converging to a similar solution. The workstations interconnected through a fast network, when dedicated to a single application behave like a multiprocessor. The modern shared memory multiprocessor relies on an interconnection network between the global memory and local processor caches, and therefore behaves similarly to the distributed memory multiprocessor. Finally, distributed memory machines through extensive use of caches, approach, in their behaviour, shared memory machines. The overall trend is to use powerful computing nodes interconnected through a high speed network of large capacity. The trend is to rely on standard, off-the-shelf components.

Figure 6. SGI costups with double memory overhead for  $a = 2$

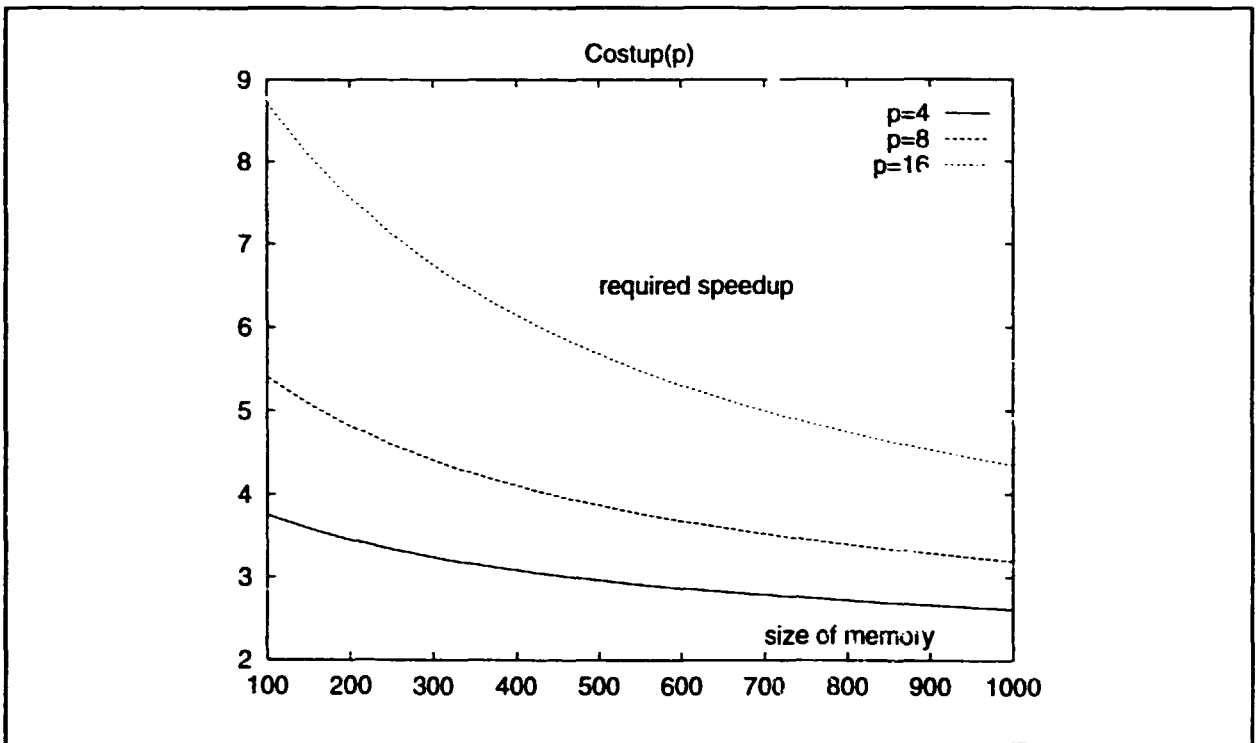


Figure 7. Impact of the Amdahl's Law on the maximum speedup

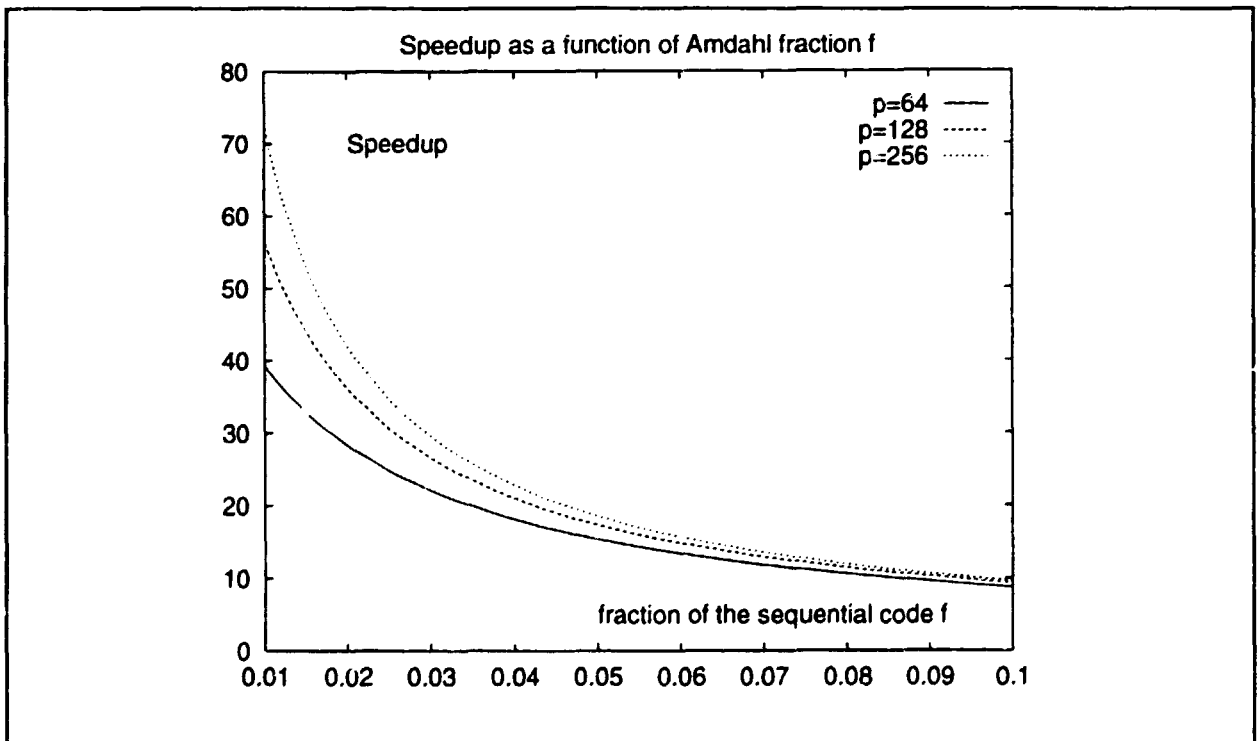
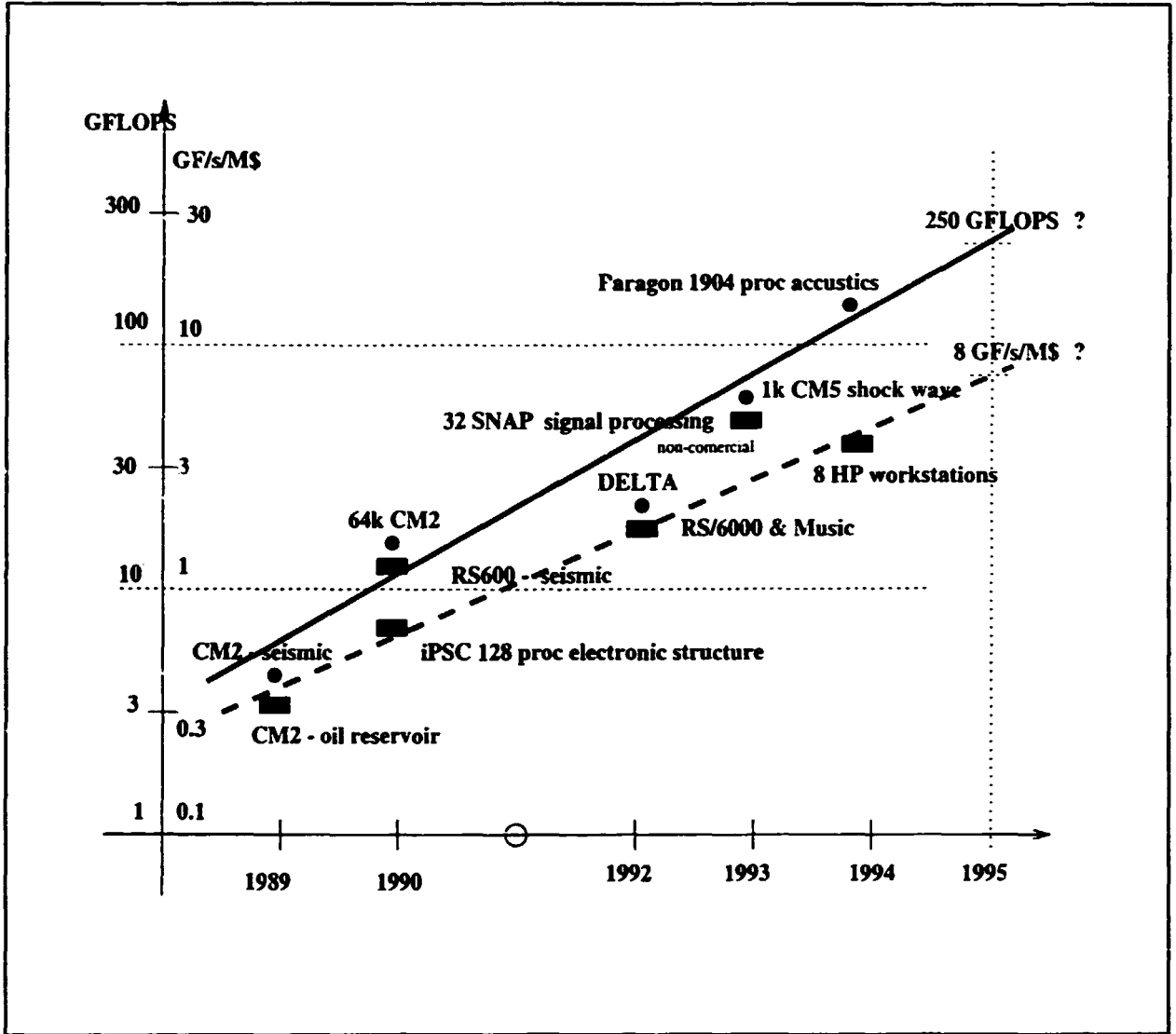


Figure 8. Trends in Gordon Bell awards winning entries



**4. Performance of Parallel Computers**

As already discussed, the speedup  $s(p)$  of a parallel machine with  $p$  processors can be found by comparing time of execution of a program by a uniprocessor ( $time(1)$ ) and by a multiprocessor ( $time(p)$ )

$$s(p) = \frac{time(1)}{time(p)}$$

The well known adage that the chain breaks at the weakest link has a computer science counterpart in Amdahl's Law, which states that the least parallelizable part of the code limits the speedup. More precisely, if  $f$  is the fraction of the code which is inherently sequential (so called Amdahl fraction) then, independently of the number of processors used  $s(p) \leq 1/f$ , simply because  $f \cdot time(1) \leq time(p)$ .

Amdahl's Law seems very pessimistic: after all, every program has sequential parts and even if these parts are small and limited to few per cent of the code, still the

speedup is limited to less than a hundred times (see figure 7).

Fortunately, often the execution time of sequential parts of the algorithm do not change, or change slowly with the growth of the problem size, whereas execution time of parallelizable parts changes rapidly when the problem size is increased. Hence, the Amdahl fraction is dependent on the problem size. For a wide class of problems  $f$  can be made arbitrarily small by selecting a sufficiently large problem size. Consequently, for such problems, the speedup can be made arbitrarily large.

Often the problems computed on parallel machines are too large to fit on a uniprocessor, so measuring an Amdahl fraction for them is impossible or difficult. John Gustafson [6] proposed a different measure,  $g$ , that represents a fraction of time during which the parallel machine executed the sequential part of the code. Therefore  $time(p) = g + (1-g) \cdot p = p - (p-1) \cdot g$ , so the speedup is:

$$s(p) = p[1 - (1-1/p) \cdot g]$$

The nice feature of this formula is that it clearly shows how to improve the speedup. If we start adding processors (i.e., increasing  $p$ ), but keep the work of all processors the same, then most likely  $g$  will stay the same and the speedup will grow. Likewise, with the constant number of processors, we decrease  $g$  by increasing the problem size. The final conclusion is similar to what the Amdahl's Law implies: by selecting a large enough problem to keep all processors occupied for a long time, the impact of the sequential parts of the program could be made negligible.

Though these principles may seem simple in theory, applying them to real problems is difficult. To encourage innovation, the annual Gordon Bell Awards are given for achievements in supercomputing. The three categories are performance, price/performance and compiler parallelization. The last six Gordon Bell Awards are summarized in figure 8. They provide a wealth of information about the current trends in parallel computing.

In figure 8, the winners of the price performance category are marked with black rectangles and winners of performance category by black circles. After initial successes of SIMD machines (please note three CM2 machine winners in 1989-90) came the reign of Intel machines (Intel hypercube iPSC in 1990, DELTA in 1992 and Paragon in 1994). The price/performance category is clearly dominated by workstations. A quick glance through applications indicates that scientific computing is still the dominant and favoured domain. The trend is very clear in both categories and it indicates rapid exponential growth in capabilities of the machines.

Over the years, the actual speed record was rapidly growing and the holders of the record were changing quickly. Until recent years, the record was usually held by vectorizing supercomputers with a single or a few processors. Only recently have massively parallel machines started to provide better performance. As of this writing, Intel's Paragon XP/S MP Supercomputer is the record holder with a sustained speed of 281 GFlops, achieved on an industry standard MP Linpack benchmark in December 1994. The previous record of 170 GFlops was made by Fujitsu in August 1994. The Intel machine even achieved 328 GFlops while executing a double-precision complex LU factorization code. The Paragon system used for the record-breaking runs was created by joining two machines at Sandia National Laboratory in the USA. It included 2256 compute nodes, each with three Intel i860 XP processors, a total of 6,768 microprocessors.

It should be noted that since 1993, awards similar to the USA's Gordon Bell Prizes were introduced in Europe. The so-called SuParCups are awarded yearly at the Mannheim Supercomputer Conferences.

### 5. Distribution of Parallel Programming Resources

Distribution of parallel machines and supercomputers is still heavily concentrated in the most developed countries. The data quoted below are based on the TOP500 list of the most powerful computers in the world, compiled by Dongarra, Meurer and Strohmeir for November 1994. The list publishes  $R_{max}$ , the maximum performance of a machine on one particular benchmark, so it is not indicative of the speed which can be achieved on an entire application. The total performance installed world-wide in these 500 machines is over 2,600 GFlops, or 2.6 TFlops. The

geographical distribution of the computers is given in table 3.

A similar list of nearly 200 sites with the most powerful computers is maintained by Gunter. The summary of this list for May 1995 is given in table 4.

The sites outside of the USA, Europe and Japan were located in Canada, the Republic of Korea and Taiwan Province of China (for sites ranked 26-100) and two sites in Australia, two in Hong Kong, as well as single sites in Mexico, Canada, China and Saudi Arabia in tier 100-200. It is interesting to observe that the most powerful sites are mainly governmental laboratories, medium sites are mainly commercial and the smallest sites are mainly academic.

The growing importance of parallel computing to many countries in the world was demonstrated in the special session of Supercomputing '93 entitled Supercomputing Around the World. Among others, researchers from Singapore, Indonesia and Malaysia were talking about their countries' support for using parallel computers for aerospace, oil and environmental applications.

### 6. Software Models

The increasing importance of parallel processing prompted growth in the body of standardization in parallel programming languages and tools. Yet, there is no evidence of convergence of the supported programming paradigms to a single model. Currently there are two most popular models for parallel program design: data parallelism and message passing.

Data parallelism is popular because of its simplicity. In this model, a single program (and therefore a single thread of execution) is replicated on many processors and each copy operates on a separate part of data. Depending on the tightness with which the execution of programs is synchronized, there are two modes of using data parallelism. When each instruction of the program is synchronically executed on all processors, then Single Instruction Multiple Data (SIMD) mode is used. Such tight synchronization requires hardware support.

SIMD machines were quite popular at the turn of the last decade (see Gordon Bell Awards in the previous section). From the software engineering point of view, SIMD machines are easy to program because there is a single flow of control on all processors. The main focus of parallelization is to find large data structures that can be distributed to all processors to keep them all occupied. Another concern is to minimize the data movements necessary to provide data to processors that are to execute them. Due to the small granule of parallelism (single instruction), SIMD machines consist of a very large number of simple processors (tens or hundred thousands of processors in a single machine is not unusual). Each of these processors must either execute the same statement as all the others or idle, so SIMD machines achieve poor efficiency on programs that do not contain sufficiently large data structures. They also do not perform well on programs which require irregular data references (list structures, dynamic memory, etc.). The consensus is that SIMD architecture has a very specialized niche of applications (e.g., visual information and scene processing), but it is not the best choice for general parallel processing.

Data parallelism can also be used in a loosely synchronized mode, when the program execution consists of two stages:

1. Computational stage, when copies of the same program are executed in parallel on each processor locally. The execution can differ in the conditional branches taken, number of loop iteration executed, etc.;

2. Data exchange stage, when all processors concurrently engage in exchanging non-local data.

It should be noted that the data exchange stage is very simple in the case of shared memory machines (when it can be enforced by use of locks or barriers). The frequency of synchronization in the SPMD model can be adjusted to correspond to the latency of the interconnection network. The SPMD model is very adequate for scientific computing, which often basically requires applying the same algorithm at many points of the computational domain. SPMD parallel programs are conceptually simple because of a single program executing on all processors, but more complex than SIMD programs.

For more complex applications, running a single program across the parallel machine may be unnecessarily restrictive. In particular, dynamically changing programs with unpredictable execution times result in poorly balanced parallel computations when implemented in SPMD mode. This is because in SPMD mode, processors synchronize at the data exchange stage, and none of the processors can proceed to the next computational stage until all others reach the data exchange stage.

The SPMD model was abstracted into a Bulk-Synchronous Parallelism model proposed by Leslie Valiant of Harvard University.[13] The model attempts to provide the abstraction for parallel algorithm description that lends

itself to performance analysis. The model also became a basis for a library that facilitates the creation of portable parallel software.

The BSP model consists of three components

1. Processors perform processing or memory functions;
2. A router provides point to point communication between pairs of components;
3. A synchronization mechanism synchronizes all or a subset of the components at regular intervals of L time units (L is called also the synchronization periodicity).

In the BSP model, computation consists of a sequence of supersteps. In each superstep, a component performs some local computation and transmits messages to other components. After a period of L time units, a global check is performed to determine if all components completed the superstep. If not, the superstep is extended by another L time units, after which the check is made again. In the BSP model, the data transmitted are not guaranteed to be available at the destination until after the end of the superstep at which they were sent.

Using this model, the cost of an algorithm can be expressed in terms of L and g, two parameters that are defined by the network latency and bandwidth, respectively. Using the BSP cost of an algorithm, it is possible to predict the performance of the algorithm on new hardware, given the values of the parameters L and g for this hardware. The BSP model facilitates an algorithm optimization through data distribution selection based on the characteristics of the problem rather than the architectural features of the target machine.

Table 3. The Distribution of Powerful Computers over the World

Category	USA and Canada	Japan	Europe	Other countries
Number of computers	248	82	143	27
Installed power	54%	27%	17%	2%
Leading countries	USA	Japan	Germany, UK	Korea, Australia

Table 4. The Distribution of Powerful Computing Sites over the World

Category	USA	Japan	Europe	Others	Government	Academia	Industry
Sites 1-25	16	7	2	0	14	5	6
Sites 26-100	31	15	26	3	30	15	30
Sites 100-190	40	10	33	8	14	45	34



A BSP computer is characterized by the following set of parameters: number of processors  $p$ , processor speed  $s$ , synchronization periodicity  $L$ , and a parameter to indicate the global computation to communication balance  $g$ . The synchronization periodicity  $L$  is the smallest number of time steps between successive synchronization operations. Parameter  $g$  is the ratio of the total number of local operations performed by all processors in one time unit to the total number of words delivered by the communication network in one time unit. Processor speed  $s$  is measured in flops (floating point operations per second). Synchronization parameter  $L$  is measured in flops. Parameter  $g$  is measured in flops per word.

BSP parameters allow for algorithm performance analysis. For example, consider a superstep that needs to communicate  $h$  words of data. Since it takes  $g \cdot h$  time units for the communication network to deliver the data to its destination, and  $L$  units to synchronize all the processors performing the superstep, at least  $L + g \cdot h$  units of computation are needed to keep the processor busy; a level of computation less than this threshold results in idling of some processor, and therefore is a source of inefficiency.

In terms of the BSP parameters, distributed memory parallel machines are often characterized by large values of  $s$  (relatively fast processors) and low values of  $L$  and  $g$  (a communication network with low latency and large bandwidth). A general purpose network of workstations, on the other hand, is characterized by values of  $s$  that are somewhat lower than for the parallel machines and values of  $L$  and  $g$  that are much larger than the corresponding values for the parallel machines (high latency and low bandwidth due to the loosely coupled nature of these networks). Thanks to this distinction, optimal BSP algorithms for network of workstation use different data distribution than those designed for a parallel computer.

BSP algorithms can be directly implemented in a high-level traditional language (e.g., C or Fortran) with the addition of the necessary calls to BSP primitives. The Oxford BSP Library [9], developed by Richard Miller can be used for this purpose. The library is based on a slightly simplified version of the model presented in [13]. These simplifications require that the processors are allocated statically before the program is run and the programs are written in a SPMD mode. The most significant feature of the library is the support for remote assignment as a means for non-local data access. The library consists of just six functions and is simple to use. Despite its simplicity, we have found it to be quite useful and robust. The library for C-BSP programming includes the functions for:

1. Starting and ending a BSP session;
2. Starting and ending a superstep;
3. Fetching and storing of values from a remote processor.

The memory distributed machines use message passing for exchanging data between different processors. The SPMD model may shield the user from specifying the detailed data movements thanks to data distribution directives from which a compiler generates the message passing statements. However, the user which decides to write the message passing statements himself has full control over the program execution. In particular, the user may define when and how many processors synchronize in their execution. This gives the user a lot of flexibility at the cost of requiring the user to make a very intricate and detailed

description of the program. The programs tend to be longer and more complex than their SPMD counterparts, and therefore more error-prone. Once debugged and tuned up, they are also more efficient. The flexibility of the messaging passing model makes it applicable for a wide variety of problems. As discussed below, the newly developed standard library of functions for message passing, MPI, has a potential of becoming a universal tool for parallel software development.

## 7. Trends in Languages

There is a plethora of research parallel programming languages with different flavours to choose from, starting from functional, dataflow to object oriented, logical etc. However, the majority of parallel programs are still written in Fortran. Since 1950s this language was a favourite choice for writers of scientific programs and particularly for generations of graduate students in applied sciences. Over the years, Fortran underwent a remarkable transformation, from one of the first languages at all to the first language with a well defined standard (Fortran66) to structured programming of Fortran77, to data parallel and object-oriented Fortran90 and finally to the newest standard of High Performance Fortran (HPF). Each generation brought with it new features and set a new standard for the manufacturers of hardware and compilers.

Compared to Fortran77, Fortran90, which was introduced at the beginning of this decade, brought to the world of Fortran users several modern language design features, such as:

1. Derived types, kinds, pointers and dynamic memory allocation that enable the user to define their own data types and dynamically allocate data structures;
2. Modules, characterized by public and private data types. Modules can be imported from other programs by the USE clause and renaming;
3. Array operations and new control structures allowing for a very concise and elegant definition of data parallel programs;
4. Recursive procedures;
5. Interface blocks for abstract definition of the input/output, as well as terminal-oriented source forms.

The first two features enable the users to write object-oriented programs. In brief, object-oriented programming involves developing the user's own abstraction of the application domain. This abstraction is defined by the user in the form of data abstraction, object types and type inheritance. An object is defined by its (hidden) state and a set of operations that are applicable to it. Abstract data type is just a set of objects, whereas a class is an abstraction of objects. Each object has private data and attributes (that define its implementation) and public data and attributes visible to users of the object. Such a distinction between the object's data and attributes is often referred to as data encapsulation. Finally, polymorphism and function overloading are other characteristics of an object oriented language. Basically, they allow an operator or a function to carry different processing for different types of their arguments. The simplest example of such overloading is its use to define an optimized function of raising to a power. It could be done by using a power series approximation for non-integer exponents and also by an iterative multiplication for integer exponents. Careful analyses of Fortran90

features indicates that all the above features can be expressed in Fortran90.[10]

Another important feature of Fortran90 is the ability to operate on the whole arrays. Array expressions allow the user to define arrays of various shapes and apply operators to such arrays in a piecewise manner. Array shapes can use a set of conditions to decide to which particular elements of the argument an operation should be applied (**WHERE** clause). The array expressions allow for a very succinct definition of data parallel operations.

A new generation of parallel Fortran, HPF was introduced in 1993 by an HPF Forum, a group of parallel hardware manufacturers and academic, industrial and governmental users of high performance machines. During 1994 there were six announced commercial HPF products and 11 announced commercial HPF efforts, with many of these compilers becoming available now (mid-1995). HPF introduced new data partitioning directives, like **ALIGN/REALIGN** data structures relative to each other, **DISTRIBUTE/REDISTRIBUTE** data structures (or their templates) to processors according to one of the predefined patterns (**BLOCK**, **CYCLIC**, or **BLOCK-CYCLIC**). Directives for definition of processor arrangements (**PROCESSORS**), or loop parallelization (**INDEPENDENT/FORALL**) are available. These directives enable the user to define data movements indirectly, without the need of a detailed description of the message passing statements that must be executed to achieve directive-defined effect.

Critics of HPF think that the HPF standard is not general enough. In particular, HPF does not allow for dynamically defined alignments and distribution that are permitted in Fortran HPF - [3] However, standardization of the language features is extremely important for users and compilers and tool writers, because it protects their software investments against changes in the architecture. In that respect, introduction of Fortran90 and then HPF is an important step forward towards more stable parallel software.

HPF can be seen as the flagship of the data parallelism camp. On the other hand, the supporters of message passing based parallel programming achieved standardization of their approach in the Message Passing Interface (MPI). MPI is a large library of the message passing utilities that includes 125 functions. The basic MPI subset, sufficient for writing simple applications, consists of just the following six functions:

1. **MPI\_INIT** - to initialize MPI on in a process;
2. **MPI\_COMM\_SIZE** - to find the number of processes participating in the MPI session;
3. **MPI\_COMM\_RANK** - to find a unique rank of the calling process among the MPI session participants;
4. **MPI\_Send** - to send a message to the other processes;
5. **MPI\_Receive** - to receive a message;
6. **MPI\_Finalize** - to terminate the MPI session.

The innovations of MPI are centred around an abstract view of the communication. This abstract view supports the portability of programs using MPI to different machines. Messages in MPI are described as triples consisting of an address, data count and data type. Data types in such triples can be user defined. MPI allows the processes to group themselves and arrange themselves into a hierarchy where each process has its own rank. A process can have different

ranks inside different groups and it can participate in different communication sessions concurrently. MPI provides also a default initial group whose members are all processes that executed the **MPI\_INIT** function. Families of messages can be defined in terms of communication context and group.

MPI provides also more complex features, such as collective communication that includes data movements and global reduction operations. MPI allows the user to define virtual topologies and use different communication modes. It provides also functions for debugging and profiling and support for heterogeneous networks. The MPI standard does not define, purposefully, how the MPI startup is implemented, the amount of system buffering, or the limitations on recognized errors to avoid unnecessary restrictions on implementations.

Judging from the widespread popularity of the Parallel Virtual Machine (PVM), MPI can become an important step towards providing the efficient and unifying tool for expressing message passing in parallel and distributed applications. Although introduced recently (in 1993), MPI has been quickly embraced by manufacturers and is supported on many parallel machines (among them Cray T3D, Intel Paragon and IBM SP2).

## 8. Conclusions

Parallel processing is at a critical point of its evolution. After a long period of intense support by government and academia, it is slowly moving to derive the bulk of its support from the commercial world. Such a move brings with it a change of emphasis from record breaking performance to price performance and sustained speed of program execution. The winning architectures are not only fast but also economically sound. As a result, there is a clear trend towards widening the base of parallel processing both in hardware and software. On the hardware side, that means using off-the-shelf commercially available components (processor, interconnection switches) which benefit from the rapid pace of technological advancement fueled by the large customer base. The other effect is the convergence of different architectures thanks to spreading the successful solutions among all of them. Workstations interconnected by a fast network approach the performance of parallel machines. Shared memory machines with multilevel caches and sophisticated prefetching strategies execute programs with an efficiency similar to distributed memory machines.

On the software side, the widening of the user base currently relies on the standardization of parallel programming tools. By protecting the programmer's investment in software, standardization promotes the development of libraries, tools and application kits, which in turn will attract more end-users to parallel processing. It appears that parallel programming is ending a long period of craft design and is entering a stage of industrial development of parallel software. This is an industry in the making that will provide new opportunities for software developers and investors.

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## B. NEWS AND EVENTS

### Photovoltaics for villages

Two billion people are without an electrical connection, but the cost of hooking up their homes to a conventional grid system will be too high for most developing countries. Photovoltaic solar systems are a cheaper alternative and can reach virtually any site on Earth. Granted, new and bold initiatives are necessary to realize the required 20,000-MW peak power of photovoltaic capacity, but the breakthroughs needed are less technical and more in the areas of financing and energy policy.

Energy is not the most pressing problem of the developing countries, partly because oil prices are at present so low. Instead, they have to worry about the poverty of most of the inhabitants, their food supply, the creation of sufficient and meaningful jobs, competition in international markets for their products, and, sadly enough in some cases, the presence of war. The main energy problem in rural areas still is to find enough wood for cooking meals. In some developing countries, biomass for cooking accounts for over half of the national energy consumption.

For some decades now, photovoltaics (PV) has been on the energy scene in the developing world, particularly in established niche markets such as telecommunications, marine beacons, railway signalling, and cathodic protection of pipelines. The challenge will be to apply PV to the provision of energy to rural homes for lighting, refrigeration and TV.

The most successful to date is the individually owned solar home system: typically a 50-W solar panel that charges a battery by day and powers loads after dark. Owners are proud of having their own power system and are not susceptible to grid failure or inconsiderate neighbours, while the equipment itself can be expanded when required. Of course, the systems must be well designed, properly maintained, and paid for by the owner, because giveaways seldom last long.

On the face of it, it looks strange that people in rural areas and non-industrialized countries are satisfied with a fraction of a kilowatt-hour a day, whereas residents of industrialized countries "need" 10 kWh or more per day. The explanation is that people are not interested in kilowatt-hours as such, but in light, a working TV set, or a refrigerator. In other words, they want the services of the energy regardless whether it amounts to 0.1 kWh or 10 kWh per day. And as only a limited number of solar kilowatt-hours are available, people cannot afford to waste them and must use efficient lighting, low-power TV sets (a golden market for future flat-screen TV sets with liquid-crystal displays) and efficient refrigerators.

The only thing that matters to the owner is: how much do I have to pay for these services every week or month? As a first estimate, a reasonable part of the rural population can raise \$5 to \$8 per month. This is what they are paying now for kerosene lighting and for battery charging at grid-connected centres.

As is well known, nearly all utilities in developing countries are losing money on rural electrification. Investment capital is not the problem, being available at comparatively low rates from large multilateral banks like the World Bank and Asian Development Bank. High costs

are the issue, stemming from long transmission lines to remote customers, low consumption, the need to charge only low tariffs, and high technical and non-technical losses (transmission and distribution losses and illegal connection)—20–40 per cent in some countries. And these high costs are usually cross-subsidized by urban consumers.

Line costs are the heaviest burden, usually accounting for 80–90 per cent of the budget of a rural electrification project. They typically run \$20,000–\$30,000 per kilometre. Another factor is the widely variable number of users per kilometre of line, which may be as low as two, but in Bangladesh must be at least 75. As a result, the average cost per rural connection also varies wildly: Mohan Munasinghe, an energy expert with the World Bank, quotes a range from \$200 to \$3,650 (in 1983 prices). The monthly power consumption of rural consumers is usually low: 20–40 kWh, leading to high per-kilowatt-hour costs of 10–20 cents to \$1.

A recent report from the World Bank on its role in the power sector notes that the number of power connections in developing countries in the period 1969–1989 grew by 9 per cent per year, or 2.5 times the average population growth. In spite of this rapid growth, rather few members of the population are yet connected to an electricity supply. Average real power tariffs declined from 5.2 to 3.8 cents per kilowatt-hour in the period 1979–1988 (in 1986 dollars).

Nevertheless, Governments and utilities in developing countries have impressive plans for expanding their power sectors. The idea is to increase the total power supply capacity from the 471 GW of 1989 to 855 GW in 1999. It is estimated that no less than \$1 trillion will be needed to achieve the desired 384-GW increase. Approximately 40 per cent of this sum is in foreign exchange, and it is clear that the \$40 billion needed annually cannot be mobilized, even by the large multilateral banks (the present level of World Bank lending for the power sector is around \$7 billion per year).

The conclusion seems inescapable. Governments in the developing world will face great difficulties in expanding their power sectors as planned. Obviously, too, priority will be given to industry and the urban sector. This prospect underlines the need to consider other alternatives for rural electrification, such as pre-electrification through PV or other renewable sources. The article goes on to describe rural energy developments in various developing countries. The author, Erik H. Lysen, of the Netherlands Agency for Energy and the Environment, presented an extensive paper at the 12th European Photovoltaic Conference in April 1994, which is published in the Conference Proceedings. (Source: *IEEE Spectrum*, October 1994).

### Appropriate technologies

The ending of the cold war has released more energy for tackling the concerns of underprivileged populations. "One billion people in the developing world still lack access to clean water ... nearly 2 billion lack adequate sanitation ... Electric power has yet to reach 2 billion people", the World Bank noted in its June *World development report 1994: infrastructure for development*.

A country's infrastructure includes services based on electrotechnology, such as electric power, telecommunications, and road, sea, and air transport. Developing countries pour US\$ 200,000 million in round figures every year into new infrastructure, amounting to 4 per cent of their national output and a fifth of their total investment, according to the World Bank report.

In purely human terms, the situation of these people is unacceptable. Technologically, it dares electrical and electronics engineers to devise remedies by applying proven technology at an affordable cost.

One challenge may well be to upgrade the infrastructure in developing countries. At present, for example, about 40 per cent of their power-generating capacity is on average unavailable when needed, as a result of malfunction or scheduled maintenance; elsewhere, in the best-performing power sectors in the world, the percentage is half that figure, according to the 1994 World Bank report.

To cut back on waste and improve efficiency, the Bank is embarking on a thorough reform. Among its goals are to see the infrastructure managed as a business, and not as a bureaucracy; to see competition introduced; and to give those who use the services a stronger voice in and responsibility for their operation than has been the custom.

But what exactly is a developing country? The World Bank often refers to "developing economies" as those with low or middle per capita income, derived by dividing the gross national product (GNP) by the population count.

Low-income countries, with US\$ 675 or less per capita, include Burundi and Benin in sub-Saharan Africa, Egypt in North Africa, Cambodia in East Asia, Tajikistan in Central Asia, and Haiti in the Americas. Senegal, though, and Thailand, Turkey, Iran, Algeria, and Chile are representative of middle-income economies, with \$675-\$8,356 per capita income (in 1992).

In the October 1994 issue, *IEEE Spectrum* launched a series of articles on technology appropriate for developing countries. Topics included photovoltaic applications, telecommunications, computers and networks, and electrotechnology applications in such areas as transportation and agriculture. Intuitive, qualitative criteria for appropriateness have been adopted for the series. An appropriate technology is one that:

- . Fits in the country's infrastructure.
- . Is affordable.
- . Can be properly maintained.
- . Is not destructive to the environment.

The requirements need not imply technological inferiority. Indeed, a developing country quite often seeks to leapfrog straight into the twenty-first century, particularly if the leap makes sound economic sense. Indonesia is doing just that. Looking to a rapid expansion of its urban telephone network, it is installing a radio-based, cellular-telephone system in Jakarta and West Java for a total of 280,000 subscribers.

From reports it is clear that designing "appropriate" technology may sound easier than it is. In a West Africa project, for instance, inverters for water pumps had to be flexible enough to accommodate various pump capacities, pipe sizes, and waterheads, but this flexibility could not be bought by sacrificing efficiency. Protection of the photovoltaic system against lightning and the safety of maintenance personnel also came into the picture in a big way. (Source: *IEEE Spectrum*, October 1994)

### **Using grey literature in informal information services in Africa**

There are increasing numbers of experiments (in countries as diverse as Sierra Leone, Tanzania, Benin, Senegal, Botswana and Zimbabwe) with informal community information services dealing with health, hygiene, child care, cultivation, stock-rearing, trades, crafts and repair work, in the way in which surveys show that citizens require. Conventionally published material is in very short supply and seldom has relevant content. Extension services, and sometime libraries, in local communities make use of such materials as are available, whether printed in leaflet, pamphlet, newspaper, poster or flipchart form, or deliver information orally, on tape, filmstrip, or in the form of song, story or dramatic presentation.

Preliminary investigations show that the mechanisms for obtaining appropriate information to repackaging for this type of use, and the capacity to carry out the repackaging exercise, are poorly developed in most of Africa. The official publications, reports, planning and policy documents from non-governmental organizations, developmental agencies, aid and charitable organizations and research centres, which contain this information, are poorly represented in the holdings of national library systems, research collections or government agencies. Equally significantly, such institutions are not oriented in the dynamic way required to permit an effective repackaging exercise. There are, however, a few examples of appropriate arrangements for the acquisitions, repackaging and distribution process which are cited as partial models of the way this work might be done. (Source: *Journal of Documentation*, 50(4) December 1994)

### **Can the traditional abstracting and indexing services survive?**

The search for better access to scientific information fuelled the development of on-line search and retrieval systems. The need for better production mechanisms led to the development of scientific databases in computerized format. Today many of the earlier systems are facing obsolescence due to rapid changes in communications and computer technologies. Many organizations are in the process of, or have recently completed, the installation of new production systems, with the focus being shifted from a production system for print products that also produces a tape for on-line searching, to the production of an on-line file that can produce a variety of print and electronic products. Forward-looking publishers are seeking a greater demand for data in electronic format and realize that they need to have the flexibility to deliver exactly what the customer wants—including faster throughput, customized output, and material tailored for document delivery suppliers and new publishers.

Details of new production processes are given for Materials Information, BIOSIS, CABI, American Society of Hospital Pharmacists, NTIS and ISI. These new processes make databases more consistent, cleaner, and provide better and easier access points, but it does mean that files need to be completely reloaded wherever they are stored by commercial on-line systems, CD-ROM and OPAC's producers, or private tape customers. At Dialog, the priority is to reload new databases, and it takes on average about six months to reload files. Data entry is still the key to producing a good database, and all the new

systems are incorporating new ways of entering data. Keyboarding is still the most common method of input, but most database producers use scanning as a small part of their input process, while a few are developing major projects to use scanning for both database production purposes and electronic storage of documents for document delivery. As the roles of primary publishers, secondary publishers, document delivery services, and even authors are swirling and shifting in the electronic information age cauldron, the continuing need for abstracting and indexing services can be questioned. The organizations that survive will be those that have listened to the marketplace and respond quickly to the information collecting, organizing, filtering and delivery needs of their customers. (Source: *Database*, 17(6) December 1994)

#### **Guidelines for software in cars**

The Motor Industry Software Reliability Association (MISRA) is the first organization in the world to launch a set of guidelines for software used in the automotive industry.

The guidelines are designed to ensure that the ever-increasing complexity of software in cars is controlled and coordinated, primarily for safety reasons.

The purpose of the guidelines is to help companies create safer and improved cars. The members of MISRA include the DTI, Ford, Jaguar, Lotus, Delco Electronics, Lucas, Rover, Rolls-Royce and the Centre of Software Engineering. (Source: *Electronics Weekly*, 7 December 1994)

#### **DRAM shortage hits Taiwanese computer makers**

Taiwanese computer producers may have to scale back production levels because of a shortage of DRAMs, claims the China Economic News Service.

The shortage of 4Mbit DRAMs is giving the island's computer producers, such as Acer, Twinhead and Calcomp, sufficient concern to rein back projections on this year's computer production.

Acer is reported to be planning to scale back production of notebook PCs from 400,000 to 380,000, despite the fact that Acer has its own DRAM production plant on the island, owned jointly with Texas Instruments. (Source: *Electronics Weekly*, 12 October 1994)

#### **Clean Japan Center to research technology to recover CFC, HCFC**

According to the Ministry of International Trade and Industry, the "Freon-Refrigerant Recycling Center" completed a demonstration plant that distills and purifies freons, or chlorofluorocarbons (CFCs), and began CFC recycling in late 1994. The Freon-Refrigerant Recycling Center was commissioned by the New Energy Development Organization (NEDO) to research and develop technology to recycle CFC refrigerants. The demonstration plant is the first in Japan that recycles CFC refrigerants by recovering and distilling them. For the time being the plant will recycle specific CFCs, R12 and R502, but later it will also recycle R22, which is a CFC substitute (HCFC). (Source: *Nikkan Kogyo Shimbun*, 8 September 1994)

#### **Matsushita develops recyclable cleaning solvent for printed circuit boards**

The Environment and Energy Laboratory at Matsushita Electric's research headquarters developed a distilled-water,

glycol-ether cleaning agent for printed circuit boards. The new cleaning agent has the same cleaning power as specific chlorofluorocarbons (CFCs) and trichloroethane and can be distilled and recycled. Without using surfactants, which were mixed in with CFC-alternative cleaning agents in the past, the new cleaning agent can remove both oily and water-soluble contaminants. It also can improve the reliability of insulation and can be recycled, which was difficult with past CFC-alternative cleaning agents. The new cleaning agent can be used by simply adding distillation and recycling equipment to existing equipment for CFC-alternative cleaning agents. Matsushita is already using the new cleaning agent to remove flux from printed circuit boards.

The new cleaning agent for printed circuit boards is made of a glycol-ether compound. By controlling alkylene glycol and alkyl structures and molecular weights, Matsushita researchers did not have to resort to mixing the cleaning agent with a surfactant. Even so, the new cleaning agent can simultaneously remove oily and water-soluble contaminants.

Because it has a simple composition that does not contain a surfactant, the range of temperatures over which the cleaning agent boils is very narrow— $220^{\circ}\text{C} \pm 5\text{-}10^{\circ}\text{C}$ —which enables recycling by means of distillation.

Recycling CFC-alternative cleaning agents up until now has been difficult because of their complex compositions into which a surfactant was mixed.

In addition, a bit of a conventional CFC-alternative cleaning agent left on a printed circuit board affects the reliability of the board's insulation. The new cleaning agent, however, improves the reliability of the board's insulation: Matsushita researchers confirmed that, even if some of the cleaning agent remains on the board, the initial resistance value can be maintained.

Having confirmed that the new cleaning agent has almost no effect on resins, which had been a problem with conventional CFC-alternative cleaning agents, Matsushita researchers believe that the new cleaning agent can be used to clean metals and resins, in addition to printed circuit boards.

Production and sales of the cleaning agent, whose product name is the "PS Series", are handled by Daiichi Seiyaku Co., which will also market the product to companies outside of the Matsushita Group. (Source: *Dempa Shimbun*, 20 October 1994)

#### **PCI consortium**

A consortium of four developers of high-end industrial PC systems has been founded in the US to draw up a technical specification for passive backplanes to which PCI (Peripheral Components Interconnect) cards can be connected in industrial computing systems.

The consortium is called PCI Computers Manufacturing Group (PCIMG) and its founding members are I-Bus, Texas Micro, Teknor and Trenton Terminals. More companies could join soon.

The consortium's prime objective is to ensure interoperability between the increasing number of PCI processor cards developed by different original equipment manufacturers (OEMs).

The four companies have in the past approached an existing body, the PCISIG (PCI Special Interest Group), to try and find solutions to the existing interoperability problems but PCISIG focuses on defining the motherboard

approach and not the passive backplanes. (Source: *Electronics Weekly*, 19 October 1994)

### **EC goes satellite**

The European Commission has cleared the way for the rapid expansion of the satellite business communications market by liberalizing the skies above Europe within nine months.

The ability for operators to offer cross-border satellite services is expected to transform the VSAT point to the multipoint business communications market. One survey predicts a tenfold increase in the volume of European satellite communications traffic by the end of the decade with as many as 80,000 VSAT dishes deployed.

Operators like BT in the UK will be able to offer services through hubs in all European countries, whereas in the past it had to negotiate restrictive deals with local operators. (Source: *Electronics Weekly*, 19 October 1994)

### **Eureka goes digital**

The Eureka 95 project, set up to develop programme material and a production and transmission infrastructure for MAC-based analogue HDTV, is being folded into a new project to do the same job for digital HDTV. Eureka 1187 (Advanced Digital TV Technologies) will develop "production, reception and replay equipment and the key technologies required to achieve them".

It will aim to build a demonstrator of a complete digital HDTV system based on specifications proposed by the DVB group. Consumer electronics firms Philips, Thomson and Nokia are all participating in the programme and more than 35 other organizations have applied for membership. (Source: *Electronics Weekly*, 21 September 1994)

### **Asian telecoms**

Throughout Asia the demand for telecoms products and services is dizzying. In countries where telephones are rare and connections feeble, such as India (where there is barely one line for every 100 people), several hundred networks—each the size of an American regional telephone system—have been planned.

Telecoms growth in Asia is partly a result of the fact that eastern Asia is the fastest-growing region in the world. But some countries have also pushed telecoms growth to the top of their agendas because they fear that, without an efficient telephone system, their economic growth could stall. In theory, at least, most Asian countries now agree how to improve their telecoms. They believe that privatization and competition are the only way to attract the necessary foreign investment and know-how. In practice, Governments find it hard to give up control.

As recently as five years ago most telecoms operators in the Asia-Pacific region were State-run. Now around 30 telecoms firms are listed on local exchanges. They range from privatized giants, such as Singapore Telecommunications (ST) and Pakistan Telecom, to new competitors such as Thailand's TelecomAsia and Globe Telecom in the Philippines. There are also numerous providers of beepers, cell-phones and other telecoms services.

Foreigners, especially Americans, have found their way in. NYNEX has a stake in TelecomAsia, which will operate 2 million lines in Bangkok; USWest own 20 per cent of Binariang, which is building a digital cellphone system in

Malaysia; Bell Atlantic and Ameritech each own 25 per cent of Telecom New Zealand and Bell South partly owns Australia's Optus. But the regional companies are not giving up easily: Australia's Telestra is leading the way in Viet Nam; Japan's NTT is investing in Thailand, and Korea Telecommunications in the Philippines and Indonesia.

Apart from the sheer physical difficulty faced by companies trying to manage so many new telecoms projects, there is another constraint on growth: money. The region's telecoms companies are estimated to generate enough cash to increase the number of telephone lines by only 10 per cent a year, but the forecast is for demand to increase by 17 per cent a year.

The problem with trying to raise so much money is that there is plenty of competition for it. Not only are other telecoms firms around the world hungry for cash, but so are thousands of other development projects in Asia, from roads and railways to electricity. Unattractive policies can drive foreign investors away. Countries desperately short of telephone lines are also becoming more liberal.

The growth prospects in Asia's more prosperous economies, especially in the relatively small but wealthy markets of Singapore and Hong Kong, might seem more limited. Both are already well wired, and neither possesses a particularly liberal home market for telecoms. This is largely because their markets were once considered too small to support rivals.

That, however, is also about to change. In Singapore ST's monopoly of mobile services will be abolished in 1997, which could lead to even more beepers and cell-phones flooding onto the market. The firm's monopoly of fixed-wire services will remain until 2007. Hongkong Telecom will not lose its grip on international services until 2006, but its monopoly on local services will go next June. Three rival groups have won licences to provide competing services: Hutchinson Communications, which is partly owned by Australia's Telestra; New T&T, owned by Hong Kong's Wharf group; and New World Telephone, whose shareholders include US West and Shanghai Long Distance Telephone.

Since Hongkong Telecom does not charge for local telephone calls, these new firms plan to beat it on service and technology. The new competitors talk of multimedia, video telephones and powerful data networks. Of course, Hongkong Telecom plans to compete by providing such services itself. It is racing with ST to be among the first to pump video-on-demand along telephone lines. Prising open Asia's markets, either developed or undeveloped, will assure telecoms growth of one sort or another. (Extracted from *The Economist*, 4 February 1995)

### **Serials in the third millennium**

Within the scope of collection development policies, it is important to consider how the concept of access interrelates with that of ownership. It is important to think how new technologies change the organization of library functions and services. Will artificial intelligence and expert systems offer a system of automation appropriate for processing a plethora of research information, which is already overwhelming the ability of mankind to process, retain, recall and synthesize. The influence of fiscal resources always has and will continue to govern the development of serial collections using either access or ownership measures. In the limited resources environment, the practice of access or document delivery must be

governed by the collection development policy. Questions that demand answers are what should be owned and what should be accessed? How are financial resources to be divided between competing departments and differing classes of library users? Should access equal that amount of print-on-paper journal titles cancelled within a discipline, or should money be spent on a first-come, first-served basis? The acquisition of adequate resources will demand new funding concepts.

Scientific, medical and business subjects are likely to gain initial development funds. Serial department staff in the next millennium will need some people who are conversant with the existence, control and use of retrospective runs of print-on-paper journals and the diminishing number of traditional journal issues. Other staff will have workstations crammed with display panels, terminals and voice activated equipment which will be

integrated in operation for the receipt, storage, and retrieval of journal publications, and to communicate with publishers, vendors, and users. New access systems such as document delivery and the electronic journal will provide new resources to the public service library staff. Artificial intelligence in the third millennium may provide a computer system which can process information or read against a researcher's thesis question and pose plausible conclusions. To reach the developments projected, it will be necessary to develop common software languages, communications protocols, and equipment such as faxes with comparable receiving and transmission characteristics. It is concluded that the starting point for each library will be its present level of automation; the talent and vision of its staff; and the intellectual vigour and flexibility of the institution's faculty and administrators. (Source: *Acquisitions Librarian*, December 1994)



## C. NEW DEVELOPMENTS

### **Axode's latest OCR neural chip presented**

The OCR system of the Axode company is said to be 100 times faster than the software solutions in use today. At the source of this performance characteristic is an electronic chip tailored to replace the traditional software used in applications of this type. Developed with the help of the Jessica program and the technical assistance of the Higher Electronic School of the West, this ASIC [Application-Specific Integrated Circuit] will equip the 20 or so vision systems that Axode markets every year. However, to better amortize development costs, the company also intends to offer it to vision-system manufacturers as an OEM [original equipment manufacturer] chip in PC-type cards. In another, more compact system currently under development, the company expects to achieve a reading rate of 30-40 characters per second by using two or three new ASICs.

The NeuronEye chip of Inovatic International answers the same concerns for fast processing. Built like the human brain, with a network of 1.640 neurons, it can read up to 1,500 characters per second. Developed jointly with the INPG (Grenoble National Polytechnic Institute), it is manufactured by SGS-Thompson for scanners, telecopiers, or extension boards. It is suitable for industrial quality control as well as for security monitoring systems.

The Zisc chips, built around a 36-neuron network, use the same principle. Developed jointly by Smart International, a new company of Montpellier, and IBM France in Corbeil-Essonnes, its distinctive feature is an integrated learning function that then enables it to perform a recognition task within only 4 microseconds. Several circuits can be cascaded to obtain more powerful systems. (Source: *Industries et Techniques*, October 1994)

### **Research on theoretical and computational methods for designing advanced functional materials**

The progress achieved in recent years in theoretical and computational methods in the field of solid state physics, quantum chemistry and statistical mechanics, as well as the remarkable progress achieved in computing tools such as supercomputers, now make it possible to elucidate and estimate the structures and properties of various materials to be elucidated or estimated on the atomic and electronic level by theoretical calculation or simulation.

These calculation methods include the molecular orbital method, band-structure calculation method, molecular dynamics method, Monte Carlo method, stochastic quantization method and hybrids of these methods.

The objective of this research project at the Osaka National Research Institute is to assess the feasibility of applying these atom and electron level theoretical calculation methods at the atomic and or electronic levels to elucidating the structures, properties and other phenomena of various materials with the aim of establishing a basic theoretical calculation technology for designing advanced functional materials. (Source: *JETRO*, November 1994)

### **The virtual corporation goes 3-D**

Working with customized hardware and some off-the-shelf virtual-reality (VR) software, two Purdue University professors have built a system that lets executives roam through three-dimensional models of their organizations. The system can also create hybrid models of multiple companies to analyse the benefits of a proposed strategic partnership.

Instead of scrutinizing charts and spreadsheets, a group of managers can "walk" together through symbolic domains where colours and shapes depict everything from cash flow to manufacturing operations and staff allocations. Alok Chaturvedi, an associate professor of management and co-developer Chandrajit L. Bajaj, a professor of computer science at the school, are also now tailoring a version for the financial community. (Source: *Business Week*, 26 September 1994)

### **Minute silicon electron gun developed**

Matsushita Electric Industrial Co., in cooperation with the Agency of Industrial Science and Technology of Japan, developed minute micron-order silicon electron guns (electron sources). Fine-processing technology for ultra-large-scale integration was used to form cathodes and other such structures on silicon substrates. As in a CRT, electrons are discharged from the cathode to the anode in a vacuum. The guns' electron discharge efficiency is good, and the operating voltage can be reduced significantly to 14 per cent or less of that of conventional devices of this type. Matsushita aims to exploit the characteristics—electrons moving at high speeds in a vacuum—and apply the devices in milliwave-band ultra-high-speed devices. In addition, if many of the electron guns can be formed densely on a substrate, there may also be applications in 1-mm-thick high-detail self-luminous flat displays that are bright and easy to look at.

The electron guns are vacuum microdevices in which electrons are emitted from a cathode and move towards an anode when a voltage is applied to a gate electrode in a vacuum. Matsushita developed an electron gun for flat displays (the electrons move in a direction perpendicular to the substrate) and an electron gun for ultra-high-speed devices (the electrons move in a direction parallel to the substrate). The sizes of both are micron-order.

Anisotropic etching (dry/wet) of a silicon substrate and other techniques were used to create cathode structures between neighbouring gate electrodes. Until now, if the gate electrodes were not very large, electrons were not discharged from the cathodes. Matsushita's electron gun for flat displays has a cathode that is needle-shaped with a sharp point (a tower structure), and its electron gun for ultra-high-speed devices has a cathode that is shaped like a cylinder whose middle is whittled down (a cocktail glass structure). Because of those structures Matsushita could reduce the operating voltages to 8 V (60 V in the past) for the electron gun with the tower-shaped cathode, and 14 V (100 V) for the electron gun with the cocktail-glass-shaped cathode.

Many of the electron guns can be formed one micron apart (i.e., 100 million electron guns per square centimetre) on a silicon substrate to realize a high-detail 1-mm-thick self-luminous (even in bright places, easy to look at) flat display. And, because the electrons can move much faster in a vacuum than in a solid, there may also be applications in milliwave-band ultra-high-speed devices. (Source: *Kagaku Kogyo Nippo*, 13 December 1994)

### **Technology team develops method for strengthening silicon atoms**

The team working on the Kimura Molten-Liquid Dynamics Project (led by Shigeyuki Kimura, head of the Science and Technology Agency's National Institute for Research in Inorganic Materials), which is one of the Exploratory Research for Advanced Technology Projects (ERATO) instituted by the Research Development Corporation of Japan, was the first to discover that, near gallium atoms present as trace amounts of impurities in a molten silicon liquid at 1,430°C, silicon atoms bind much more strongly than generally thought. The research team developed a new high-sensitivity X-ray absorption fine structure (EXAFS) device for use in molten liquid to make the observations. This result will gain attention as a discovery that will have applications in technology for atomic-level control of wafer growth and will lead to higher-quality large wafers.

The EXAFS device that was developed has improved jigs, etc., so that it can be used in a molten liquid; it also has a higher degree of sensitivity in fluorometric analysis involving the absorption and re-emission of X-rays. The device can measure the structure in and around atoms in a molten liquid in the form of interatomic distances.

The research group used the device to observe the distance between silicon and gallium atoms in molten silicon that had been placed into a boron nitride crucible and doped with Group-III gallium. When the gallium concentration was 1 per cent or less, the distance between silicon and gallium atoms was 2.2 Angstroms. In comparison with the normal distance between silicon and gallium atoms in molten silicon, 2.5 Angstroms, that is a closer range.

Contrary to general thinking up to now, at low concentrations of gallium the silicon and gallium atoms line up strongly with a short distance between them, and the silicon atoms exhibit a state where there are four atoms around a gallium atom. On the other hand, that sort of structure disappeared when the concentration of gallium was 5 per cent, and the research team verified that six silicon atoms lined up around a gallium atom, as the six ligands characteristic of molten silicon.

A structure in which silicon atoms line up as four ligands around a gallium atom resembles that of Group-IV silicon's solid crystalline structure. Therefore, if that sort of ligand relationship at the atomic level can be realized in a liquid state as well, then it can be used in the control conditions for crystal pulling as the silicon changes from a molten liquid into a solid. This time the research team experimented with gallium, which is easy to measure, but similar ligand structures at the atomic level can be expected with boron, phosphorus, antimony, arsenic, and other such impurities that are used for doping monocrystalline silicon.

As silicon wafers get larger, obtaining homogeneity in the surface of the wafer will be the big issue. At the 12-

and 16-inch levels of next-generation wafers, atomic-level investigations of crystal pulling control technology will be increasingly necessary. (Source: *Nikkei Sangyo Shimbun*, 8 December 1994)

### **Toshiba develops high-speed, energy-saving MOS transistor**

Toshiba announced that it had confirmed the room-temperature operation of a trial-produced MOS (metal-oxide semiconductor) transistor that will enable significantly faster and more power-conserving LSIs. Toshiba researchers discovered a new phenomenon that occurs when a transistor's gate electrode is reduced to a very small size: even if the gate oxide film is very thin, a large current flows. The researchers produced a gate oxide film that was 1.5 nm thick, which is half as thick as the 3 nm that was thought to be the limit up until now. Although the transistor will not be ready for practical use for several years, it will enable LSIs to operate five times faster than present-day LSIs and on one-tenth as much power.

The trial-produced transistor is a silicon MOS-FET (field-effect transistor) and has a gate length of 90 nm. Its current driving force, which is an indicator of the transistor's operating speed, is 1.4 mA per micron, or about twice the maximum value ever achieved in the past at room temperature.

In general there are two ways to make an LSI faster: (1) increase the speed at which the electrons move by shortening the lengths of the transistors' gates to thereby increase the electric field in the region where the current flows (the channel), and (2) increase the electron density by making the gate oxide film thinner.

In principle, however, if the gate length is 100 nm or less, the speed at which the electrons move reaches a state of saturation. On the other hand, if the thickness of the gate oxide film is 3 nm or less, normal operation is not possible because of the leakage current that arises as a result of tunnelling.

Nevertheless, Toshiba discovered that the leakage current that occurs along with a thinner gate oxide film will decrease significantly if the gate length is made smaller than 100 nm.

This new technology may be applied in MPUs (microprocessing units). At the same operating speed the power consumption can be about one hundredth that of MPUs using current technology. (Source: *Nikkei Sangyo Shimbun*, 9 December 1994)

### **Matsushita electric develops world's smallest CMOS transistor**

Matsushita Electric Industrial Co. has developed the world's smallest CMOS transistor. By using technologies such as low-energy ion injection, Matsushita reduced the length of the transistor's gate electrode to 0.05 microns. The development broke through the conventional limit of transistor miniaturization and opens the way to gigabit memory.

Up to now the solid-layer diffusion method was used to fabricate 0.1-micron and smaller transistors, but forming n-type and p-type MOS on the substrate was difficult. Matsushita succeeded in the miniaturization by injecting ions with a low energy (5 keV) and by thermal processing for a short time (10 seconds) with a method called RTA to make the junctions shallow.

In addition, deterioration in the transistor characteristics due to the short channel effect was checked without any increase in parasitic capacitance between electrodes; the use of a metal silicide in the electrodes also reduced the parasitic resistance. Matsushita also achieved the fastest delay time in the world, 13.1 picoseconds (when the transistor was driven with 1.5 V). (Source: *Nikkan Kogyo Shimbun*, 14 December 1994)

### **Fujitsu develops CMOS/SRAM technology for logic LSI**

Fujitsu has developed full CMOS/SRAM technology that will enable the company to lower the cost of 0.25-micron logic LSIs that have built-in SRAM. Fujitsu strove to simplify the fabrication processes and achieve a smaller LSI area by developing new techniques, such as forming local wiring directly over gate electrodes without any insulating film between the two, and thereby realized a minimum-level cell size of 10 square microns for a six-element configuration of SRAM. Fujitsu thinks the technology can be ready for use in mass production in a short period of time and plans to put it into actual use by 1997 or 1998.

Fujitsu used a technique of forming local wiring made of titanium nitride for the wiring near the inside of logic gates and for parts of the cross cables that straddle one gate and connect to another gate. The local wiring was formed directly above the diffusion layer and the gate electrodes without any insulating film between the layers. With that there is no need to allow for margins because the wiring does not go through contact holes, as conventional aluminium wiring does, and the area of the LSI could be reduced. Because the wiring itself is thin, flattening is not necessary, and that leads to a reduction in the number of processes. Actually, with this local wiring technique an insulating film is deposited on the gate electrode, and openings are formed only where the local wiring is to be connected, so the local wiring is connected directly to gate electrodes. Consequently, the contacts can be formed in a self-adjusting manner because the local wiring material, titanium nitride, is selective with respect to the contacts with the upper layer wiring, and the spacing between gate electrodes and contact holes can be reduced.

In addition, by using high-energy ion injection to form a retrograde well in which the concentration is low near the surface, Fujitsu reduced the spacing between n- and p-channels to 1.8 microns. Cobalt silicide was used in the source and drain surfaces and the surfaces of the logic gate electrodes, resulting in lower resistance in even very small regions. (Source: *Nikkan Kogyo Shimbun*, 16 December 1994)

### **NTT tests room-temperature single-electron transistor**

Nippon Telegraph and Telephone (NTT) has announced it had trial-produced a single-electron transistor, which is one of the next generation of devices that utilizes quantum effects. NTT was also the first to succeed in getting the transistor to operate at room temperature. In a single-electron transistor the flow of a single electron of current can be controlled. By using ultrafine processing techniques to fabricate the single-electron transistor, NTT improved the precision of quantum fine line processing and overcame the problem encountered in the past, i.e., that the transistor would only function at temperatures below -270°C. Because

the single-electron transistor can be made to operate with less power and can be integrated on a very large scale, its application in gigabit-class memory can be expected.

The single-electron transistor is expected to be used in the four-gigabit and larger-capacity memory that should appear around the year 2010. NTT says that its next research based on these results will be on integrating many of the transistors.

NTT used its own technology, called SIMOX (insulation by oxygen injection), to trial-produce the transistor and form quantum fine lines. The technology involves implanting oxygen ions into a silicon substrate and then forming in the substrate a silicon dioxide layer that acts as an insulating film.

The fine lines are 10 nm high, 5 nm wide, and 70 nm long. In addition, by reducing the sizes of both of the fine line's ends, which connect to electrodes, NTT found a way to form energy barriers there so that the structure acts like a quantum box.

As a result the energy difference between the electrodes at both ends and the fine line is kept small so that it is possible to determine with certainty a change in energy equivalent to one electron's energy, even when the transistor operates at room temperature. With the transistors that were trial-produced before, the precision of the fine line processing was low, and extremely small energy changes could not be detected unless the transistor was cooled down to -270°C.

If a way can be found to further reduce the dimensions of the quantum fine lines, NTT hopes to proceed with improving the transistor so that it will operate more reliably at room-temperature levels.

The single-electron transistor utilizes a quantum-mechanical phenomenon called the tunnel effect. Because the tunnel effect occurs in an extremely small region, the size of the transistor is kept small. (Source: *Nikkei Sangyo Shimbun*, 16 December 1994)

### **Highest transmission speed achieved with 0.05 micron gate electrode**

Matsushita Electric Industrial Co. has developed the smallest-scale CMOS (complementary metal-oxide semiconductor) transistor in the world. The length of the transistor's gate electrode is 0.05 microns. Reducing the length of a gate electrode to 0.25 microns or less had been regarded as an extremely difficult feat. Matsushita also achieved the highest signal transmission speed in the world for a CMOS transistor, and that may lead to the development of practical gigabit-class memory.

An important point about the development is that Matsushita used a better method of forming the transistor's source and drain electrodes, which are the electrodes through which current flows into and out of the transistor. In existing CMOS transistors, the depth of the source and drain electrodes is between 0.2 and 0.4 microns, and the plane where the electrode and substrate are joined is large. The shortcoming of those transistors is that current leaks out and the transistors do not operate properly if the distance between the electrodes is shortened. Matsushita's development team combined that way of forming electrodes with ultrafine processing technology for the gate electrodes to realize a gate length of 0.05 microns.

To speed up circuit operation, Matsushita made the electrodes out of a metal silicide, which is a compound containing silicon and a metal, such as titanium. A

metal-silicide electrode has much lower electrical resistance than silicon. When the newly developed device was driven with 1.5 V, the signal delay time was 13.1 picoseconds.

There are examples of non-CMOS transistors with gate lengths under 0.1 microns. However, this is the first development of a CMOS transistor that consumes less power. This result will open the way to the next generation of ultra-high-integration memory. Matsushita expects applications of the new transistor in devices such as the CPUs (central processing units) of high-performance portable computers that are driven by dry cells. (Source: *Nikkei Sangyo Shimbun*, 14 December 1994)

### **New transistor last 100 times longer**

Mitsubishi Electric has established the technology for processing ultra-small CMOS transistors in which the length of the gate electrode is 0.15 microns. Decreasing the transistor's electrical resistance helped boost its operating speed. In addition, because deterioration of the silicon oxide film beneath the electrode is prevented, the transistors last about 100 times longer than conventional CMOS transistors. Mitsubishi emphasizes that its technology is already practical and that it will use the technology to achieve more highly integrated memory and increase the speed of CPUs.

To make a transistor operate at a higher speed, the electrical resistance of the part of a transistor where current flows must be reduced. Mitsubishi vapour-deposited cobalt on the surfaces of the transistor's gate electrodes and the semiconductor substrate, then injected silicon ions to form a thin film of cobalt silicide.

As a result, the transistor's electrical resistance could be reduced to about one hundredth of the resistance of a conventional CMOS transistor. When the transistor was driven by 2 V of power, the delay time (the time it takes for current to pass through one transistor), which indicates the operational speed, was 20 picoseconds—the world's highest level of speed for a CMOS transistor.

In addition, to keep the silicon oxide insulating film between the gate electrode and the semiconductor substrate from deteriorating, Mitsubishi used a method of injecting nitrogen ions into the electrode.

The one-gigabit DRAM is highly integrated memory that is expected to become practical in the early twenty-first century. The issues for DRAM makers are the speed of the memory's ultra-small transistors, and making the transistors last longer. (Source: *Nikkei Sangyo Shimbun*, 14 December 1994)

### **Sharp produces prototype 256-kilobit FRAM**

Sharp trial-produced a 256-kilobit ferroelectric memory (FRAM) using a 0.6-micron process that is used in 16-megabit memory production. The charge-storing capacitors are made of a ferroelectric material and are stacked three-dimensionally on top of the transistors, which enables a higher degree of integration. When the power is on, the FRAM acts as a DRAM, and data rewriting is fast. In addition, the FRAM is non-volatile, so recorded data is not lost when the power is cut off. Application of the memory in equipment such as portable information terminals is expected. Sharp plans to develop megabit-class FRAM products based on that memory cell structure by 1997.

The FRAM consists of one-capacitor, one-transistor memory cells. It is non-volatile and uses a thin film of PZT (lead zirconate titanate), which is a ferroelectric

material that stores a great deal of electric charge. In order to reduce the size of the memory cell area, Sharp formed the capacitors on top of the transistors' outgoing electrodes.

Sharp established a dry-etching technique of forming microscopic (1.5 square micron) capacitors by using a 0.6-micron design rule, performing high-density plasma etching with a chlorine-mixture gas, and then heating the substrate to 200-300°C. Sharp uses platinum for the electrodes, and employs other materials, a structure and a fabrication technique that are suitable for stacked capacitors.

The capacity of the trial-produced FRAM is 256 kilobits, and its operating voltage is 5 volts. The FRAM is at the level of practical use: its rewriting speed is the same as that of DRAMs, and the number of memory writes as the power is toggles on and off is 10<sup>7</sup> or more. The cell size is 10.5 square microns (a 16-megabit DRAM's cell size is 4-5 square microns). (Source: *Kogyo Nippo*, 13 December 1994)

### **NEC develops production technology for high-performance BiCMOS**

NEC has developed bipolar device fabrication technology that will enable low-cost high-performance bipolar-CMOS. Until now, forming high-performance bipolar elements and MOS (metal-oxide semiconductor) elements on the same substrate required more processes. This time NEC developed a new process using an ultra-high-vacuum chemical vapour deposition (UHV CVD) device to form the outer base region of the bipolar elements. As a result, NEC was able to produce bipolar CMOS (Complementary metal-oxide semiconductor) using 12 masks, which is two masks less than with conventional methods and a 15 per cent reduction in the number of production processes. The bipolar and CMOS elements perform just as well as elements that were produced individually. NEC will work to make the technology practical for the next generation of 0.25-micron processes.

Forming the p-type MOS gate electrode and outgoing bipolar p-type base electrode with the same polycrystalline silicon was an effective way to reduce the number of bipolar-CMOS processes. However, because of the mismatch in the thermal processing temperatures, boron in the p-type MOS gate electrode penetrated through the gate's oxide film and affected the threshold voltage. Because of that problem the p-type MOS gate electrode and the outgoing bipolar p-type base electrode had to be formed separately.

To get around the problem, NEC developed a new process to form the external base region of the bipolar element. The strong point of the new technique is that the diffusion area of the outgoing base electrode was formed with the oxide film over the bipolar side of the substrate, which was formed at the same time as the 7-nanometre-thick MOS gate oxide film as the reference. After the oxide film was formed, an outgoing base electrode of polycrystalline silicon was formed. In making the emitter electrode window, that oxide film was etched away to create a 7-nanometre-thick, 200-nanometre-deep space.

A silicon film doped with a high concentration of boron was then deposited into that space by means of UHV CVD, then rapid thermal processing (RTA) for 10 seconds at 1,000°C was carried out, and the substrate was connected to the external base region. After that, impurities were injected into the p-type MOS gate electrode and the outgoing bipolar p-type base electrode, which

served to eliminate the problem of boron penetrating through the gate's oxide film. The bipolar and CMOS gate delay times of a trial-produced bipolar-CMOS transistor were 29 picoseconds and 54 picoseconds, respectively. The bipolar-CMOS transistors exhibited the same level of high performance as that of separately formed elements. (Source: *Nikkan Kogyo Shimbun*, 14 December 1994)

### **Toshiba develops 0.06 cubic centimetre power amplification module for PHS transmission**

Toshiba Corp. has developed a power amplification module for 2.7 V, simplified portable telephone (PHS) transmission. At 0.06 cubic centimetres, it is the smallest in the industry. In addition to optimizing the circuit arrangement to the module through a simulation, a land grid array (LGA) connection was adopted, so that the mounting area is one third that of existing modules. Toshiba will utilize these for second generation PHS in two years.

The module was completely optimized through a highly precise simulation of a function for a monolithic microwave integrated circuit (MMIC) which unifies the gallium and arsenic power amplifier IC with the surrounding circuits, and of a circuitry arrangement that includes the wiring. The module mounting was reduced in area with an LGA mounting that organizes all the connecting terminals to the outside on the back of the substrate. This enabled the creation of the industry's smallest module, 5.5 x 5.5 x 2.0 mm.

The module has a MESFET power element and employs a tungsten nitride- and tungsten-laminated gate, which has superior mass producibility. In addition, a high resisting pressure was devised by means of a self-adjusting asymmetrical source drain structure, enabling low distortion, high efficiency operation despite the low voltage and single power source drive.

The surrounding circuits external to the power amplifier IC consist of only six low-cost parts, and were devised to be high performance, smaller, and less expensive, through measures such as solder heating, which can lower the cost of bonding to the substrate. (Source: *Nikkan Kogyo Shimbun*, 25 November 1994)

### **Organics on the television**

The search for organic materials for electronics dates back five decades, and has always been stumped by the same problem: electrons just cannot move as fast in organic materials as they can in inorganic semiconductors. German chemists may now have found an exception to this rule—a liquid crystal which could revolutionize imaging technologies.

The conductivity of organic materials is governed by how easily the charge carriers (electrons and "holes") can move within the material. Most so-called organic conductors have charge carrier mobilities around  $10^{-4} \text{cm}^2 \text{V}^{-1} \text{s}^{-1}$ ; this increases to  $1 \text{cm}^2 \text{V}^{-1} \text{s}^{-1}$  in single crystals, but these are difficult and expensive to make and often too rigid to be useful.

A team, led by Dietrich Haarer of Bayreuth University and including scientists from BASF, is working with disc-shaped organic molecules which form liquid crystals. These materials, although highly runny, are more ordered than other liquids. One of the team's "discotic" molecules, HHTT (2,3,6,7,10,11-hexahexylthiotriphenylene), has a charge carrier mobility of around  $0.1 \text{cm}^2 \text{V}^{-1} \text{s}^{-1}$ , the highest

mobility ever recorded for an organic material other than single crystals.

HHTT is a photoconductor—it emits electrons and conducts when hit by light at a particular frequency. When molten, its charge carrier mobility is about the same as any other organic conductor. As it cools, however, it forms a new phase where the disc-shaped molecules stack up like coins; at this point, the mobility suddenly jumps by one order of magnitude and rises slowly as the temperature drops further.

A little later, the stacked molecules align themselves to form twisted columns, and the mobility increases by two orders of magnitude to its maximum value. If the cooling continues so that the substance solidifies, electrons are "trapped" at crystalline boundaries and the mobility drops.

The material is chemically stable, easy to purify and should be no dearer than other organic conductors, says Haarer. Because it is liquid, it can easily form thin films, such as those used in flat-screen liquid crystal televisions; its photoconductivity makes it ideal for photocopiers. Its fast conduction and response to light could lead to sharper images on both devices. However, he adds, such films must be solid; the team is trying to "cross-link" the twisted column phase without affecting its electrical properties. (Source: *European Chemical News*, 19 September 1994)

### **Through a glass, darkly**

Mino Green of the Societa' Italiana Vetroso says that making large sheets of electrochromic glass is difficult, because the larger the sheet, the less uniform the colouring.

Green has devised an electrochromic "cell" sandwiched between two sheets of glass which, he claims, provides uniform colouring. The key is an electrolyte polymer solution, made by dissolving lithium perchlorate in a 3:1 mixture of polymethylmethacrylate and propylene carbonate, then using a high-vacuum technique to evaporate some of the PMMA, leaving a 1.68:1 ratio.

The electrode on one sheet of glass is a 3,500Å-thick layer of tungsten oxide ( $\text{WO}_3$ ), and the electrolyte solution is silk-screened on top of this. A gold reference electrode is then inserted between the layers, with the gold in contact with the electrolyte but insulated from tungsten. The other sheet of glass has a 1,700Å-thick layer of a 1:2 mixture of vanadium pentoxide ( $\text{V}_2\text{O}_5$ ) and molybdenum oxide ( $\text{MoO}_3$ ). This layer has lithium ions incorporated into it.

To make the cell, says Green, the two sheets are pressed together, glass sides out. Applying a voltage across the two metal oxide electrodes, so that the reference electrode measures the tungsten oxide's electrochemical potential at  $\pm 1.2\text{V}$ , forces the lithium out of solution and darkens the cell to uniform opacity within a minute, he claims. (Source: *Chemistry & Industry*, 5 September 1994)

### **LSI Logic unveils 32-bit ASIC cores**

Embedded system designers can save money by using a core-based ASIC which incorporates the microprocessor rather than discrete ICs, claims LSI Logic.

The firm, unveiling its miniRisc family of 32-bit Mips RISC processor ASIC cores, promises its approach has to be cheaper than the discrete IC based system.

The first core LSI will offer is the 32-bit CW4001, which implements the Mips 2, R4000 compatible instruction set. A dual-issue superscalar core, the CW4010, is to follow early next year with the CW4100 high-

performance dual-issue superscalar core following by the end of next year.

The CW4001 runs at up to 66 MHz, the CW4010 at up to 80 MHz with the CW4100, which is still being defined, targeted at over 100 MHz. A range of other cores, such as an MMU, cache, DRAM controller, ATM functions and MPEG codecs can be added to the ASIC. (Source: *Electronics Weekly*, 9 November 1994)

#### Gate array record

Toshiba has developed a gate array it claims to be the world's largest containing up to 750,000 usable gates.

The TC200 family provides single gate delay times of 0.19 ns (with a fan-out of 2) operating from a 3.3 V supply. Manufactured in a 0.4µm 2 or 3-layer metal silicon gate CMOS process, the firm will begin accepting development orders for the TC200G gate array and TC200C cell-based variants this month. An embedded array version is due early next year.

The TC200 macrocell libraries include Gunning transceiver logic (GTL) cells and phase-lock loop circuits as well as 5 V input pads. Design support includes the Cadence Verilog-XL simulator and the Synopsys VSS VHDL simulator augmented by non-linear scaling models to provide accurate sub-micron timing analysis. (Source: *Electronics Weekly*, 9 November 1994)

#### Cambridge researchers in chip breakthrough

A microtechnology achievement made by the scientists of the Toshiba Cambridge Research Centre (TCRC) and Cambridge University, is set to create a revolution in microprocessor and computer technology.

The researchers have developed a process for fabrication of quantum device structures that use the quantum mechanical "tunnelling effect". Quantum ICs have been fabricated on a wafer scale using Molecular Beam Epitaxy (MBE).

The breakthrough will lead to three-dimensional ICs with densities a thousandfold higher than conventional integrated circuits, logic circuits with speeds of up to 1,000 GHz and super-capacity logic and memory circuits which can be switched optically and read electrically.

Many other research organizations have been working on this technology including NEC and Hitachi from Japan. NEC's researchers have demonstrated that the quantum effect devices can operate at room temperatures, which so far has proved impractical.

NEC has also grown a 5 nm thin quantum structure.

The first operational ULSI circuits are expected in two yearstime. (Source: *Electronics Weekly*, 2 November 1994)

#### Actel sea-of-gates FPGA on the way

Actel has confirmed it will launch a sea-of-gates antifuse-based FPGA in 1995 taking it into direct competition with Xilinx.

The Actel FPGA is likely to be dubbed the ACT4 part and will offer densities up to 40,000 usable gates. Built on a 0.65-micron process, the FPGA will, crucially, exploit a metal-to-metal antifuse which the company's engineers are currently developing.

Presently, the firm's current silicon (SiO<sub>2</sub>)-based antifuse technology could not be used on a sea-of-gates architecture although significant technical problems need to be overcome to produce workable metal-to-metal antifuses.

However, Actel is more advanced than Xilinx in developing this type of antifuse and is confident the sea-of-gates FPGA will be launched. (Source: *Electronics Weekly*, 2 November 1994)

#### US firm claims SIMMs "first"

A Californian company has leapt into the data storage market with what is believed to be one of the first single in-line memory modules (SIMMs) using flash RAM devices.

Smart Modular Technologies has introduced 4 Mbyte and 8 Mbyte SIMMs which combine the non-volatility of flash with the speed and capacity of DRAM on one chip.

The technology combines the high-speed readability of DRAMs and the non-volatile update capabilities of flash. It offers intermediate storage devices, sitting somewhere between traditional DRAM and disc storage. It significantly reduces board size requirements and system cost in embedded applications needing large amounts of memory.

The SIMMs will have mainly "read" applications in systems where data is read in memory more frequently than written. (Source: *Electronics Weekly*, 2 November 1994)

#### Polymers find the light

Researchers at the University of Rochester say they have developed ways to dramatically boost the efficiency of light emission from conjugated polymers. The work, the scientists say, could lead to the use of inexpensive polymers in a range of electronic applications and the development of new materials through the control of supramolecular structure and morphology. Working with polybenzobisazoles, the researchers show that the luminescence of conjugated polymer thin films is due to intermolecular excimers that are relatively inefficient in converting energy into light. But precisely modifying the polymer chains to avoid the excimer formation boosted efficiency up to fivefold, according to the Rochester researchers. (Source: *Chemical Week*, 17 August 1994)

#### Tinier still

In the past 10 years scientists have started to explore a world of quantum dots, wires and wells, in which individual electrons are trapped and demonstrate new tricks. Researchers envisage quantum-electronic computers a hundred times smaller than today's, with capabilities as much beyond present ones as these are beyond the valve calculators of the 1950s.

Led by Michael Pepper, a physicist from Cambridge University's Cavendish Laboratory, the Toshiba research centre in Cambridge has succeeded in making not just single quantum features, but in putting a collection of them side by side on a single chip a quantum-electronic integrated circuit. They started with a conventional chip-making technique (spray-paint-layers of molecules to build up a sandwich of different semiconductors, then etch away parts to leave patterns that form circuits) and refined it to produce details a few atoms across. Hitachi, another Japanese company investing heavily in similar nanotechnology, also has a quantum-electronics research group based in Cambridge.

Toshiba compares its achievement to the invention of the first integrated circuit in 1958, and promises developments as spectacular as those that have followed that invention. They are some way off. Toshiba's device needs to sit in chilly liquid helium to work but the way

ahead has been signposted. The technological slog starts now. (Extracted from *The Economist*, 29 October 1994)

### **Analysis of atom distribution on strontium-titanium oxide single crystal surface layer**

Shimadzu Corp., together with Prof. H. Koinuma and his research team of the Industrial Materials Laboratory, Tokyo Institute of Technology, have jointly established a new analysis technique by which they succeeded in analysing the distribution of atoms on strontium-titanium oxide (STO) single crystal surface layers for the first time.

Strontium-titanium oxide is an oxide that is used as the basic material for producing high-temperature superconducting materials. The establishment of the primary layer analysis technique now enables thin superconducting films to be laminated with stability, so superconductivity can be improved substantially.

It has been clarified theoretically that titanium oxide and strontium co-exist in the STO surface layer of about 0.2 nm. These atoms cannot be discriminated by using conventional equipment such as the reflection high energy electron diffraction (RHEED) system, photoelectronic spectroscopic (PS) system and scanning tunnel microscope (STM). Thin superconductive films such as those made of yttrium-barium-copper (YBCO) used to be formed without the surface state having been clarified, so the existing state is that superconducting characteristics cannot be manifested reliably due to the inferior crystallinity. In fact, no surface analysis technology has been commercialized up to now.

The surface was analysed successfully, this time on the atomic level, by using a coaxial impact-collision ion scattering spectroscopy (CACISS). The university confirmed that when the titanium oxide layer is given molecular beam epitaxial growth treatment at a high temperature, the STO wafer surface layer is converted into a strontium layer, and that a quality film can be formed with stability. The lamination of thin superconductive film made of YBCO can be controlled flexibly, so it will be possible to develop superconducting materials of stabilized superconducting characteristics, and the yield will also be improved substantially. Further information is available from Shimadzu Corporation, Marketing Research and Planning Dept., 1, Kuwahara-cho, Nishinokyo, Cyukyo-ku, Kyoto 604. Tel.: +81-75-823-1110. Fax: +81-75-811-3188. (Source: *JETRO*, December 1994)

### **Deposition of monocrystalline diamond film on silicon substrate**

Professor H. Kawarada and a research team at Waseda University have developed technology for depositing monocrystalline diamond film on a silicon substrate. The conventional epitaxial technology for monocrystalline diamond usually involves a diamond substrate synthesized under high pressure. No heteroepitaxial deposition of monocrystalline diamond has succeeded with a substrate made of silicon or others with a lattice constant much different from that of diamond.

The new heteroepitaxial technology uses a silicon carbide interlayer between a silicon substrate and monocrystalline diamond. Diamond is deposited on a high-grade  $\beta$ -SiC Si substrate, which has recently become available. On the buffered substrate, pyramidal nuclei of diamond are formed in a uniform distribution. The nuclei grow until a flat monocrystalline layer of diamond is

formed. The two-step selective deposition process is carried out by optimizing gas conditions.

Because the diamond lattice constant differs from that of silicon by as much as 52 per cent, monocrystalline diamond is difficult to deposit directly on a silicon substrate. Although homoepitaxial growth of monocrystalline diamond succeeded with high-pressure synthesized diamond, heteroepitaxial deposition has not. All heteroepitaxial diamond obtained so far has used a substrate made of cubic boron nitride (c-BN), nickel, and others with a lattice constant differing from diamond by only 1 per cent or so, so the process was little more than homoepitaxial deposition. c-BN is more expensive than diamond, and unrealistic for industrial use. Nickel is likely to absorb so much carbon that devices using the metal would easily fail. In contrast, silicon is hard and inexpensive as well as easy to make into big wafers.

To make uniform monocrystal nuclei on a SiC Si substrate, the research team optimized the plasma potential difference in the vapour deposition system. The selective deposition of the two-step process is performed by selecting a source gas that includes carbon dioxide. The deposition of monocrystalline diamond was confirmed by the metallic appearance and electron beam diffraction.

With unusual properties, diamond films have a vast range of applications. The new technology may allow production of inexpensive diamond films. Further details from Waseda University, School of Science and Engineering, 3-4-1, Okubo, Shinjuku-ku, Tokyo 169. Tel.: +81-3-3203-4141. Fax: +81-3-3200-2567. (Source: *JETRO*, December 1994)

### **System for broad-band optical atmospheric transmission with laser beam**

Mitsubishi Electric Corp.'s Imaging Systems Laboratory has developed a system for atmospherically transmitting multiplexed video and audio signals with a semiconductor laser beam.

A wideband laser beam is used, so over 20 channels of TV pictures or 6-7 channels of high-vision pictures can be transmitted simultaneously. Another distinct advantage is that programmes can be set up in wide spaces as in large athletic arenas or halls without using complicated video systems or laying cables, and there is hardly any signal deterioration by electromagnetic induction compared to wireless transmission with radio waves.

The new transmission system consists of an optical transmitter and an optical signal receiver. Inputting video images in the optical transmitter converts these images into light signals at laser with a built-in conversion circuit and the signals are transmitted to the optical signal receiver. The optical signal receiver converts the received signals into video images and displays them on a monitor. The optical transmitter is capable of transmitting signals to distant spots about 1 km away from the optical transmitter.

The semiconductor laser is the same infrared laser that is used for readout of compact disks (CDs). The output is 1 mW and the frequency bandwidth is as wide as 10-250 MHz, so multi-channel, long-distance transmission is possible. The information transmission speed is roughly 500 Mbit/s (in digital equivalent), comparable to a wired communications system using optical fibre cables.

The system is usable as a transmission mean for linking video cameras and extra-large screens when installing video systems in athletic arenas. The system is simply mounted

on a wall or ceiling, so the installation work is simpler and the cost far less than installing underground cables, so the system is applicable to two-point communications without having to lay cables as between buildings. Further details from Mitsubishi Electric Corporation, Public Relations Dept., 2-2-3, Marunouchi, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3218-2172, Fax: +81-3-3218-2431. (Source: *JETRO*, December 1994)

#### **Grinding process for micromachine components**

The Mechanical Engineering Laboratory, Agency of Industrial Science and Technology (AIST), has developed a grinding process for micromachine components. When machining a needle-like cylinder, the process can make the diameter as small as 20  $\mu\text{m}$ . This may lead to a breakthrough, because the grinder, a typical method for processing metallic or other workpieces, has been thought unsuitable for microfabrication because the grinding process would cause too much grinding force in the workpiece, and result in deformation.

Grinding is one of the two major machining processes, the other is cutting. In the process, a grinding wheel (a rotating wheel of abrasive material) is applied to a workpiece to be ground. The grinding process works well with hard workpieces that cannot be cut. Another advantage is suitability for making three-dimensional products. The process, however, involves too much grinding force caused by contact of the rotating grinding wheel with a workpiece, which is thus likely to be deformed or broken. The grinding process is therefore not compatible with fabrication of micromachine components, which must have accuracies on the order of micrometres.

The research team overcame the problem by devising grinding conditions to yield ever smaller chips so that the grinding force is reduced. The new process can machine a cylinder 20  $\mu\text{m}$  in diameter. The process could also produce more intricate configurations, such as a micro-sprocket gear wheel with eight teeth. The fabrication was achieved with a grinder and a workpiece manipulated by hand while the contact was observed with a microscope. Further details from Mechanical Engineering Laboratory, AIST, 1-2, Namiki, Tsukuba City, Ibaraki Pref. 305, Tel.: +81-298-58-7035, Fax: +81-298-58-7007. (Source: *JETRO*, December 1994)

#### **Forming PN junctions at depth of 0.04 $\mu\text{m}$**

NEC Corp. has developed a boron diffusion from polysilicon oxide (BDSOX) structure technology for forming PN junctions at a shallow depth of 0.04  $\mu\text{m}$ , indispensable for producing complementary metal-oxide semiconductors (CMOS) of 0.1- $\mu\text{m}$  class.

A polysilicon oxide two-layered structure impregnated with P-type impurity-free boron was used and a 0.18- $\mu\text{m}$  PMOS fabricated by a new technique for diffusing boron on a silicon wafer by instantaneous heat treatment (RTA). Compared to the conventional ion impregnation method, the threshold voltage disparity was decreased to one tenth while achieving about the same level of drive capacity, by which a practical impurity-free diffusion technique was developed for the first time, paving the way for the commercialization of high-performance CMOS of 0.1- $\mu\text{m}$  class.

With this BDSOX technology, oxide and polysilicon films are first laminated on a silicon wafer, followed by boron ion impregnation. Boron is diffused on the wafer via

the oxide films by applying the RTA heat treatment technique. The formed NMOS side is protected with resist, followed by PMOS gate formation, after which the new BDSOX technology is applied. Removing polysilicon provides an extremely shallow junction of low resistance, and the process is compatible with conventional CMOS technology. The NMOS comprising the CMOS can be produced with the element size of 0.1  $\mu\text{m}$  even by the conventional ion impregnation technology, but in PMOS, the boron impurity diffusion rate is rather large, so it had been difficult to form shallow junctions as desired by the method of ion impregnation.

The BDSOX technique enables shallow diffusion at a depth of less than 0.05  $\mu\text{m}$ , which suppresses the unique short-channel effect. Therefore, with the prototype 0.18- $\mu\text{m}$  PMOS, there is little disparity in the threshold voltage that is problematic in the fabrication of LSIs. The impurity density on the surface is also as high as  $5 \times 10^{17} \text{ cm}^{-2}$  and enables junctions of low resistance to be produced, so it is possible to obtain a drain current providing a high drive capability comparable to that achieved by ion impregnation technology.

When the electrical characteristics of 0.1- $\mu\text{m}$  PMOS FET were estimated from the pn junctions of 0.04- $\mu\text{m}$  depth fabricated by the BDSOX technology, it was found that the threshold voltage change is decreased to an adequately low level even with 0.1  $\mu\text{m}$  PMOS FETs. The company plans further research to fabricate a 1- $\mu\text{m}$  class CMOS as soon as possible by applying the new technology. Further details from NEC Corporation, Public Relations Office, 5-7-1, Shiba, Minato-ku, Tokyo 108-01, Tel.: +81-3-3798-6511, Fax: +81-3-3457-7249. (Source: *JETRO*, December 1994)

#### **Superconducting AC wire with lowest loss and highest strain resistance**

Hitachi Cable, Ltd. has developed a superconducting alternating current (AC) use wire made of Nb<sub>3</sub>Sn with the lowest AC loss achieved so far into that material and excellent strain resistance. Due to the minimal AC loss, the current-carrying capacity has been improved to over double, in comparison to that of conventional counterparts.

Actual superconducting conductors commercialized so far are limited to either the niobium-titanium type or the niobium-tin type. Generally, Nb<sub>3</sub>Sn-based conductors show greater thermal stability than NbTi-based conductors, because of the higher superconducting state to normal state.

In order to utilize this advantage, the company is engaged in research to commercialize large-capacity Nb<sub>3</sub>Sn-based AC use conductors to be used in such AC equipment as superconducting generators, current-limiters and transformers, etc.

The new superconducting wire is produced by adding tantalum to niobium filament to suppress the abnormal ribbon-like deformation of the filament, which is typically observed for the wires with pure Nb filament when drawing down the size, and by adding germanium (Ge) to the bronze matrix to increase the matrix resistivity, which reduces the AC loss.

This work has been carried out by Hitachi Cable Ltd., jointly with Prof. Tachikawa of the Faculty of Engineering, Tokai University, as a part of "R&D on Superconducting Technology for Electric Power Apparatuses", and the New Sunshine Project of AIST, MITT, consigned by NEDO. Further details from Hitachi Cable Ltd., Legal



and Document Section, 2-1-2, Marunouchi, Chiyoda-ku, Tokyo 100, Tel.: +81-3-5252-3261, Fax: +81-3-3214-5779. (Source: *JETRO*, December 1994)

### **First graphic SRAM**

Sony Corp. has developed the first graphic processing memory that uses a static random access memory (SRAM) in the random access memory (RAM).

Compared to products using the existing dynamic random access memory (DRAM), the new memory features a processing speed that is three times faster, and the write-in process can be controlled more easily.

The new graphic SRAM uses a SRAM cell in the RAM unit, by which high-speed random access of 20-24 nsec has been achieved with a 2-Mbit capacity, while high-speed processing is more than three times faster than conventional types of video RAM (VRAM) systems. The source voltage is 5 V. Further details from Sony Corporation, Corporation Communications, 6-7-35, Kita-Shinagawa, Shinagawa-ku, Tokyo 141, Tel.: +81-3-5448-2200, Fax: +81-3-5448-3061. (Source: *JETRO*, December 1994)

### **World's first high-brightness, green (512 nm) LED**

Sony Corp. has developed a 512 nm wavelength, green light emitting diode (LED) with a brightness of 4 candela (cd). The LED consists of a layer of zinc-cadmium-selenide sandwiched between two cladding layers of zinc-magnesium-sulphur-selenide in a double-heterostructure.

Conventional high-brightness LEDs, such as those used in level metres for stereo systems, or to display text on store displays, emit light in a range of four different colours using different operating wavelengths: blue (630-700 nm); orange (610 nm); yellow (570-590 nm) and yellow-green (555-566 nm). When used in combination with other high-brightness, short wavelength LEDs which emit blue or green light, all the primary colours can be generated. This allows the use of large-scale thin full-colour displays based only on LEDs for indoor and outdoor applications.

The LED developed by Sony is the first to provide emission of green light between blue-green and yellow-green operating at a wavelength of 512 nm. The wavelength of an LED depends upon the materials used in the semiconductor and the technology employed to achieve the crystal growth. The successful development of an LED emitting green light was made possible by the discovery of a cladding layer of zinc-magnesium-sulphur-selenide and the use of crystal growth technology.

The prototype LED is composed of a gallium arsenide base above which is the emission layer of zinc-cadmium-selenide, which confines the holes and electrons. The molecular beam epitaxy method is employed to achieve crystal growth.

At 4 cd, the on-axis luminous intensity of the LED with a 12 degree cone viewing angle (the full width at half the maximum angle of beam divergence) is the highest ever recorded.

Minimization of impurities in the emission layer restrict the band width of the LED to 512 ± 10 nm, resulting in light of a very pure green colour. Pure colours are a key factor in the development of full-colour displays, as they allow effective blending of primary-colour lights in order to achieve a broader spectrum of hues. Further details from Sony Corporation, Corporation Communications,

6-7-35, Kita-Shinagawa, Shinagawa-ku, Tokyo 141, Tel.: +81-3-5448-2200, Fax: +81-3-5448-3061. (Source: *JETRO*, December 1994)

### **Smallest chip mica capacitor**

Soshin Electric Co., Ltd., a leading manufacturer of capacitors, has developed the smallest chip mica capacitor for the high frequencies of mobile communications equipment such as cellular phones. A distinct characteristic is the use of natural mica featuring an excellent stability in place of the plastic and ceramic dielectric material. The company plans to engage in mass production and to supply the capacitor to communications equipment manufacturers.

The chip mica is 1.6 mm long, 0.8 mm wide and 1.2 mm thick (maximum). The thickness will differ with the capacitance design, but the length and width are smaller by about 20-30 per cent compared to the company's existing counterparts.

In experiments, the new capacitor's frequency characteristics such as Q, ESR and IR are much better than those of compact high-frequency ceramic capacitors in the frequency range of 1 GHz that is the mean frequency band of mobile communications. Power consumption is also reduced.

The increasing use of digital signals in mobile communications is making it necessary to use such an excellent capacitor in high frequency ranges. In addition, there is a need to save space to cope with the existing trend for product miniaturization and large-scale circuit integration. Further details from Soshin Electric Co., Ltd., 1-18-18, Nakamagome, Ota-ku, Tokyo, Tel.: +81-3-3775-9119, Fax: +81-3-3775-7092. (Source: *JETRO*, December 1994)

### **First 64-Mbit synchronous DRAM**

Fujitsu Ltd., has developed the world's first 65-Mbit synchronous dynamic random access memory (DRAM).

Recently the arithmetic processing speeds of processors used in electronic equipment, such as computers, have increased rapidly with the progress in multimedia, and so DRAMs are required to feature faster working frequencies and data transfer speeds compatible to the speeds of these processors.

The synchronous DRAM is designed to meet this need. Data input/output is performed continuously, synchronous to the processor clock frequency, so the data transfer speed is increased by 2-3 times compared to the conventional type of DRAM that temporarily terminates operations with each input/output of data.

The 8-bit version enables data transfer at a rate of 100 Mbyte/s, with the access time from the clock as fast as 6 ns, the highest speed in the trade. The current 16-Mbit conventional 16-bit synchronous DRAM has two banks of memory array, but the new DRAMs use four banks, by which the memory processing capacity has been substantially improved. The power voltage is as low as 3.3 V ± 0.3 V. The chip size, which is a problem with synchronous DRAMs, has been reduced to about 232 mm<sup>2</sup>, about the same as that of conventional DRAMs.

The synchronous DRAM is capable of continuous data input/output synchronous with the processor, so compared to the conventional type of DRAM that terminates operations temporarily after a data input/output operation, the data transfer speed is considerably increased.

Further details from Fujitsu Limited, Public Relations Dept., 1-6-1, Marunouchi, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3213-4160, Fax: +81-3-3216-9365. (Source: *JETRO*, December 1994)

### **Super-high-resolution, large-screen display system**

NTT Corporation has developed a 110-inch LCD projector, aimed at creating a "virtual presence" sensation in video-communications applications, that attains 2880 x 2048 pixels, four times the number used in HDTV-class projectors.

The development of "same room" video-communications systems good enough to give the impression that the other party is present before one's eyes is one of the ultimate goals to which telecommunications technology can aspire. The attributes required of the image display device for such a system include high resolution and brightness and large screen size to allow the display of images at a size that will achieve sufficient impact. For some time, NTT has been pursuing the development of image display devices that will satisfy these requirements.

The new super-high-resolution large-screen display system incorporates a unique interleaved projection method which projects four pixels onto an area occupied by a single pixel in HDTV-LCD projectors. These four pixels are very precisely shifted by a minute distance in relation to each other and superimposed, to give four times the number of pixels as well as the brightness achieved by HDTV-LCD projectors.

In order to interleave the minute pixels of HDTV images accurately, it is necessary to achieve precise positioning control of the four screens to be interleaved. For this purpose, NTT developed a special screen adjustment mechanism incorporating a liquid prism. The angle of the prism is easily adjusted electronically to achieve micron-level accuracy in screen positioning control, virtually impossible to achieve with conventional mechanical adjustment systems. To achieve a brightness corresponding to the number of images interleaved, NTT developed an optical system which minimized the loss of light involved in projecting each image. The high resolution and 110-inch screen size obtained by means of these systems achieves a screen viewing angle of 60° at a distance of two metres, the distance at which single pixels cannot be recognized. Compared with the viewing angle of approximately 10° achieved by conventional NTSC (National Television System Committee) system television, and approximately 30° achieved by HDTV, an angle of 60° gives very natural images which does not show the gap between the screens and gives a very life-like image on the screen.

The 110-inch screen (vertical: 1.3 m, horizontal: 2.4 m) also allows the projection of life-size full-length images of people, by which a big step forward has been achieved towards attaining the target of the futuristic communications technology that provides a high sense of reality.

NTT plans to pursue the development of super-high-resolution large-screen display systems and peripheral equipment and will work in future to create video-communications systems that project images from remote locations onto walls and other large surfaces to create the impression that the distant object is right there. Further

details from NTT Corporation, Press Relations, Public Relations Dept., 1-1-6, Uchisaiwai-cho, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3509-3101, Fax: +81-3-3509-4290. (Source: *JETRO*, December 1994)

### **Frequency stabilization and oscillation integrate circuit**

NEC Corp. and Milliwave Co., Ltd. have jointly developed a frequency stabilization and oscillation integrated circuit, a leading component for millimetre communications systems, which features an oscillation frequency of 55 GHz, output of 2.3 mW, and frequency stability of 3.9 ppm °C.

Millimetre wave communications is performed in a broad frequency band of 30-300 GHz and is characterized by the handling of a huge volume of information. It is particularly ideal for short-haul communications including simple radio communications and local-area radio communications. Due to its short wavelength, miniaturization of equipment such as antennas is possible.

Miniaturization and cost reduction of millimetre wave communications systems requires a monolithic microwave integrated circuit (MMIC) that integrates super high-speed transistors made of gallium arsenide (GaAs) and passive elements such as capacitors on the same wafer. An oscillation circuit and dielectric resonator combined into an MMIC chip for use in the high frequency band of 55 GHz has now been commercialized as a frequency stabilization and oscillation circuit.

In the advanced information-oriented society, the most urgent demands will be placed on ultraminiaturized and portable wireless type general communications and office communications equipment, in which everyone has their own compact portable wireless terminal. Millimetre communications systems are under intensive development to respond to the needs of such an age, and the technology is a vital facet of pioneering into the development of the millimetre band (30-300 GHz), an untapped frequency band, to most effectively utilize the wavelengths that are an asset common to all mankind.

Millimetre band circuits have used the waveguide microwave transmission circuit and hybrid IC, but compared with these circuits, the MMIC integrates super-high-speed transistors and high-frequency passive elements on a semiconductor wafer and will feature superlative accuracy, uniformity, reproducibility, and mass-production attributes.

The new millimetre wave oscillator MMIC has a gate length of 0.15  $\mu\text{m}$ , uses an AlGaAs/InGaAs heterojunction transistor as its basic element and mounts millimetre wave passive elements such as a high withstand voltage metal-insulator-metal (MIM) capacitor and microstrip channel on a single semiconductor wafer. This oscillation circuit features excellent frequency stabilization and phase noise suppression by action of a dielectric resonator linked via the microstrip channel and electromagnetic field distribution on the semiconductor wafer. Further details from NEC Corporation, Public Relations Div., 5-7-1, Shiba, Minato-ku, Tokyo 108-01, Tel.: +81-3-3798-6511, Fax: +81-3-3457-7249. (Source: *JETRO*, December 1994)

### **Low voltage field emitter structures developed**

Researchers from Matsushita Electric Industrial Co. Ltd., have developed two types of new low voltage, submicron silicon-based field emitter array structures.

The researchers say the new structures can be uniformly fabricated using conventional VLSI dry etching and anisotropic wet etching technology. One is a "tower" structure and the other is a "cocktail glass" structure. While the tower structure is close to the theoretical ideal, the cocktail glass structure is more stable and more easily integrated with LSI devices, they add.

The fabrication process for the tower structure is as follows:

- The dot array mask pattern for emitters with a diameter of 0.5  $\mu\text{m}$  and 1  $\mu\text{m}$  pitch is exposed using optical lithography, and reduced to 0.3  $\mu\text{m}$  by HF solution.
- A combination of dry and anisotropic wet etches (the latter based on ethylenediamine) are used to reveal stable (331) crystal planes. The orientation of the starting silicon was (100).
- The surface surrounding the emitters is dry etched, followed by thermal oxidation to obtain sharp emitter tips.
- $\text{SiO}_2$  and Nb thin films are deposited, followed by lift-off to complete the emitter array.

The fabrication process for the cocktail glass structure is similar, but the  $\text{SiO}_2$  and Nb thin films are deposited after the anisotropic wet etch. (Reprinted with permission from *Semiconductor International Magazine*, December 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### **AFM added to optical microscopy**

While Nobel prize winning scanning probe microscopy (SPM) has been around since 1981, moving it into semiconductor production applications has been relatively slow. For example, only recently have the various suppliers of this technology been making progress in applying SPM to lithography applications. Now, Danish Micro Engineering A/S (DME, Herlev, Denmark) and Technical Instruments (San Francisco, Calif.) have revealed an intuitive implementation of atomic force microscopy (AFM) that may make this technology as easy to use and accessible as an optical microscope.

DME's president, Dr. Curt Sander, is the innovator of the company's dualScope; this intricate instrument integrates an AFM probe tip with an optical microscope objective. Control of the probe tip, interpretation of AFM scans and manipulation of the scan data is completely automated through software. The net result is a user friendly AFM in the form of a universal instrument that interfaces to the human eye, a format familiar to anyone with technical training. Another view is that the AFM objective can extend an optical microscope beyond diffraction-limited resolution, making such an instrument instantly applicable to IC development needs around 0.1  $\mu\text{m}$ , and with three-dimensional capability to boot. (Reprinted with permission from *Semiconductor International Magazine*, December 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### **UHV-RTCVD selective epi studied**

Researchers at North Carolina State University (Raleigh, N.C.) have studied silicon nucleation on silicon dioxide and selective silicon epitaxial growth in an ultrahigh vacuum rapid thermal chemical vapour deposition (UHV-RTCVD) reactor using 10 per cent  $\text{Si}_2\text{H}_6$  diluted in  $\text{H}_2$ .

The use of  $\text{Si}_2\text{H}_6$  provides an advantage over more commonly used silicon source gases since it provides relatively high growth rates even at pressures as low as 10 mTorr. Low pressures not only reduce the probability for critical nuclei formation essential for selective growth, but also reduce the impurity background in the growth ambient, which is essential for good quality film growth. (Reprinted with permission from *Semiconductor International Magazine*, December 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### **Non-sticky tape**

Audio cassettes are full of puzzling little components, like the little fabric pad behind the tape. Traditionally made of wool or rabbit-fur felt, this cushions the tape against the play and record heads and keeps up the tension in the tape. However, the felt creates problems with more advanced tapes, such as the ones used in digital audio cassettes. These are backed with a carbon coating to discourage static electricity build-up; however, this does not slide easily over the felt, but sets up a "slip-stick" friction which jerks the tape past the heads and ruins the sound quality.

Masaru Watanabe of the Matsushita Electric Industrial Company in Osaka has developed a new type of cushion. Instead of a fabric pad, this consists of a fluorocarbon polymer "brush". Its base is a small strip of synthetic rubber or a soft polymer with similar properties. This is coated with adhesive, then "filled" with short fluorocarbon fibres, which are charged at one end and "fired" at the adhesive so that they stand up on end.

The brush is mounted onto a springy metal strip, which is fixed into the cassette behind the tape. The carbon backing slips smoothly over the fluorocarbon polymer "bristles", claims Watanabe, giving flawless recording and playback. (Source: *European Chemical News*, 3 October 1994)

#### **Photon probing for IC failure analysis**

Researchers at Sandia National Laboratories (Albuquerque, N.M.) have developed three new localized photon probing failure analysis techniques. These provide non-destructive capabilities for both frontside and backside IC examination. All three techniques are easily implemented with existing scanning optical microscopy (SOM) equipment.

Two of the techniques use light induced voltage alteration (LIVA) imaging to localize open circuits and damaged junctions, and image transistor logic states. The third technique uses SOM to control logic states optically from the backside of an IC.

Briefly described, the technique produces LIVA images by monitoring voltage fluctuations of a constant current power supply as a laser beam is scanned over an IC. What results are high selectivity for localizing defects and logic state mapping, similar to previous work using biased optical beam induced current (OBIC).

The Sandia engineers have demonstrated application of the two LIVA based techniques to backside failure analysis using an infrared laser source. Optical logic state control is based upon earlier work examining transistor response to photon injection.

LIVA produces signal strength high enough to examine an entire die in one image. Also, logic state mapping has a greatly improved signal-to-noise ratio compared to OBIC. LIVA has been applied to backside failure analysis of flip-

chip packaged ICs and multilevel metal ICs in conventional packages. (Reprinted with permission from *Semiconductor International Magazine*, August 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### **Thin cap layer enhances via reliability**

Four engineers at Texas Instruments (Dallas, Texas) have found that the layering design of Al-0.5% Cu and Al-1%Si-0.5% Cu metallization systems has a strong impact on the electromigration lifetime of tungsten plugs. The investigation looked at leads with refractory barrier and capping layers, and tungsten-filled via holes. The work was recently reported at the 1994 IEEE International Reliability Physics Symposium in San José, California.

These studies with accelerated current-temperature stressing have shown that the addition of a thin titanium layer between the aluminium alloy lead and its titanium-nitride capping layer greatly enhance via reliability by suppressing early failures. Reportedly, the most likely explanation for this observation is that the aluminium is protected from physical damage during via etch by the continuous TiAl<sub>3</sub> layer that forms from reaction between titanium and the aluminium.

Other results showed that the addition of titanium between the aluminium and its barrier layer did not have the same effect on via lifetime, although it did considerably enhance the lead lifetime. Early failures of simple titanium nitride cap designs were believed linked to structural and chemical damage caused by the via etch to the aluminium lead, subtle crowding effects at the via lead interface and accelerated dopant depletion below the vias.

The continuous TiAl<sub>3</sub> buffer layer also provides additional current carrying capacity in the lead and supplies dopants that effectively slow down void formation at the plug aluminium interface, particularly when grain boundaries may be present. (Reprinted with permission from *Semiconductor International Magazine*, August 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### **Novel, chrome-free photomask process**

Researchers at Canyon Materials (San Diego, Calif.) have come up with a laser direct write photomask blank that creates an instant, absorption phase-shift mask. The mask and its process eliminates any need for chrome photomasks and associated photoresist developing, etching and stripping or associated defects.

The blanks are monolithic glass plates with no coatings of any kind. The top portion of the glass appears black because it has been chemically altered to contain a high density of colour centres ( $10^{17}$   $\mu\text{m}^{-2}$ ). The exposure process uses a focused laser beam to "heat erase" these colour centres, instantaneously changing the exposed portion to a visually transparent state.

The advantages attributed to these masks include faster turnaround, self "pelliclizing," unlimited washing and no latent defects.

Potential applications include photomasks for wafer and related processing, and write-once optical disks, glass scales, encoder disks, optical reticles, and others. (Reprinted with permission from *Semiconductor International Magazine*, August 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### **Ferroelectric etch process developed**

PlasmaQuest (Richardson, Tex.) reports the development of a dry etch process for ferroelectric materials, such as lead zirconate titanate (PZT) and barium strontium titanate (BST), which are being considered for advanced DRAMs and non-volatile memories due to their high dielectric constant. The new process uses the PlasmaQuest 357 ECR reactor, which combines the current ion beam of the ECR source with an rf-biased chuck. PlasmaQuest says the lack of volatile halides found in PZT, BST and platinum electrodes creates a greater degree of difficulty in dry etching. (Reprinted with permission from *Semiconductor International Magazine*, August 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### **Glasses based on nitrogen**

Scientists at Arizona State University (Tempe) report making a new family of glasses based on nitrogen, rather than oxygen. The nitrogen-based glasses are made at extremely high pressures, using a high-temperature piston cylinder. The researchers say the materials could eventually have a variety of uses, including electronic and high-temperature applications. (Source: *Chemical Week*, 1 June 1994)

#### **Ion beam induction opens up low temperature process potential**

The Electrotechnical Laboratory announced the results of research into the application of ion beam induction crystal growth in semiconductor materials. This method uses a high energy ion beam from several hundred keV to several MeV above the transition temperature ( $T_c$ ) of the surface of a semiconductor non-crystalline layer to initiate crystal growth from the crystal non-crystal interface, causing epitaxial growth to the surface. The new process offers:

- Low temperature processing.
- The ability to create dopant distributions in the crystal lattice not possible with thermal balance techniques, and
- Localized processing.

The ion beam induction method can induce crystal growth above about 200°C. Doping was performed at room temperature on an Si (100) substrate with independent continuous implantation of 100 keV As ions and 160 keV Xe ions. The injection was  $5 \times 10^{14}$  ion  $\text{cm}^{-2}$  for each. A non-crystalline layer formed about 160 nm thick on the Si surface. Crystal growth was then initiated on the test pieces with 400 keV Ar at 350°C, and all test pieces crystallized to the surface.

Test pieces doped with solitary As show a growth rate slightly faster than those with a non-crystalline layer of the same thickness made with 70 keV Si doping at  $5 \times 10^{14}$  ion  $\text{cm}^{-2}$ .

Whether with solitary As atoms or continuous implantation of As and Xe ions most atoms depended on Si lattice position after crystal growth, but in both cases almost all Xe atoms were found to be between lattice points. (Reprinted with permission from *Semiconductor International Magazine*, November 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

### **New technique protects liquid crystal displays**

The Thomson (France) and Philips (Netherlands) companies have developed self-regulating liquid-crystal displays for laptop computers. The new technology should make the displays brighter and cheaper. Defects in the control transistors could be corrected automatically. In this way, the useful life of the display is extended. The first display panels of this type are coming off the assembly line in a factory in Findhoven. They are 24 centimetres along the diagonal and can already be used in current screen production.

Non-functioning dark spots may appear on conventional screens if the corresponding control transistors fail. Until now, the entire screen needed to be replaced if this happened. The Philips glass pane has about 300,000 cells, each containing a tiny diode. These sit like tiles in the corner of the cell filled with liquid crystals. The screen is covered with a network of thin, transparent electrodes that supply current to the liquid crystals.

According to the claims, the diodes, made of silicon-nitride, operate like pressure-relief valves that allow the current to pass only when it has reached a particular level. If the diode is defective and allows too much current to pass, the nitride resistance increases automatically. In this way, the current is limited to the correct amount and the liquid crystals are undamaged. Screen manufacture is, according to claims by Philips, cheaper because less precision is required. As the diodes allow about 10 per cent more light to pass through the cells, the screens are also brighter. (Source: *Frankfurter Zeitung*, 12 October 1994)

### **Computer tomography aids non-destructive testing of materials**

Images even of the internal structures of sensor systems or material samples can be obtained using computerized tomography. However, the computerized tomographs developed for medical applications are not suited for this purpose. The Juelich Research Centre has now developed a microtomography system that can be used for the testing of materials.

The system consists of a miniature X-ray source, a manipulator for holding the sample and the X-ray detector. The microtomograph is able to reproduce objects to a scale of five micrometres. Hence, in terms of resolution, the device is superior to an ordinary tomograph.

To realize the required quality of reproduction, the sensor elements comprising the X-ray detector had to be scaled down, but that simultaneously requires a significant enhancement of the radiation intensity of the X-ray source to end up with a reproduced precision image.

The electron gun of a scanning electron microscope is used to achieve this. The electron beam is directed at a metallic cutting edge and at that point it generates the required intensive X-ray radiation. In this way the sample is irradiated through a number of strata. Using an image processing system, a two- and three-dimensional X-ray image also emerges as a high-resolution reproduction of the internal structures. In addition to tomographic analysis, an electron microscope approach can also be applied to the sample.

The Juelich system, for instance, can be used to diagnose pores and cracks in ceramics or composite fibre materials. In microsystems technology the process is appropriate, among other things, for microtomographic

monitoring of airbag sensor systems. Another area of application is petroleum extraction. Microtomography facilitates the analysis of the penetration of the oil water mixture through porous rock.

In this way an especially effective process for extracting oil could be developed. In biological research the system facilitates the non-destructive three-dimensional reproduction of the internal organs of microorganisms. Filter structures too are studied at Juelich. Such studies help simulate the exhaust flow through filters and enhance the level of their effectiveness. (Source: *Frankfurter Zeitung*, 2 November 1994)

### **Metal bonding studies with scanning electron microscope**

Using a scanning electron microscope, the Institute for Metallography and Metal Physics of the RWTH (Rhine-Westphalian Institute of Technology), Aachen, is studying the structure of dissolved niobium from a copper-niobium compound, to combine the good electrical properties of copper and the mechanical strength of niobium in one material. The three-dimensional structure of niobium is only visible through a scanning electron microscope. Niobium precipitates out from a common melt first in the form of three-dimensionally branched structures (dendrites). At lower temperatures, the copper then also solidifies and surrounds the niobium dendrites. To study the niobium structures, Professor Dr. Guenter Gottstein and his team chemically etch away the copper in the test preparation. Equipping the microscope with additional detectors and analysis programmes offers the Aachen researchers completely new insights into the microstructural development of metals through the electron backscattering procedure. With this technique the frequency distribution of crystal orientations can be directly measured even in the smallest areas and a microstructure can be linked with its orientation. A knowledge of the formation and growth mechanisms of grains in these substances should then help in the manufacture of these materials. (Source: *Frankfurter Zeitung*, 26 October 1994)

### **Biological and man-made designs converge to create DNA chips**

Hewlett-Packard recently joined forces with Affymetrix to co-develop and market systems that will use so-called "DNA chips" to perform sophisticated analysis of DNA samples.

These DNA chips represent a new direction in extremely sensitive medical analysis equipment, which could quickly detect genetic diseases for example, and in computing where synthetic DNA molecules could be used as a type of microprocessor, capable of performing calculations much faster than today's high-end silicon chips.

As silicon and biological systems converge on the molecular level, there are also moves to use synthetic DNA fragments as a high-performance microprocessor. Since like-DNA base pairs react very quickly with each other, it is possible to use a radically different computational model to determine the results of very complex computing problems.

Dr. Leonard Adelman, a researcher at the University of California in Los Angeles, says he has discovered a way of using DNA fragments to solve a complex mathematical problem, sometimes known as the travelling salesman

problem, which involves finding the shortest path to link seven cities.

In an experiment described in the US *Science journal*, Adelman said that his results show that it will be possible to build "molecular computers" that are 10,000 times faster than current microprocessors, and use one billionth of the energy. Data storage is also much more efficient, with a single DNA molecule capable of storing one trillion times more data than magnetic media.

However, building such DNA-based molecular computers will require a departure from the current computational models pioneered by Hungarian mathematician John von Neumann in the 1940s and they will require new programming languages.

DNA chips from Affymetric and others, signal the impending convergence of man-made and biological designs, as silicon based chips start to approach the molecular dimensions of DNA molecules. This process will produce radical new types of electronic devices and applications. (Source: *Electronics Weekly*, 11 January 1995)

### **New technique to produce GaAs single crystals studies**

The gradient-freezing technique of the Institute of Physical Metallurgy, Freiberg, can be used to manufacture gallium arsenide [GaAs] single crystals with low cross-linking density and high homogeneity of physical properties. This method, according to a statement by Professor Dr. Heinrich Oettel, represents an alternative to the Czochralski process, which has been used until now. The process is carried out in computer-controlled multizone furnaces in which the temperature of the individual heat zones can be varied selectively. The design of the furnace and the gradient-freezing software used allow the thermal conditions to be set. Compared to traditional growing methods, single crystals can be grown with this process without using mechanically moving parts. In this way, latent vibration sources are avoided. It is suitable for growing crystals at extremely low temperature gradients and for the manufacture of single crystals, low in cross-linking. A moderated arsenide reservoir stabilizes the arsenic partial pressure during the growth process. The Freiberg scientists are also working with other materials with melting points from 500° to 1,250°C for crystal diagnosis. (Source: *Frankfurter Zeitung*, 10 November 1994)

### **Latest high-temperature superconductor**

Researchers at the CNRS (National Centre for Scientific Research) at Grenoble have discovered a critical high-temperature copper-free superconductor made up of potassium (K), barium (Ba) and bismuth oxide (BiO), which displays a particular critical field behaviour, i.e., in the magnetic field, where superconductivity disappears.

This substance without copper, which is remarkable for its high transition temperature ( $T_c$  30°K), does not possess any of the behavioural characteristics of other copper-based critical high-temperature superconductors. While traditional superconductors are linear in behaviour near the critical temperature, and flatten at zero temperature, the experimental measurements on the new superconductor show a linear critical field regardless of temperature. (Source: *Composites et Nouveaux Matériaux*, 21 September 1994)

### **French develop monosilicon on quartz wafers**

Engineers at SOITEC (Grenoble, France) have successfully developed proprietary SIMOX (separation by implanted oxygen) process technologies that yield a thin monocrystalline film of silicon-on-quartz wafers. Demonstrations have shown 2000 Å thick films with a thickness uniformity of better than 50 Å.

André Auberton-Hervé, vice president and general manager of SOITEC, says, "Electrical behaviour is five to ten times better on a pure monocrystalline film than on an annealed polycrystalline film on quartz." Thus, potential applications include those currently applied to the polycrystalline-on-quartz films: these include thin-film transistor (TFT) liquid crystal displays, charge coupled device detectors, virtual reality devices and high definition television projection systems.

One of the advantages of the new material is to reduce TFT area, increasing the brightness and resolution of liquid crystal displays. In addition, this new material allows the integration of drivers and control electronics with low leakage current and high speed on the quartz wafer in the TFT matrix periphery.

Volume production will start in mid-1995 with future wafer size extensions up to 200 mm in diameter. (Reprinted with permission from *Semiconductor International Magazine*, October 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

### **UK collaboration produces BESOI devices**

The first devices have been produced under the UK Government funded BELPA (Bond and Etch for Low Power Applications) project at the Swindon plant of GEC Plessey Semiconductors (GPS). In this SOI process, a silicon wafer is fused to another oxidized wafer, the top wafer is ground and polished back to a thickness of 10 µm and fine trenches are then etched around the areas requiring isolation. The trenches are filled with oxide.

The wafer fusion process in this BESOI (Bond and Etch back SOI) technique has been advanced by work at the Queen's University, Belfast, Northern Ireland, to achieve a perfect joint between the wafers without defects or voids. An ultrasonic microscope is used to check the bonded wafers for the slightest flaws at their interface. BCD Technologies of Belfast produces the dielectrically isolated substrates for GPS which makes devices with minimum features sizes of 0.75 µm. Other involved in this project are Phoenix VLSI Consultants Ltd., of Towcester, Northants, Elettronica (UK) Ltd. of Milton Keynes, Cambridge Consultants of Cambridge, and the British Government's Defence Agency, Malvern.

The first devices are mixed analogue digital circuits for radio applications. A direct digital frequency synthesizer will be built that has very fine frequency steps and a wide frequency operating range. The workers believe they will achieve high yields by minimizing stress induced defects in the bonded SOI film during processing. The BELPA circuits are twice as fast as junction isolated circuits at low power, but the difference is less noticeable at higher power. (Reprinted with permission from *Semiconductor International Magazine*, October 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

### **First all-polymer transistor**

The first all-polymer field-effect transistor (FET) has been realized (F. Garner et al., *Science*, 1994, **265**, 1684).

All components of the transistor, even the metallic electrodes of its predecessors, have been replaced by organic polymeric materials. The all-polymer FET, which can be made under mild conditions, is yet another example of a flexible, potentially large-area, low-cost plastic electronic device. The device consists of an insulating layer (a 1.5  $\mu\text{m}$  thick polyester film) covered on one side with a 10  $\mu\text{m}$  thick layer of a conducting graphite-based polymer ink (the gate electrode) and a substrate (a simple adhesive tape); on the other side two contacts (source and drain electrodes) made of the same conducting polymer ink are placed opposite the gate and separated from each other by 200  $\mu\text{m}$ . The device was completed by vacuum deposition of a 40 nm thick layer of the organic semiconductor  $\alpha,\omega$ -dihexylsexithiophene between source and drain. The thiophene oligomer is an old favourite of Garnier's group and it has an unusually high charge carrier field-effect mobility which is slightly less than that seen in amorphous hydrogenated silicon, the semiconducting material for conventional thin-film FETs. Apart from a simple device fabrication protocol, all-polymer FETs have excellent device characteristics, thus proving the suitability of the transistor as an amplification device. Unlike ordinary FETs they are insensitive to mechanical treatments such as rolling-up, bending or twisting. (Source: *Chemistry and Industry*, 5 December 1994)

### Capacitors based on polypyrrole

A research group at Matsushita has reported its latest experience on aluminium solid electrolytic capacitors based on polypyrrole as the electrolyte. The capacitors are already mass-produced by the company and their performance compares favourably even with multilayer ceramic capacitors. In principle, they consist of (i) an aluminium foil covered with a thin surface oxide layer (obtained by anodic oxidation), (ii) a very thin  $\text{MnO}_2$  layer serving as a contact onto which pyrrole can be electropolymerized which provides (iii) a tri-isopropyl-naphthalene-sulphonate-doped polypyrrole layer. Capacitance and life-time of aluminium (anode)  $\text{Al}_2\text{O}_3$  (insulating dielectric) doped polypyrrole (cathode) capacitors compete well with other commercial products. The capacitors show excellent frequency characteristics and stability at higher temperature. No deterioration was observed after several thousand hours at 150°C, if the capacitors were hermetically sealed from oxygen. (Y. Kudoh et al., *Synth. Met.*, 1994, 66, 157). (Source: *Chemistry & Industry*, 5 December 1994)

### Electrochemical capacitors

Electrochemical capacitors and batteries can be used as storage devices for electrical energy. There is considerable interest in electrochemical capacitors as an electric power source which operates parallel with a battery, acting as a load leveller and power back-up, with anticipated applications in electric vehicles and computers. Two recent reports describe some very promising results for an electrochemical cell using high surface area carbon paper electrodes (75  $\mu\text{m}$  thick) that are coated with a 10  $\mu\text{m}$  thick film of conducting polymer and separated by an electrolyte solution. The electron-withdrawing fluoro substituent in poly[3-(4-fluorophenyl)thiophene] plays a crucial role. Most conducting polymers are more easily oxidized (p-doped) than reduced (n-doped), but in n- and p-dopability are almost equally balanced. Furthermore, poly(3-arylthiophene) does not suffer from undesirable

charge trapping which is a serious drawback of the closely related poly[3-(4-trifluoromethylphenyl)thiophene] and a consequence of the even more powerful electron-withdrawing trifluoromethyl group. The right choice of electrolyte is important and the most suitable system is a solution of  $\text{NMe}_4^+ \text{CF}_3\text{SO}_3^-$  in acetonitrile. The charged capacitor has one electrode in the n-doped state and the other in the p-doped state. After discharge both polymers will be in the undoped state. Electrochemical capacitors based on poly[3-(4-fluorophenyl)thiophene] have high energy densities, and a constant voltage of 3 V is maintained during the whole discharge process (A. Rudge et al., *J. Power Sources*, 1994, 47, 89; *Electrochim. Acta*, 1994, 39, 273). (Source: *Chemistry & Industry*, 5 December 1994)

### Partial DRAMs yield results

An Edinburgh firm believes it can successfully resurrect the idea of using partial DRAMs—chips that have a number of defective cells—in memory modules.

Partial DRAMs are potentially a source of cheap storage if the bad bits can be avoided given that on-chip redundancy schemes have limited effectiveness.

Memory Corporation claims its patented technology overcomes the traditional pitfalls of previous attempts to use partials: often the techniques simply did not work and degraded memory performance.

The technique centres on an ASIC, dubbed the partial memory engine, which maps the bad bits on the DRAMs and replaces them with storage elements on the ASIC. The ASIC can handle up to two million defective cells and has about 148,000 logic gates to hold the configuration data and perform the mapping process. The partial memory engine is not a simple address decoder that directs accesses to the on-chip storage instead of the DRAM's bad bits but has a special architecture where the recognition and mapping stages are performed concurrently. It works on the principle that the time taken to disable an output is much less than a DRAM's access time. The ASIC storage uses SRAM-type latches which are faster to access than DRAM cells. This helps prevent any performance penalty.

The mapping mechanism is also "intelligent" in that algorithms identify defect patterns and redirect memory accesses appropriately. The ASIC can work with most types of DRAM I/O including EDO, page mode and nibble mode devices. (Source: *Electronics Weekly*, 7 December 1994)

### High-speed 4-Mbit SRAM

Hitachi, Ltd., has developed a high-speed 4-Mbit static random access memory (SRAM) for data recording in portable type information processing terminal equipment.

The access time required for retrieving data has been shortened to 6 ns, less than one-tenth that of lower-power 1-Mbit SRAMs commercialized up till now. The power voltage of 5 V required up till now has also been reduced to less than 3 V, which enables the fabrication of much more compact terminal equipment with higher performances.

The SRAM is a chip central to portable information processing terminal equipment and holds the key to the fabrication of compact and highly durable terminal equipment. Existing portable information processing terminal equipment uses an MPU with a processing speed of 10 MIPS (million instructions per second) and a SRAM

with an access time of 100 ns. However, the next-generation chip is expected to use a standard high-speed MPU of 33 MIPS, and will therefore be required to work at an access time shorter than 15 ns. Further details from Hitachi Ltd., Public Relations Secretary's Office, 4-6, Kanda Surugadai, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3258-1111, Fax: +81-3-3258-2375. (Source: *JETRO*, November 1994)

#### **High-speed MOSFET with ultrashort gate electrode**

NEC Corp. has developed a high-speed field effect transistor (FET) with a new structure and a gate electrode as short as 0.1  $\mu\text{m}$ . The FET was developed by applying a combination of technology for selective crystal growth and doping impurities into transistors to improve performance, by which the manufacturing process was substantially simplified.

The new FET features a working speed that is 1.5 times that of conventional counterparts, and NEC observes that applying related technologies would permit the manufacture of 4-Gbit dynamic random access memories (DRAMs).

With the new structure, boron is impregnated on the silicon wafer at a high energy of 300 eV to form a layer in which the surface impurity density is not increased up to regions about 1  $\mu\text{m}$  away from the wafer surface. Boron fluoride is then impregnated at 10 eV to form a high-density impurity domain on the wafer surface. The ion-impregnated wafer is then given a silicon crystal layer containing no impurity and the gate electrode is fitted on this layer.

Compared with conventional transistor manufacturing processes, only a single silicon crystal growth process is added, and compared with FETs produced by the conventional ion impregnation process, the expansion of a high-density impurity layer is suppressed by which the transistor performance is substantially improved.

When performance tests were conducted on a prototype FET with the new structure fitted with an ultrashort gate electrode of 0.1  $\mu\text{m}$ , it was confirmed that the FET performed as conceived in the original design. Previously, it had been impossible to actuate FETs with ultrashort gate electrodes of less than 0.13  $\mu\text{m}$ . It was also confirmed that the current control speed is improved by 1.5 times compared with FETs of conventional structures.

NEC observes that the new technology will expedite the development of 4-Gbit DRAMs whose commercialization is anticipated in about a decade, and plans to use the technology as a basic approach for the development of superlarge-capacity DRAMs. Further details from NEC Corporation, Public Relations Div., 5-7-1, Shiba, Minato-ku, Tokyo 108-01, Tel.: 81-3-3798-6511, Fax: +81-3-3457-7249. (Source: *JETRO*, November 1994)

#### **High performance nano-slider for hard disk drive**

Hitachi Metals Ltd. has started mass production of a double-metal-in-gap (DMG) type nano-slider that attains a recording density as high as 290 Mbit/in<sup>2</sup>.

The nano-slider is a component used in the recording head of hard disk drive systems for personal computers. DMG type nano-sliders have already been commercialized for recording densities of up to 200 Mbit, but will be replaced by those of higher performances in one to two years. However, the development of the new nano-slider

featuring performances comparable to those of thin film heads has paved the way for using the nano-slider in next-generation type recording heads.

The new nano-slider core uses a ferrous base nanocrystalline alloy film (saturated magnetic flux density of 1.5 T), so the nano-slider playback output characteristic and overwrite characteristic have been improved substantially compared with those using sendust-based mild magnetic alloy films (saturated magnetic flux density of 1.15 T). In addition, to suppress the head floating change and variation during recording, the core is machined into an ideal air bearing surface shape by a special blending technique, by which a high performance has been achieved.

At present, a recording density of 175 Mbyte has been achieved with 2.5-in HDDs and 420 Mbyte 3.5-in HDDs, a performance comparable to that of a thin-film head. This high-performance nano-slider can be supplied at a lower price than that of a thin-film head of comparable performance. Further details from Hitachi Metals, Ltd., Public Relations Dept., 2-1-2, Marunouchi, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3284-4552, Fax: +81-3-3214-1029. (Source: *JETRO*, November 1994)

#### **US team bid to crack 0.25-micron barrier**

Top US electronics companies have joined forces in a bid to crack the 0.25-micron barrier by developing new chip making processes using X-ray lithography.

IBM, AT&T, Loral and Motorola have created the Proximity X-Ray Lithography collaborative Association in a bid to find ways of using X-ray lithography to make a new generation of high density semiconductors.

The four companies will share key technologies in a bid to develop ways of producing chips in commercial quantities using X-ray lithography. Other companies are expected to join the grouping in future.

Current ultraviolet photolithography techniques can produce feature sizes as low as 0.25-microns but the wavelength of ultraviolet light is too large to go much below this level. X-rays have much shorter wavelengths but they are more difficult to generate and to control.

IBM and AT&T have both been experimenting with X-ray lithography for more than 20 years. IBM operates one of the only commercial synchrotrons, set up at a cost of \$100 million, which generates X-rays by accelerating electrons. AT&T has developed the only commercial point source X-ray stepper for lithography.

Motorola has been experimenting with X-ray lithography over the past four years, using synchrotron sources at the University of Wisconsin and IBM. Loral has one of the best radiation-hardened foundries in the US.

Much of the \$100 million cost of the project will be funded by the Pentagon's Advanced Research Project Agency. (Source: *Electronics Weekly*, 12 October 1994)

#### **SCSI link makes 100 Mbyte/s**

BusLogic, a US hardware company, is developing Fibre Channel, a serial SCSI architecture which can allow data transfers of up to 100 Mbyte/s.

It is likely that BusLogic will use its proprietary MultiMaster architecture in the development of Fibre Channel. This is an ASIC technology on which BusLogic has based its selection of SCSI host adapters, which are supported by one common device driver per operating system.



Fibre Channel is the latest development in SCSI host adapters which is going to allow CPU-to-peripheral communications at speeds of 100 Mbyte/s.

At present there are three evolving standards for the serial SCSI architecture in which Fibre Channel belongs. The other two are SSA (Serial Storage Architecture), which was developed by IBM, and P1394 which is promoted by Apple as "Fire-Wire".

The advantage of Fibre Channel over parallel SCSI is that it allows high data-transfer speeds on fibre links or copper cables.

The Fibre Channel, as a box-to-box communication link, can be up to 10 km long. (Source: *Electronics Weekly*, 12 October 1994)

### **AT&T breaks the gate array record**

AT&T Microelectronics has launched what it claims to be the industry's highest-density FPGA with 26,000 gates—but rival Altera plans to double that within 12 months.

The AT&T ATT2C26, the largest device in the ORCA 2 family with clock rates up to 150 MHz, offers users 384 I/Os and 2304 flip-flops in the core logic cells. There are increased routing resources (about 20 per cent more than the original ORCA 1 family) and a number of architectural modifications, such as direct routing between input pads and registers, that boost performance.

Altera intends to have the world's biggest monolithic programmable logic device on the market in 1995, a monster 50,000 usable gates chip which will further expand the share of the gate array market being taken by programmable devices.

The increase in density has been achieved not only by the migration from 0.6-micron to the lower geometries but by significant architectural improvements. (Source: *Electronics Weekly*, 26 October 1994)

### **Optical device gives sight to computers**

A new type of optical computer, which can "see" complete optical images through a pattern recognition device, is being created by two US researchers.

The computer, which is designed to compare images and recognize similarities, works on principles similar to those used to create holograms. It consists of a lens, a glass cell filled with caesium gas and a laser.

The "CPU" of the experimental computer is the glass cell in which "the caesium gas atoms do the actual computing", according to Dr. Randall J. Knize, a physics professor at the University of Southern California, who has been working on the device for the past three years. The caesium gas is used as an erasable film to store infrared light patterns.

The researchers shine a single laser through a lens to split it into two beams, one of which reflects off the object and the other shines directly into the gas, producing an interference pattern. When a third laser beam is focused at the gas from the opposite direction, it is bent in the areas where the two images are similar, producing bright spots. (Source: *Electronics Weekly*, 19 October 1994)

### **NEC copper chips**

NEC engineers have succeeded in using copper for interconnect patterning on chips. Copper is a better conductor but tends to "poison" the silicon circuits

underneath; hence aluminium is used today. However, NEC engineers have managed to isolate the copper wires by inserting a titanium nitride film as a barrier layer between the copper and silicon. (Source: *Electronics Weekly*, 19 October 1994)

### **UK researchers find way to deliver 3D TV pictures**

Researchers at De Montford University in Leicester believe they may have found a practical way to deliver three-dimensional TV pictures.

Experimental work carried out by the team suggests that it could be much easier than previously thought to build a system which can capture, transmit and display full-parallax 3D TV pictures (i.e. pictures in which the viewer can look round the image by moving his or her head) without the need for special glasses.

According to the team it should be possible to build a full colour 3D display using receivers with horizontal resolution of 2,048 pixels and a vertical resolution of 1,536 lines, requiring a transmission rate only about 1.5 times higher than that needed for 2D high definition TV (HDTV) pictures. To send this using current transmission methods the data would need to be compressed by a relatively modest factor of 16:1.

The work is based on a theoretical 3D imaging system which uses a single integrated imaging device made up of arrays of large and small lenses to capture the picture, rather than multiple cameras.

The theory behind such devices has been known for some time, but it has only recently become possible to make planar arrays of micro lenses with a fine enough pitch. In the De Montford system the finest micro-lens arrays have a lens spacing of 125 microns.

The team used printed images to model the pictures which would be produced by such a system on a liquid crystal display. Using a viewing micro lens array with a lens pitch of 1.25 mm the team found that the parallax information in the images was preserved even with only a single pixel behind each lens in the array. (Source: *Electronics Weekly*, 21 September 1994)

### **Silicon comes in from cold**

Japanese scientists have observed a quantized conductance in a silicon wire that forces current to change in steps rather than proportionally to applied voltage. They claim it is a key step to developing practical semiconductor devices with the low resistance, high-speed performance of quantum-well devices.

Nippon Telegraph and Telephone (NTT) investigated quantum-effect phenomena to improve the performance of semiconductor devices. NTT claims it is the first to observe quantized conductance of silicon that almost matches the theoretical value.

As a single element semiconductor, silicon is more stable than compound materials like GaAs and so would better suit device fabrication.

The experiment was made possible fabricating a silicon wire 10 nm in diameter.

The quantum effects depend on reducing physical dimensions of the semiconductor to the wavelengths of the electron waves in the material. As the mean free path for electrons in silicon is shorter than in compound semiconductors such as GaAs, the size reduction required is even greater.

In addition the quantum effects are still only possible at very low temperatures, typically  $-253^{\circ}\text{C}$ , which is approaching absolute zero.

NTT's silicon wire experiment may have moved this closer to a practical room temperature phenomenon, as its researchers reported quantized conductance at  $-173^{\circ}\text{C}$ ,  $100^{\circ}$  above absolute zero. This is  $20^{\circ}$  above the temperature of the liquid nitrogen, normally seen as the landmark temperature in low temperature physics. (Source: *Electronics Weekly*, 21 September 1994)

### **Alpha breaks record—again**

Digital Equipment has claimed a microprocessor speed record with a new version of its 64 bit Alpha chip, which it claims can process more than one billion instructions per second.

The Alpha AXP 21164 microprocessor doubles the on-chip resources of its predecessors to make it a four-way superscalar microprocessor with twin integer and twin floating point instruction pipelines. The chip is offered in 266 and 300 MHz versions and has more than 9.3 million transistors.

The Alpha 21164 microprocessor integrates the microprocessor world's first two-level, on-chip cache memory that can talk directly to system RAM storage.

A 16 kbyte level-one cache, split equally between instruction and data, feeds an on-chip 96 kbyte level-two unified cache.

However, the power consumption of both variants is high: the 266 MHz version takes 40 W and the 300 MHz chip 60 W. (Source: *Electronics Weekly*, 14 September 1994)

### **NIST nanolithography method available**

A recently patented patterning process from the National Institute of Standards and Technology (NIST, Gaithersburg, Md.) is now available for licensing: this is a method for fabricating extremely small metallic structures.

The process, known as laser controlled nanolithography, manipulates chromium atoms into precise locations on a silicon surface using laser light. According to NIST scientists, "This technique of focusing atoms with a laser opens new avenues for creating smaller and faster electronic devices". NIST researchers have used the process to form parallel rows of atoms on a silicon surface. The rows, visible by atomic force microscopy, are approximately 65 nm wide, 35 nm high and 212 nm apart. The nanolithography process could be refined to form more complex three-dimensional structures. (For more information, contact Nancy Hale at the NIST Office of Technology Commercialization, 301-869-2751.) (Reprinted with permission from *Semiconductor International Magazine*, September 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

### **Bending battery technology**

A prototype plastic high-energy battery that is rechargeable and can be bent into any shape, has been developed by telecommunications research company Bellcore in the US. The battery looks like a solid no liquid leaks out if it is punctured but acts as a lithium-ion battery. Bellcore says it will "revolutionize" the consumer electronics and telecommunications industries. Its performance relies on a polymer matrix; the elements are permanently bonded together then covered by a moisture-

proof barrier coating. At 3.8 V its energy density clearly makes it competitive with normal nickel-cadmium and lead-acid batteries, without the environmental worries—it contains no toxic metals. (Source: *Electronics World & Wireless World*, September 1994)

### **Plastic lens array for facsimile systems**

Fujitsu Ltd. has developed the first erect image magnification type plastic lens array for use in the readout units of facsimile systems and copiers.

The new lens array is a unitized assembly of lens and prism and is formed by injection moulding using "zeonex", a Tetracyclododecene derivatives-based resin. Lenses are arranged on the objective side and on the sensor side, with a prism in between, and a beam of light passed through to produce an erect image.

Today, readout units are used which employ a lens array in which a few hundred glass optical fibres are bundled together and the terminals arranged neatly. The difficulty is that the characteristics of these optical fibres must be matched one by one. With the new plastic lens array, the characteristics were evaluated by irradiating a beam of 570 nm wavelength generated by a light-emitting diode (LED), and the spatial frequency of the prototype lens measured. The eccentric transmission function, an index of resolution, was 70-80 per cent, which is comparable to that of current lens arrays.

The surface smoothness of the prototype lens array was  $0.6\ \mu\text{m}$  on the lens surface and  $1.6\ \mu\text{m}$  on the opposite side, and  $0.3\ \mu\text{m}$  on the prism face, so by making further improvements it will become possible to increase the spatial frequency by 90 per cent. However, smoothness improvement will necessarily demand an improvement of the mould inside smoothness, so precision machining of moulds will become indispensable.

The plastic lens array features the advantage that it can be mass produced by using moulds, which will enable substantial cost reduction in the manufacture of optical units of facsimile systems, copiers and optical printers. Further details from Fujitsu Limited, Public Relations Dept., 1-6-1, Marunouchi, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3213-4160, Fax: +81-3-3216-9365. (Source: *JETRO*, October 1994)

### **World's smallest 0.13- $\mu\text{m}$ pattern formed by optical lithography technology**

Hitachi, Ltd. has succeeded in forming a miniature pattern as fine as  $0.13\ \mu\text{m}$  by light exposure while achieving the focal depth essential for commercialization.

An integrated exposure technology was established that uses a krypton fluoride excimer laser with a wavelength of  $0.248\ \mu\text{m}$  as the light source, optimizes the phase shift mask, and uses a reduction projection exposure system (stepper) using a newly developed non-chemical amplification type resist and bright lens, through which a resolution that is about one half of the light source wavelength was achieved, which approaches the theoretical limit.

This development is on the line of projection of the existing semiconductor mass production technology and is compatible costwise, so the new technology indicates the possibility of applying optical exposure to the process of manufacturing next-generation 4-Gb DRAMs.

The new technology is applicable to periodical patterns, and further research will apply the technology in

combination with other technologies such as electron beam exposure technology for the exposure of other isolated or nonperiodical patterns. Further details from Hitachi Ltd., Public Relations Secretary's Office, 4-6, Kanda Surugadai, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3258-1111, Fax: +81-3-3258-2375. (Extracted from *JETRO*, October 1994)

### **Controlled alignment of optically responsive proteins**

Fuji Photo Film Co. Ltd. has succeeded in aligning an optically responsive protein called bacteriorhodopsin that exists on the surfaces of certain types of bacteria.

The orientation of the protein molecules is controlled by an antibody that discriminates the specific structures of substances inside biological bodies. When this technique was applied to the fabrication of biosensors, the visual information processing capability for moving image extraction and for edge detection is improved twofold compared with when the orientation was not controlled.

Fuji Photo Film used bacteriorhodopsin isolated from the surfaces of cells of advanced basophilic bacteria existing in highly saline environments, with a structure closely resembling that of the photosensitive protein called rhodopsin present in the eyes of vertebrates. The company created an antibody that discriminates the front and back of bacteriorhodopsin, through which it succeeded in controlling the protein orientation.

When a thin tin oxide film was coated on the surface of a transparent substrate, it bonded with one of the antibody binding sites, and the remaining site bonded with bacteriorhodopsin. In this case, two types of elements are created due to the different state of bonding since the protein front and back are bonded selectively. Experiments showed that the bonding with the protein cell side and wafer together displays a greater light sensitivity.

The company is already producing 256-pixel bioelements without protein alignment and verifying the visual functions. However, it has confirmed that aligning the protein directions provides double the optical response and enables the capacities of image sensors to be improved. Further details from Fuji Photo Film Co., Ltd., Corporate Public Relations Office, 2-26-30, Nishi-Azabu, Minato-ku, Tokyo 106, Tel.: +81-3-3406-2492, Fax: +81-3-3406-2909. (Source: *JETRO*, October 1994)

### **New millimetre-wave flip-chip IC on Si substrate**

Matsushita Electric Industrial Co. Ltd. has developed a new millimetre wave IC that is attracting attention as an IC for next-generation frequency bands.

The passive circuit is fabricated on an inexpensive silicon wafer, so the IC chip can be produced at about one-tenth the cost of a microwave monolithic (MM) IC using expensive compound semiconductors. The plan is to commercialize the chip and distribute samples within two to three years.

The company calls this new IC for the millimetre wave band the Millimetre-Wave Flip-Chip IC. The passive circuit is fabricated on a silicon wafer and a separately prepared ultrahighfrequency transistor is mounted subsequent to inspection. The mounting method is the micro bump bonding technology of chip fixation by utilizing the contraction force of a photosetting resin.

The MMIC is the optimum device for communications in the millimetre wave band, but is produced by integrating

the passive circuit and extra-high frequency wave transistors on an expensive GaAs wafer, so the development of this new IC for the millimetre wave band had been needed for cost reduction and to eliminate complex inspections subsequent to manufacture. Further details from Matsushita Electric Industrial Co., Ltd., International Publicity Tokyo, 1-1-2, Shibakoen, Minato-ku, Tokyo 105, Tel.: +81-3-3578-1237, Fax: +81-3-3437-2776. (Source: *JETRO*, October 1994)

### **Technology for automatic arrangement of Levenson phase shifter**

Toshiba Corp. has developed technology for the automatic arrangement of the Levenson type phase shifter which is applicable even to irregular patterns and logics. The Levenson type phase shifter is regarded as the most effective technology for improving the exposure resolution of LSIs, but application had been limited to irregular patterns such as those of memory cells.

The newly developed automatic shifter arrangement technology is usable in two modes for coping with regular and irregular patterns. In the regular pattern mode, the shifter is arranged in interactive mode at the stage of layout designing as in the past. In the irregular pattern mode, symbolic design compaction is performed under the photoengraving design rule without shifter, followed by determining the shifter phase in groups by automatic shifter arrangement technology, after which secondary compaction is performed with respect to adjacent patterns in mutually reversed phases, then narrowed down to the resolution limit by the Levenson method.

With large-scale logic LSIs, the apertures serving as the mask patterns run up to an enormous number, so in the Levenson method in which the phases of adjacent patterns are mutually reversed, it will be impossible to reverse the phases of all shifter arrangements as observed from the entire mask, because a contradictory arrangement is generated. Therefore, the company studied the Levenson type phase shift effect and perceived that there is a resolution improvement effect within the range of a fixed interpattern distance determined by the exposure conditions, and that beyond this distance, there is no need to recognize any arrangement contradiction even if the shifter phases are the same in adjacent patterns. As a result, the arrangement contradiction was eliminated compared with the conventional arrangement method.

The company applied this new technology to the design of 64-Mb class DRAMs and confirmed that the shifter arrangement which used to require about two months of manual work can be accomplished in two days, or in about one-thirtieth the usual time. As a result, it is now possible to apply the Levenson method to the expansion of peripheral memories and microchips, which translates into reduced capital investments. Further details from Toshiba Corporation, Public Communications Office, 1-1-1, Shibaura, Minato-ku, Tokyo 105, Tel.: +81-3-3457-2100, Fax: +81-3-3456-4776. (Source: *JETRO*, October 1994)

### **Polymer-dispersed liquid crystal light valve**

Japan Broadcasting Corp. (NHK) has developed a spatial light modulator (light valve) suitable for projecting picture images on a screen-like conventional liquid crystal video projector. NHK has invented a polymer-dispersed liquid crystal light valve with a limiting resolution allowing

50 pairs of black and white lines to be displayed in 1 mm. This means that the light valve with a 2 inch long diagonal can enlarge and project high-definition video images.

This device has liquid crystal droplets about 1  $\mu\text{m}$  across, which are dispersed in a polymer matrix. The light valve is made up of the polymer-dispersed liquid crystal layer, a dielectric mirror, a light absorption layer, and a  $\text{Bi}_{12}\text{SiO}_{20}$  (BSO) photo-conductive layer. Further details from Japan Broadcasting Corporation, Public Relations Bureau, 2-2-1, Jinnan, Shibuya-ku, Tokyo 150-01, Tel.: +81-3-5478-2445, Fax: +81-3-3469-8110. (Extracted from *JETRO*, October 1994)

#### **352 MB capacity 2.5-inch slim hard disk drives**

Toshiba Corp. has developed a 2.5-inch super slim hard disk drive (only 12.7 mm high) with a formatted capacity of 352 MB.

The new 352 MB disk drive has the highest capacity available in the increasingly important half-inch form factor. The new drive is the smallest possible combined with excellent performance and low weight. Production began in September 1994. Further details from Toshiba Corporation, Public Communications Office, 1-1-1, Shibaura, Minato-ku, Tokyo 105, Tel.: +81-3-3457-2100, Fax: +81-3-3456-4776. (Source: *JETRO*, October 1994)

#### **4-mm diameter optical isolator for 0.98- $\mu\text{m}$ band**

Tokin Corp. has developed the world's first 4-mm diameter optical isolator for the 0.98- $\mu\text{m}$  band, a key device for low-cost optical fibre communications networks, which are the foundation of the oncoming age of multimedia.

The major precondition for multimedia acceptance is the establishment of optical fibre communications networks capable of transmitting huge volumes of information at low cost. However, current repeaters installed every 50 kms are a big burden that raises the cost of the overall optical fibre communications system.

Tokin Corp. developed a 9-mm diameter, 0.98- $\mu\text{m}$  product in 1993, and has been engaged in research to develop a 4-mm product within the range of the optical communications transmission system package specifications. The development of a unique crystal material allowed miniaturization of the product.

The crystal is made of a Cd-Mn-Hg-Te material prepared by adding mercury to the conventional Cd-Mn-Te material. This features less noise than the 1.48- $\mu\text{m}$  wavelength amplifier used as the 0.98- $\mu\text{m}$  alternative product, and is distinct in that the power consumption of the excitation light source is halved.

The successful development of the 0.98- $\mu\text{m}$  band optical isolator with a diameter of 4 mm responds to the need for capacity enlargement of communications systems and, at the same time, decreases the noise and lowers the cost of amplifiers through less power consumption, so will accelerate the construction of optical communications networks.

The company plans to introduce automated manufacturing facilities and to engage in mass production with the aim of attaining a sales volume of several hundred million yen in the initial fiscal year. Further details from Tokin Corporation, Product Development Laboratories, 28-1, Kitahara, Hanashima-Shinden, Tsukuba-City, Ibaraki

Pref. 305, Tel.: +81-298-38-1761, Fax: +81-298-38-1028. (Source: *JETRO*, October 1994)

#### **High-performance image memory for 3-dimensional graphics**

Mitsubishi Electric Corp. has developed a new type of dynamic random access memory (DRAM) 3D-RAM, incorporating a logical circuit to increase the 3-dimensional (3D) graphics function. The 3D-RAM was developed based on technology established for manufacturing a cache DRAM and high-speed memory chip.

Compared with conventional types of specific graphics DRAMs, this new graphic memory features a high-speed imaging capacity that is about 10 times greater. The company plans to commence mass production from 1995.

The 3D-RAM incorporates the minimum necessary functions indispensable for the high-speed processing of a series of time-consuming processes, such as reading out and then rewriting DRAM data, which is performed frequently in 3-dimensional graphics, and incorporates an arithmetic logical unit (ALU) that is a special-purpose logical circuit for 3-dimensional graphics data processing. Up till now, 3-dimensional data processing had required the use of a separate special-purpose LSI, but the 3D-RAM reduces the time for access with this LSI, so the system speed is increased.

The introduction of these new technologies now permits the 3D-RAM to display the function of drawing 1,800,000 triangles/s, for example, a processing capacity that is 10 times greater than that of the VRAM that has been used as the graphics DRAM for high-speed processing. In addition, the graphics LSI becomes unnecessary, so the number of system parts can be reduced substantially. Further details from Mitsubishi Electric Corporation, Public Relations Dept., 2-2-3, Marunouchi, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3218-2172, Fax: +81-3-3218-2431. (Source: *JETRO*, November 1994)

#### **Vanadium redox type large battery for high-capacity electricity storage**

Mitsubishi Chemical Corp. has developed a redox battery for electricity storage that uses vanadium recovered from power plant waste and sulphuric acid as the raw materials for its electrolyte.

Increasing the volume of electrolyte will make it easier to produce the high-capacity batteries used by power utility companies and enterprises, and compared with the high-capacity secondary batteries developed by electric utility companies and others, the electricity storage facility construction cost will be reduced to less than half.

The new secondary battery for high-capacity electricity storage was developed by the company jointly with Kashima-Kita Power Corp., a subsidized company supplying energy resources to a local petrochemical conglomerate, and with the cooperation of the Electrotechnical Laboratory of the Agency of Industrial Science and Technology

The new battery uses vanadium recovered from power plant wastes and sulphuric acid recovered from power plant fume as the raw materials for the electrolyte. Battery charging and discharging are performed by electron exchange between the electrodes and the vanadium in the sulphuric acid solution. In the discharge process, vanadium ions supply electrons to the anode, the cathode receives the

electrons, and a current flow is generated. It is actually possible to store electricity in the tank electrolyte.

The storable power will be proportional to the tank size. A tank with a diameter of 20 m and height of 10 m will have an output of 10,000 kWh. This will be equivalent to the power consumed by a large-sized intelligent building, and seven hours of power consumed by about 5,000 households. The tank can be installed below the building.

The system is safe since it is operated at room temperature, and the electrolyte is usable semi-permanently.

The new system also uses recovered wastes as its electrolyte, and uses no expensive materials for battery fabrication, so it enables high-capacity batteries to be fabricated at low cost.

Using the new battery will enable power utility companies to supply the power stored at night to meet the peak daytime demand, and enable industrial plants and office buildings to use nighttime electricity effectively. The new battery is also usable as a backup power source for photovoltaic power generation on days sunlight is unavailable, and conveniently usable by remote or isolated island communities as well as by developing countries as a local power source.

Mitsubishi Chemical plans to work together with Mitsubishi Heavy Industries, Mitsubishi Electric and Mitsubishi Corp. with the aim of commercializing the battery system within this century. Further details from Mitsubishi Chemical Corporation, 2-5-2, Marunouchi, Chiyoda-ku, Tokyo 100, Public Relations Dept., Tel.: +81-3-3283-5700, Fax: +81-3-3283-5472. (Source: *JETRO*, November 1994)

## D. MARKET TRENDS AND COMPANY NEWS

### Market trends

#### **GaAs market grows; SiGe may offer competition**

As gallium arsenide (GaAs) device manufacturers convert to 10 mm wafers and continue to shrink device features to 0.4  $\mu\text{m}$ , GaAs ICs have become more competitive with silicon. This was the evaluation of Integrated Circuit Engineering (ICE, Scottsdale, Ariz).

Fujitsu has taken over the top GaAs producer ranking because it has ramped up a dedicated GaAs fab in Yamanashi, Japan.

All together, GaAs IC manufacturers are now shipping products with over 350,000 gates. ICE forecasts that the market for these and other GaAs circuits will grow to have a 1993-1998 CAGR of 23 per cent, hitting about \$1.2 billion in 1998.

Interestingly, the portion of the market represented by development contracts is expected to decline significantly beginning in 1995.

ICE estimates that military and aerospace applications will represent only 13 per cent of the GaAs market in 1998.

The booming market for communications equipment should fuel the long-awaited commercial success of GaAs technology. High speed computing and fibre optic applications may offer substantial volumes for high performance GaAs devices.

ICE technologists are also watching silicon germanium (SiGe) technology, particularly that of IBM. (Extracted with permission from *Semiconductor International Magazine*, November 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### **Bringing the market to technology (telecoms regulation)**

Many fields of modern technology are not contributing as much as they might to social well-being because of the way in which they are regulated. Telecommunications is a glaring example with cramped trade being notoriously obtrusive. Leaders in the Republican Congress in the USA are saying that a telecommunications bill will be reintroduced, but this will probably not lead to a free market in telecommunications. The largest issue is whether the regional telephone companies created by the breakup of the old Bell System 10 years ago will be free to sell long-distance services, partly to compensate for the business loss caused by cellular telephony. It also does not seem likely that there will be an end to Congress' regulating (through the Federal Communications Commission) the prices charged by cable TV companies.

Things are no better in the UK where the Government has decreed that British Telecom will not be allowed to sell pay-tv signals through telephone connections until 1997 to avoid complicating the life of cable television companies who have only recently gained their franchises. On the European mainland, the European Commission has decreed that it will be three more years before national telecommunications organizations will be required to accommodate other long distance telephony companies on their networks. In Japan, the main telecommunications provider, NTT, is being privatized by degrees, but it

remains to be seen how liberally the new company will be regulated. It is necessary to understand the ground rules—if there is a capital installation of high cost, such as a national telephone network, it should be turned into a common carrier, made accessible to all potential users, even mutual competitors. In retrospect, British Telecom should have been privatized into two parts—a common carrier network and a telephone company. (Extracted from *Nature*, 372(6504) 24 November 1994)

#### **DECT chips will halve cordless phone prices**

DECT digital cordless telephones will make their first real impact on the domestic telephone market in 1995, as prices fall with the introduction of new highly integrated designs.

Manufacturers are confidently predicting a DECT handset and domestic basestation package could break the DM400 (£160) barrier.

SiTel Sierra is the latest semiconductor supplier to introduce a low-cost highly integrated DECT baseband processor which will sell for less than \$10 in volume.

The SCI4420 is intended specifically for the domestic single-line cordless telephone market and it joined second generation DECT chips launched by Philips Semiconductor and Advanced Micro Devices in October 1994. (Extracted from *Electronics Weekly*, 30 November 1994)

#### **Europe top of the telecoms chart**

Europe is the largest market for telecommunications equipment and will grow in importance between now and 1997, according to a report published by Elsevier Advanced Technology.

In 1993 Europe accounted for 37 per cent of the world telecoms equipment market, which includes radio, business as well as public network equipment, and just over half the production.

The USA accounted for 34 per cent of the market and 27 per cent of production. The global telecoms equipment market was \$87 billion in 1993 and is expected to shrink by 1.9 per cent per annum between now and 1997.

The radio communications market will grow by 10.8 per cent per annum up to 1997. (Source: *Electronics Weekly*, 30 November 1994)

#### **End of the road for CD-ROM networks?**

Just when everybody in library management thought that CD-ROMS were the ultimate in storage and local access, three major CD-ROM publishers—UMI, SilverPlatter and the Institute of Scientific Information (ISI)—have unveiled plans to distribute their data on-line. The motivation varies from company to company but all seem concerned that CD-ROM networks may not be the best way to deliver data onto the desktops of library users.

UMI's scheme will duplicate its CD content and make all of its current data, both ASCII and images, available on-line. Access will be wither through direct connection or the Internet. It is an option that UMI feels can offer a definite advantage over a networked CD-ROM. ISI's project is still in its development stage, and during trials will offer full text and images of 1,350 scientific journals through a combination of on-line access and locally held

information. SilverPlatter is taking a multi-purpose approach to distributing its CD-ROM based information with its Electronic Reference Library (ERL) client server product. Using the Internet as its communication path, SilverPlatter foresees users accessing information normally held on CD-ROM from a central server, which could either be locally or remotely based.

The real problem for library managers making purchasing decisions today is that most of the new on-line systems are still in development and the economics still being worked out. In reality, the only options librarians have is CD-ROM network towers, or if the budget stretches to it, jukeboxes. The CD-ROM publishers say that in the future CD-ROM and on-line options will coexist but the fact that their development money is being spent on on-line services may tell a different story. (Source: *Library Manager*, 1 November 1994)

### **PC card sales to rise tenfold**

A rosy future is predicted for PC card sales which will grow more than tenfold from \$500 million in 1993 to \$5.8 billion in the year 2000, according to market research firm Frost & Sullivan.

Flash memory cards are forecast to increase from 17 per cent of the market in 1993 to 47 per cent by the year 2000. Fax/modem cards will grow from 14 per cent in 1993 to 32 per cent of the market in 1996, then declining to 26 per cent of the market in the year 2000.

The demand for networking will boost LAN card sales from 8 per cent in 1993 to 20 per cent in 1996, remaining at or near that level until 2000. RAM cards will decline from their dominant market share of 47 per cent to 8 per cent by 2000.

The market research firm says that the development of the PCMCIA standards will help spur growth in sales and that flash memory cards will replace magnetic disk drives in some applications. (Source: *Electronics Weekly*, 9 November 1994)

### **Chip growth steady at 15 per cent until the year 2000**

The boom and bust cycles that have characterized the economies of the world-wide chip market may be finally over according to the World Semiconductor Trade Statistics (WSTS) global forecast which predicts a mostly steady 15 per cent chip sales growth for most of this decade.

Chip content in electrical equipment is expected to rise to about 30 per cent in 1995 and beyond, compared to about 10 per cent in the early 1990s, and 7 per cent in the 1980s.

WSTS predicts that world-wide chip shipments will be \$99.9 billion by the end of this year. The global semiconductor industry will finish 1995 at a projected \$114.6 billion. The industry will grow to \$130.4 billion in 1996 and to \$153.8 billion in 1997. The North American market will remain the world's largest in 1995 and the Asia-Pacific (excluding Japan) region will move ahead of the European market by 1997. However, in order to maintain healthy growth, semiconductor firms will have to invest a staggering \$150 billion in the next few years to achieve production at 0.25-micron and below. (Source: *Electronics Weekly*, 2 November 1994)

### **DRAMs in short supply until the year 2000**

There will be a shortage of DRAMs for the rest of the century, according to the world's largest manufacturer of DRAMs, Samsung of Korea, which blames the situation on Japan.

Japanese investment in DRAM manufacturing peaked in 1984 at over US\$ 6 billion and since then has run at sub- \$4.5 billion levels.

Texas Instruments has estimated that 40 new fabs will be needed to meet the demand for DRAM until the year 2000. Samsung will probably only build three new ones in that time.

Hyundai, which aims to overtake Samsung in the 1996-97 timeframe, has built a 20,000 eight-inch wafer a month plant and is building two more due to come into volume production in 1996. That will give Hyundai a capacity of 60,000 eight-inch wafers a month compared to Samsung's 50,000.

But even with all this capacity, demand for DRAM will be more than estimated. (Source: *Electronics Weekly*, 5 October 1994)

### **Company news**

#### **Hyseq Inc. obtains exclusive rights to Argonne super chip**

Hyseq Inc. (Sunnyvale, CA) received exclusive, world-wide patent rights to a biochemical "super chip" developed at the US Department of Energy's Argonne National Laboratory. The chip will be used to accelerate the decipherment of the human genome.

The agreement was signed between Hyseq and ARCH Development Corp., a commercialization arm of the University of Chicago. The university operates Argonne for DOE.

Under the agreement, Hyseq was granted exclusive patent rights to a variation of Sequencing-By-Hybridization (SBH) technology known as Format 3 that allows large-scale gene sequencing to be done on a 1-inch-square special plate capable of decoding the chemical sequence of hundreds of genes in one pass.

The company also gained non-exclusive world-wide rights to special software used to analyse and interpret genetic code deciphered by SBH technology. (Source: *Genetic Engineering News*, 1 October 1994)

#### **Company selected to develop novel semiconductors**

Johnson Matthey Electronics has been selected by the Advanced Research Projects Agency in the USA as prime contractor in an \$8.7 million programme to develop semiconductors based on bulk single-crystal ternary III-V alloys—compounds made of three elements from columns II and V of the periodic table. The materials will allow mass-market production of commercial and industrial devices like CDs with higher data storage capacities and longer wave infrared detection. (Source: *European Chemical News*, 26 September 1994)

#### **Companies cooperate in digital signal processor network**

Most of the signals surrounding us are analog; digital is the exception. Microelectronics, and therefore also the

miniaturization of the control elements, rely for the greater part on digital processing of data. To be able, therefore, to control or simulate the analog world with digital "instruments", changing over from analog to digital and back again, means that speed and calculating capacity are essential.

Processors are becoming more and more powerful (greater word length) and faster. For so-called "realtime" applications, "digital signal processing" or DSP are needed. There has been an explosive growth in the last few years in the number of products that make use of digital signal processing technology.

These products can be found in various areas, such as telecommunications, medical instrumentation, robotics, consumer electronics, multimedia, and so forth. It is becoming increasingly harder to find electronic products in which DSP technology is not an essential constituent. At the moment, annual growth world-wide is over 30 per cent.

In the area around Leuven, two research institutes, IMEC (Inter-University Microelectronics Center) and the Catholic University of Leuven, have set up a "network" under the name "DSP Valley" together with four companies which work closely together with them, Philips ITCL, EDC (European Development Centre), EASICS, and Intelligent Systems International. Together they intend to turn the expertise they have built up jointly (built up among other ways through many mutual collaboration schemes and involvement in international projects such as ESPRIT (European Strategic Programme for Research and Development in Information Technologies), JESSI (Joint European Submicron Silicon Initiative), ESA (European Space Agency), and bilaterally) into commercial ventures. In this way, total solutions can be offered to potential clients, as a result of which one or more partners will be able to put in their optimal available complementary potential. This project is coordinated by Dr. Patrick Pype, head of technical and administrative coordination for VSDM (VLSI (Very Large Scale Integration) Systems Design Methodologies) at IMEC. (Extracted from *Technivisie*, September 1994)

### **Trio unveil disc storage attack**

Advanced disc-based storage systems have been unveiled by 3M, Toshiba and Hitachi.

US digital media firm 3M showed a new type of high capacity CD-ROM disc that doubles the storage capacity of high density CD-ROM discs through the use of an innovative dual layer technology.

The disc has a second layer that can be accessed by a CD-ROM drive read head by shifting the angle of reflected laser light as it shines through the top layer. 3M says its discs can store as much as 6 Gbytes, 10 times the current 600 Mbyte capacity of CD discs. The new disc was developed with help from Philips and Sony.

Meanwhile Toshiba is set to become the second company after Panasonic to sell rewritable optical disc systems based on phase change technology. The company has developed a double-sided 3.5 inch disc that can store 1.3 Gigabytes. It expects to launch its first products towards the end of 1995.

Toshiba and Hitachi have both announced 2.5 inch magnetic hard disc drives with capacities of over a gigabyte. The drives are due on the market early in 1995. (Source: *Electronics Weekly*, 23 November 1994)

### **US firms team up over cable TV**

US computer companies and telephone operators have formed separate industry groups in their bids to take advantage of the growing US cable TV market. Cisco Systems and Digital Equipment Corp. have teamed up with PC makers Apple and Compaq to develop networking and interactive TV technology for proposed digital cable TV networks. Three Bell telephone operators Nynex, Bell Atlantic and Pacific Telesis are each investing \$100 million over the next three years in a US cable TV joint venture. The collaboration will initially develop video-on-demand technology, which will be tried out in the USA in 1995. (Source: *Electronics Weekly*, 9 November 1994)

### **Microsoft signs global multimedia alliance**

Software giant Microsoft has announced a global alliance with electronics and communications firms to develop set-top TV boxes and associated technologies based around its video server software.

The partners include Hewlett-Packard, Compaq Computer, General Instrument, US West, Telstar, Deutsche Telecom, NTT Data, Olivetti, Alcatel Cable and Andersen Consulting.

Hewlett-Packard said it will develop set-top TV boxes based on Microsoft's system specifications.

Microsoft's video server software, code named Tiger, will handle the transmission of video-on-demand and a variety of future interactive multimedia services. Microsoft has delayed some pilot trials of its software, saying the other components such as set-top TV boxes and content were not ready. (Extracted from: *Electronics Weekly*, 9 November 1994)

### **486 cloners plan launch**

Two new 486 clonemakers, National Semiconductor and Integrated Information Technologies (IIT) are finalizing plans to enter the market in the first half of 1995.

Santa Clara-based IIT is preparing to enter the 486 market both as a CPU provider for PCs on its own account, and as a supplier of embedded x86 solutions in conjunction with National Semiconductor.

National and IIT have had a working relationship for some years and earlier in 1994 National bought 8 per cent of IIT's shares. Although the two companies are sharing knowledge on their 486 development programmes, the projects are being kept separate. (Extracted from *Electronics Weekly*, 2 November 1994)

### **Cambridge "first" with interactive TV service**

Cambridge Cable and its technology partners Online Media and ATM Ltd., are claiming a world first for their Ltd., broadband communications network which provides interactive TV services to 10 homes in Cambridge (UK).

According to a spokesman for Online Media it is the first trial of its kind which uses the asynchronous transfer mode (ATM) broadband communications protocol throughout the network from switch right through to the customer's set-top box received.

Online Media is already in discussions with BT and other cable TV operators who are interested in using its ATM set-top boxes. The Cambridge trial will have 200 users by the middle of 1995 and a commercial service will be launched in 1996.

The ATM switch and set-top box are based on the ARM 32-bit Risc processor. Robin Saxby, managing



director at Cambridge-based ARM, said the company's microprocessor was currently being designed into six set-top box projects around the world. (Source: *Electronics Weekly*, 5 October 1994)

#### **Broadband via microwave consortium**

Japanese electronics companies are seeking government money to develop the low-cost microwave technology necessary to offer broadband services such as video over radio links. A group of companies including Sony, NEC, Fujitsu, Hitachi, NTT, Oki and Mitsubishi are discussing a seven-year collaborative development programme which could cost \$60 million. The aim is to make use of newly proposed Japanese microwave frequency standards to develop broadband links capable of carrying video and high-speed data to hand-held, in-building and car mounted receivers. (Source: *Electronics Weekly*, 5 October 1994)

#### **C-Cube puts squeeze on MPEG "barriers"**

C-Cube, the US compression chip pioneer, expects to smash the cost and power barriers preventing MPEG compression technology being used in consumer products within two years.

Alexandre Balkanski, C-Cube's founder and executive vice-president, expects to deliver a battery-powered MPEG-2 codec (encoder decoder) costing around \$40 "in 24 months".

To date firms developing MPEG-based consumer electronics hardware are incorporating only decoders, because real-time MPEG encoders are only just becoming available, cost thousands of dollars and need special cooling arrangements because they draw so much power. But a \$40, battery-powered codec would open up the possibility of new MPEG-based consumer devices such as digital camcorders and video-phones.

C-Cube has scooped rivals with a new highly-integrated MPEG-1 decoder which will be used by a clutch of Asia's top consumer electronics firms in Video CD players on sale in Japan. JVC, Sony, Sharp, Matsushita, Sanyo and Goldstar are all building machines based on the chip. US and European sales are expected in 1995.

C-Cube expects the market for decoder chips in CD-based video players and PCs to be worth \$500 million in 1997. (Source: *Electronics Weekly*, 5 October 1994)

#### **No LCD bid until '96**

The first credible high volume competition to Japan's near-monopoly supply of flat colour screens for computers will not materialize until the fourth quarter of 1995 at the earliest.

That is when Samsung and Goldstar of Korea expect to begin volume production of 9.4-inch and 10.4-inch colour, active matrix thin film transistor (TFT) LCDs. Six to nine months later, Hyundai's production is expected to start. (Extracted from *Electronics Weekly*, 5 October 1994)

#### **Philips ties fab deal with IBM for extra capacity**

Philips and IBM intend to create a European semiconductor making joint venture, which may also result in the two companies working together on developing next generation technology.

For Philips it is an important deal which solves a short-term capacity problem, but also gives it access to IBM's 16 Mbit and eventually 64 Mbit DRAM technology.

Philips will take a significant stake in a new chip-making company which will be centred on IBM's existing 0.8 micron wafer fabrication plant at Boeblingen Huhb in Germany.

The plant currently processes between 500 and 600 eight-inch wafers a day, mainly 4 Mbit DRAMs for IBM. Philips designs will be qualified on the 0.8-micron process by 1995. (Extracted from *Electronics Weekly*, 12 October 1994)

#### **Mietec Alcatel builds up CMOS wafer base**

Mietec Alcatel, the Belgium ASIC foundry, has developed a modular CMOS process that allows low-voltage analog, high-voltage DMOS, vertical bipolar transistors and non-volatile memory to be added to the base wafer.

The process has been designed to appeal to automotive system integrators heralding a shift in Mietec's strategy away from a reliance on telecoms applications.

Mietec's move brings it into direct competition with Motorola and Texas Instruments, among other leading semiconductor companies, which have developed sophisticated modular processes for the automotive electronics sector.

The first production version of the I-T process, currently available, utilizes 0.7  $\mu\text{m}$  line widths. But a shrunk 0.5  $\mu\text{m}$  variant is being developed and is due in production during spring 1995. A further shrink to 0.35  $\mu\text{m}$  is planned for 1996.

The inclusion of non-volatile memory is not scheduled until 1996, said Jean-Pierre Liebaut, Mietec president. The firm is hoping to license SGS-Thomson Microelectronics flash memory technology. The intention is to offer customers the capability of including 64 Kbit of flash and 8 Kbit of EEPROM on an Asic. (Extracted from *Electronics Weekly*, 12 October 1994)

#### **Motorola invests in Chinese plant**

Motorola is to invest \$12 billion in China by the end of the decade.

Speaking at the official opening of Motorola's Chinese subsidiary, Motorola (China) Electronics, the company's president P. Y. Lai said Motorola's Chinese workforce is expected to rise to 10,000 people by the year 2000.

The goal of Motorola in China over the next few years is to build up the company's manufacturing and development of computer, semiconductor and wireless communications products.

The company's sales in China have already jumped from \$100,000 in 1992 to a forecast figure of \$2 million for 1994.

The Chinese investment is part of a growing Motorola presence in the Asia-Pacific region. Coinciding with the Chinese announcement, Nippon Motorola, the group's Japanese unit, revealed that it will invest \$206 million in expanding production of logic ICs. Nippon Motorola plans to acquire additional land and build a new facility at its plant in Fukushima prefecture in northern Japan. (Source: *Electronics Weekly*, 26 October 1994)

#### **Technology gets Quantum ahead**

US disk drive maker Quantum has joined IBM in applying magneto-resistive (MR) head and partial-response maximum-likelihood (PRML) read channel technologies to its products. These two technologies, when combined,

significantly improve areal density (number of bits per square inch) lowering the cost per megabyte.

IBM was the leader in this field. But with the acquisition of Digital's drive businesses, including the head business, Quantum has inherited Digital's MR technology. Quantum has combined it with its own PRML technology.

MR heads employ a magnetically sensitive thin-film resistor element to detect data bits written on the magnetic disk's surface.

These heads can produce large, identifiable signals independent of disk speed, unlike conventional inductive thin-film read-write heads. MR head technology also employs two separate, closely spaced read and write elements, which increase track density. The writing element is an inductive thin-film head, designed specifically for recording data. This element is usually wider than the reading element to minimize crosstalk from adjacent tracks.

PRML was first used in digital communications for high-speed modems and was adopted by IBM for disk drives in 1990. PRML is rapidly becoming a replacement for the "peak detect" read channel technology currently in wide use.

PRML avoids most of the problems associated with "peak detect". PRML does not work on individual peaks but recognizes multiple transitions and converts them into patterns.

For example, a 16-bit pattern will be compared to all known, possible patterns to determine its identity. This

way inter-symbol interference has been taken into account.

PRML also has more efficient coding which allows better use of disk space by allowing more bits to be encoded on a track. So PRML works as a sequence detector rather than a peak detector. (Source: *Electronics Weekly*, 26 October 1994)

#### **IBM leads pressure group for low speed ATM spec**

A group of 25 networking suppliers have committed themselves to pushing through a low speed 25 Mbit/s ATM (asynchronous transfer mode) specification thrown out by the industry's standards forum last year.

The move will put pressure on the ATM Forum standards committee to define, by the end of 1994, a 25 Mbit/s interface for the ATM broadband communications protocol.

The support for a 25 Mbit/s LAN interface is wider than the 25 members of the alliance and has raised a doubt about the long-term future of the 51 Mbit/s rate agreed by the ATM Forum.

The group, called the Desktop ATM25 Alliance, is led by IBM, which made the original 25 Mbit/s proposal and includes ATML of Cambridge, Fujitsu Microelectronics, Madge Networks, LSI Logic and TranSwitch.

The group will redraft the original 25 Mbit/s proposal, including a full physical layer specification for category 3 unshielded twisted pair cable, and resubmit to the ATM Forum. (Source: *Electronics Weekly*, 14 September 1994)

## E. APPLICATIONS

### **Semiconductor optical amplifier for optical networks**

NEC Corp. has developed a semiconductor optical amplifier that efficiently amplifies optical signals input with optical fibres. The most advanced semiconductor manufacturing technologies are applied and the waveguide for optical amplification downsized to one half compared with conventional counterparts, so that optical signals can be amplified to an intensity of 100 times with one half the power required up to now. Due to low power consumption, the generated heat is reduced and large-scale integration has become possible to amplify a huge volume of signals simultaneously.

The optical amplifier is a device whose primary role is to compensate the optical loss generated when transmitting signals in optical communications. It is used in combination with optical exchanges, switches, and computers and is an integral component of optical communications equipment.

The company believes that the amplifier will become a central device for communications and data storage systems, handling huge volumes of information, and plans to commercialize the optical amplifier within two years. Further details from NEC Corporation, Public Relations Office, 5-7-1, Shiba, Minato-ku, Tokyo 108-01, Tel.: +81-3-3798-6511, Fax: +81-3-3457-7249. (Source: *JETRO*, December 1994)

### **Three new LSIs for imaging and communications**

Oki Electric Industry Co., Ltd. has commercialized three new types of LSIs for use in imaging, voice and broadcasting receivers and plans to commence the mass production of these chips between February and June 1995.

These LSIs consist of an LSI for image coding, one for text-to-speech synthesis and one for FM multiplexed data demodulation.

The image coding LSI conforms to the international specifications of the Joint Photographic Coding Expert Group (JPEG) for colour static picture compression and decompression. Low power and cost reduction have been achieved by introducing the fixed Huffman table and adopting the new arithmetic circuit.

The text-to-speech synthesizer LSI has the function of converting Japanese language text consisting of kanji and kana characters into voice. It incorporates a D/A converter and low-pass filter, a read-only memory (ROM) with a dictionary of 60,000 words and speech segment and a dynamic random access memory (DRAM), by which text-to-speech synthesizer is possible. Typical examples of applications are the word processor, electronic book reading function, and amusement equipment.

The LSI for FM multiplexed data demodulation conforms to the DARC system used in broadcasting. The LSI demodulates digital data from multiplexed broadcasting baseband signals and incorporates a bandpass filter consisting of SCF, frame synchronization circuit and error correcting circuit. Simply connecting an external microcontroller (MC) unit and data temporary storage memory enables a digital data retrieval system to be constructed with ease. Further details from Oki Electric Industry Co., Ltd., Public Relations

Dept., 1-7-12, Toranomon, Minato-ku, Tokyo 105, Tel.: +81-3-3501-3111, Fax: +81-3-3581-5522. (Source: *JETRO*, December 1994)

### **Ultrasonic flaw detection and imaging system**

Hitachi Construction Machinery Co., Ltd. has developed an ultrasonic flaw detection and imaging system HYE-FOCUS that enables the minuscule internal flaws of semiconductor packaging to be imaged in units of a few micrometres by a non-destructive method.

Successful sound pressure stabilization of the piezoelectric element generating ultrasonic waves as well as 50 per cent noise reduction of related equipment have led to a resolution that is five times higher than conventional counterparts, and an image magnification of maximum 500 times, ten times that of conventional counterparts.

The system uses ultrasonic waves and images the minuscule defects such as the voids generated inside semiconductor packages in the process of manufacture, defective wafer bonding, defects inside metals and the strengths of plastic materials, and is used for product evaluation and for checking manufacturing processes.

The magnification of images by 1-500 times now enables switching from macroscopic observation to microscopic observation, making the system applicable to other fields, such as ultrasonic flaw detection and imaging plated materials. Further details from Hitachi Construction Machinery Co., Ltd., Public Relations Section, 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100, Tel.: +81-3-3245-6305, Fax: +81-3-3246-2607. (Source: *JETRO*, December 1994)

### **Superthin diffractive type silicon microlenses for infrared rays**

Matsushita Electric Industrial Co., Ltd. has developed a superthin diffractive silicon microlens for infrared rays with a thickness of only 2-4  $\mu\text{m}$ , a thousand times thinner than conventional counterparts. In addition, the lens enables the simultaneous incorporation of filters and other optical elements, so is expected to contribute to the miniaturization of optical systems.

The new lens is a serrated diffractive (wavelength 10  $\mu\text{m}$ ) lens that is formed on a silicon wafer by the photolithography (exposure) technique used in semiconductor manufacture. Silicon has the characteristic of cutting light with wavelengths of less than 1.2  $\mu\text{m}$ , so the wafer material also serves as a filter. Further details from Matsushita Electric Industrial Co., Ltd., 1-1-2, Shiba-Koen, Minato-ku, Tokyo 105, Tel.: +81-3-3578-1237, Fax: +81-3-3437-2776. (Source: *JETRO*, December 1994)

### **"Cybernetic" limbs take control**

An EU-funded consortium has completed the first stage of a project which might lead to the direct control of artificial limbs by the human nervous system.

The goal of the INTER project is to develop a neural connector implant in which a regenerating nerve passes through holes in a silicon device designed to record signals from sensory axons and stimulate motor axons.

The INTER consortium of research institutes, which is funded by the Information Technologies Programme of the

EU. has shown that nerves can regenerate within the connector.

It believes that its early results hold out the hope of "cybernetic" limbs for amputees, which are close to being natural extensions of the body. The technology could also have applications in neurophysiology and reconstructive surgery, it says. (Source: EU: Belgium: Tel.: 32 22969577; Fax: 32 22968390)

### **UV light may offer VOC destruction**

A new waste treatment technology called photocatalytic oxidation is now being developed that uses ultraviolet light and a catalyst to destroy volatile organic compounds (VOCs) generated by semiconductor processes.

The photocatalytic system consists of a reactor vessel, an acid gas scrubber, an exhaust blower and other components such as monitoring instruments and controllers. Air emission streams are fed into the reactor where UV light activates the catalyst, titanium dioxide. This initiates a chemical reaction that destroys compounds before being emitted to the atmosphere.

The technology is being researched as part of a CRADA agreement between SEMATECH and the US Department of Energy's National Renewable Energy Lab (NREL). NREL will perform lab and on-site tests on SEMATECH-identified air streams. SEMATECH will then compare the effectiveness and cost of this technology with other technologies under consideration for commercialization. For more information call Mike Coe at NREL at (303) 275-4085. (Reprinted with permission from *Semiconductor International Magazine*, December 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

### **System for reclaiming and recycling waste home electrical appliance materials**

Hitachi, Ltd. has developed a system for reclaiming and recycling waste home electrical appliance materials, and plans to complete a pilot plant for the purpose in Hitachi City, Ibaragi Prefecture, by March 1995. This is the first such plant in the country in which waste home electrical appliance materials are automatically crushed and classified by type for reutilization.

Existing technology to treat large-sized wastes are being applied to crushing these wastes for burial or for recovering useful metals. Therefore, the ultimate treatment volume (burial volume) is as much as 60-70 per cent of the total waste volume, with the result that burial grounds, especially around large urban regions are filling up and posing a serious social problem. There is also the hazard of atmospheric pollution and environmental disruption by harmful substances such as fluorine gas, creating an urgent need to treat wastes effectively.

The results of demonstration tests on the pilot plant will be studied with the aim of commercializing and marketing the plant. Further details from Hitachi Ltd., Public Relations Secretary's Office, 4-6, Surugadai, Kanda, Chiyoda-ku, Tokyo 101, Tel.: +81-3-3258-1111, Fax: +81-3-3258-2375. (Source: *JETRO*, November 1994)

### **Computer-aided preservation and transcription of ancient manuscripts**

The Institute for Computational Linguistics in Pisa (Italy) is involved in a project for the preservation of old manuscripts using digital optical tools and the creation of

a specialized workstation for transcription and electronic processing. This project is part of the CEU programme for telematics systems in areas of general interest (libraries). The system under development is intended for philologists, papyrologists, epigraphists, and other scholars working with ancient texts. It will make it easy to look up an image archive which displays a digital representation of source documents on a high resolution monitor; transcribe texts using a word processor; and automatically match each word in the transcription with the relevant portion of the source document. The original document, photograph, or microfilm version is optically scanned and the digitized image is then displayed on the screen at a very high definition to ensure legibility. A second window contains the scholar's transcription of the document and new text can be entered or already transcribed text can be viewed and corrected.

Work is currently in progress to provide an intelligent component that can perform restoration operations to provide a special tool which will identify legible characters in the digitized image. The system will produce a model represented by several relations obtained by calculating the size of each line, stroke and curve and include certain stylistic variations. A specific keyboard character is then attributed to each model representation. System performance can be improved by the addition of a textual/linguistic component which will allow the text of the fragment including both the restored and the easily legible parts to be compared with a textual archive where there is a good chance of finding the piece being examined. (Source: *ERICIM News*, No. 19, October 1994)

### **Towards multimedia electronic journals - not serial monomania**

The Institute of Physics (IOP) (UK) is involved in a number of collaborative experiments in electronic publishing. Products and service range from using the Internet to provide physicists with current awareness services to giving librarians free back run CD-ROMs when they take out new subscriptions for journals which are four to five years old. In addition there is an IOP World Wide Web server with a full text and image research available to subscribers. Journal publishers are interested in the use of electronic media as it can add value to the print-on-paper version; and it allows the integration of data and services which would otherwise have been distributed over different channels. The SuperJournal Project was a pilot SuperJANET project to test and demonstrate the value of very high-speed networks for the academic community, and to determine if multimedia access and display could provide the image quality and mathematical text required by research communities. Four interfaces were explored for UNIX X-windows and HyperNEWS display.

The move to electronic media will demand new procedures in librarianship. Multimedia journals will develop when the specific needs of different disciplines can be met effectively. There will be a need to provide multimedia tools to support the information providers. At present most tools require hand-crafting and with over 5,500 articles being published annually by IOP, such hand-crafting is not economically viable. Despite recognizing the difficulties, the opportunities for enhancing scholarly communication are great, and there is an exciting decade ahead of innovation and strategic development in scholarly communication, librarianship and publishing which aims at

multimedia access and display. (Source: *ITs News*, No. 30, September 1994)

### Railroad applications

Whether a large northern German shipyard wants to present a customer in the Far East with the draft of a new shipbuilding operation or a planning office wants to submit a just projected new building complex—virtually nothing goes any where any longer without visualization. Wolfgang Opel, one of the managing directors of Engineering and Design Bureau GmbH (IKB) in Bautzen, has focused for a long time "on the three-dimensional visualization of our designs". In this context, the drawings stored in the CAD system produce both photo-realistic images having true-colour quality and also full animations as camera trips through three-dimensional objects. Colours, materials and lighting situations are selectable at will and can be varied in accordance with the customers' desires.

Opel's latest coup is Dresden's fixed cable railway. IKB engineers designed the cars in their historical design—albeit on the basis of modern design standards. As Opel states: "Our customers were able to fashion for themselves an image of the new cars from virtually every angle—before they were produced".

The basis of the three-dimensional depiction was the design drawings under AutoCAD developed by CAD market leader Autodesk in Munich. Using 3D-Studio from the same software firm, many individual images were progressively generated from it that could then be modelled into and visualized as "real" objects. The result was a video realistically portraying entry into the cars and cable railway's trip. Not even by leaving a newspaper behind on one of the seats did the designers neglect producing even more near reality.

IKB engineers' results won over the wagon building managers from Bautzen on another project too: visualization and animation of a streetcar for Dresden based on 3D design data. In the meanwhile it is a foregone conclusion that the city on the Elbe will get a modern subway. Opel suspects that the deciding factor in that was "not only design and costs but the successful presentation of the photo-realistic model of the new trolley on a laptop also contributed to the outcome". (Source: *INGENIEUR DIGEST*, October 1994)

### New electronic process improves materials testing

At the University of Kassel (Germany), a new electronic test method has been developed that can be used for the materials testing of components. The process, called shearography, provides advantages over conventional interferometry, reports Professor Dr. Wolfgang Steinichen (Laboratory for Photoelasticity and Mechanical Engineering).

The material sample to be studied is illuminated using a laser. The reflected beams can then be recorded using an interferometer and a CCD (charge-coupled device) camera. By means of a prism mounted in front of the camera—a shearing element—two different images of the sample are produced. These images are superimposed over one another. This creates an interference pattern.

The image is recorded by the CCD camera and sent to a personal computer. If the material is then subjected to a load, the interference pattern changes because of the deformation. The second image is also recorded and can be

compared to the interference image of the unloaded sample stored in the computer.

The shearogram created in this manner now makes possible a precise determination of the location of deformed areas. Only these areas are shown as a striped pattern. The parts of the material that have not deformed under the load do not exhibit a striped pattern on the other hand. This is different from holographic interferometry where the entire image of the material sample is covered with stripes.

As Steinichen explained, the search for defect points is considerably facilitated by shearography. The new method is also less prone to interference and precise measurements can even be made if the sample has been moved unintentionally. In this manner, shearography is also well suited to materials testing and quality control in industrial settings. Isolating the system against vibrations is not necessary.

It is also claimed that shearography is very fast by coupling it with electronic image processing. Components can be optimized for later use while being produced, and improvements can be assessed immediately. In Kassel, shearography is being used for materials tests on composite fibre components, for quality control of rubber-metal compounds and for the vibration analysis of components. At this time, a mobile shearography tester is being developed for industrial use. (Source: *Frankfurter Zeitung/Blick durch die Wirtschaft*, 13 October 1994)

### Electronic product reliability improved with laser scanning microscope

Safety systems are only as reliable as their electronic controls. According to the Fraunhofer Institute for Reliability and Microintegration (IZM) in Berlin, error-free operation of complex electronic components cannot be guaranteed unless their behaviour in critical situations is known. Since the weak points of an electronic component cannot be located precisely, even with the most detailed calculations, scientists at the institute have developed a method which combines experiments with a theoretical model.

The component is cut at a suspect location and receives an ultrafine polish. Then its complicated geometric structure is examined with a laser scanning microscope. It sends a spatial cross-section to a computer into which many characteristics of the manufacturing materials have been fed. The computer calculations can then be used to derive information regarding the design, technology and materials use. (Source: *Frankfurter Zeitung/Blick durch die Wirtschaft*, 10 October 1994)

### PowerPC 604 in production

IBM and Motorola have completed development and fabrication of the PowerPC 604 microprocessor, said to be the most powerful high-volume microprocessor in the industry. The PowerPC is designed in a 0.5  $\mu\text{m}$ , 3.3 V CMOS technology and incorporates 3.6 million transistors. Die size is 196 mm<sup>2</sup> (12.4 mm x 15.8 mm), power dissipation is less than 10 W @ 100 MHz and it is available in a 304 pin CQFP or 256 pin BGA package.

PowerPC microprocessors, jointly designed by Apple, IBM and Motorola, are based on reduced instruction set computing (RISC) architecture. The 604 is the third chip produced by the alliance, just 18 months since fabrication of the first chip, the PowerPC 601. In July 1994, IBM said

it had already shipped over one million PowerPC 601 chips, marking one of the fastest ramp-ups of any microprocessor in the computer market. (Reprinted with permission from *Semiconductor International Magazine*, October 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA.)

### **Virtual reality goes consumer**

IBM and UK virtual reality specialist Virtuality are expected to launch the world's first integrated immersive VR system for the consumer market by 1996.

The system will consist of IBM's hardware, including a head-mounted motion sensor, joystick, tracker and graphics cards, and Virtuality's software.

The package will be sold either as a PC upgrade kit, priced around \$5,000, or already integrated in a PC.

Currently the two companies are delivering the more expensive version of this product, called Elysium, to beta sites. It costs between \$10,000 and \$70,000, depending on the model version, and is aimed mainly at companies and software designers would like to develop software for their own immersive VR model use for promotion or advertising. (Source: *Electronics Weekly*, 23 November 1994)

### **Music on silicon**

Japanese electronics giant NEC has developed a portable music player/recorder that produces CD-quality sound from data stored on an IC flash memory card.

Called Silicon Audio, the solid state player has no moving parts, unlike conventional portable players which use discs or tape to store the music. NEC hopes the technology will eventually result in a direct competitor to the latest Walkman-type systems such as Sony's mini disc and Philips' digital compact cassette.

The prototype player uses a 32-Mbyte flash memory card, containing 16 x 16 Mbit flash chip. (Extracted from *Electronics Weekly*, 7 December 1994)

### **Fuzzy applied magnetic ink character recognition (MICR) system**

Omron Corp. has developed a magnetic ink character recognition system applying fuzzy logic technology. It achieves a recognition rate as high as 99.9 per cent by using magnetic waveforms. Erroneous judgement is nil.

Up till now, accurate magnetic ink character recognition for bank cheques and bonds required a system which used the magnetic head in combination with the optical character recognition system. However, the application of fuzzy logic technology eliminates the need for the optical character recognition system, so there is a possibility of reducing the entire system cost by half, and the system is also more compact.

Since it is possible to reduce the cost and dimensions of the unit, the new magnetic ink character recognition system is applicable to the automatic recognition of securities such as bank cheques and bonds as well as traveller's cheques and to automatic ticket gates for expressways.

Magnetic ink characters can be read in accordance with their magnetic characteristics, so fraud is difficult. However, this character recognition system had the disadvantage of magnetic waveform disturbance due to disparities in magnetic intensity and ink quality as well as deflection caused by conveying speeds at the time of

reading. Therefore, financial institutions used optical character recognition systems costing several hundreds of thousands of yen in combination with magnetic ink character recognition systems.

The company uses a fuzzy processor FP5000 and an algorithm to perform fuzzy inference on the basis of the magnetic waveform. It realizes accurate character recognition without using an optical system in combination. In addition, the fuzzy system has a learning effect, and the level of accuracy is improved gradually with continued use.

Furthermore, the increased recognition capacity enables the system to read at a conveying speed of 0.45 m/s, one-fourth the time of the previous method. It allows manual insertion of securities. Although the magnetic waveform S/N ratio is deteriorated due to the decreasing speed of conveyance, fuzzy logic enables recognition of the entire character form, so the new system features an excellent recognition capability. Further details from Omron Corporation, Public Relations Dept., 3-4-10, Toranomon, Minato-ku, Tokyo 105; Tel.: +81-3-3436-7139; Fax: +81-3-3436-7029. (Source: *JETRO*, November 1994)

### **System for diagnosis of coke oven refractory deterioration**

Kawasaki Steel Corp. has developed a new system that automatically diagnoses the deterioration of coke oven refractories, and has commercialized the system after demonstrating the performance in the coke oven of its Mizushima Steel Works.

A camera is inserted in the coke-oven chamber to evaluate the degree of furnace wall damage by image processing. Coke furnaces were inspected visually by skilled inspectors from the furnace inlet, but the company developed the system to improve the working environment and to cope with the shortage of skilled furnace inspectors.

The Coke-oven Diagnosis System was developed by applying the coke oven chamber refractories diagnosis technologies of the company in combination with an image processing system developed by the company's System Electronics Business Department, and consists of three cameras inserted into the chamber and a system that analyses video images automatically to establish a database for repair work planning.

Each camera is equipped with a cooling system using nitrogen and cooling water to withstand use inside the chamber whose inlet temperature is as high as 1,200°C, and a neck swing mechanism to permit separate sides of the walls inside the furnace to be monitored when inserting and drawing out the camera for 16 m.

The company is presently studying the feasibility of selling the diagnosis system to other enterprises in the trade as well as to electric power and gas companies which use coke batteries. Further details from Kawasaki Steel Corporation, Public Relations Section, 2-2-3, Uchisaiwai-cho, Chiyoda-ku, Tokyo 100; Tel.: +81-3-3597-3845; Fax: +81-3-3597-4911. (Source: *JETRO*, November 1994)

### **Terminal IC for ISDN communications**

Yamaha Corporation has developed a new type of integrated circuit YTD410 for mounting on communications terminals for integrated services digital network (ISDN) services.

The ISDN service uses digital circuits enabling large-capacity, high-speed communications, and provides diverse services such as telephone, facsimile, image, and data

communications, all through a single network system. In Japan, NTT Corp. started offering services from 1988 through its INS Net 64 and, as of the end of July 1994, had about 300,000 subscribers for this system that is recognized as a next-generation communications network through an expansion of its service areas and introduction of an information highway concept.

The new product YTD410 is intended to cope with the steady introduction of ISDN circuits into general households. The model is a new version that retains the functions of the conventional YM7503 and YM7405 models but with a power consumption lowered to permit operation with local power feeds for use as a basic network interface LSI by ISDN users. Further details from Yamaha Corporation, Public Relations Division, 2-17-11, Takanawa, Minato-ku, Tokyo 108. Tel.: +81-3-5488-6601. Fax: +81-3-5488-5060. (Source: *JETRO*, November 1994)

### **Chip enables cheap PCMCIA**

Cirrus Logic believes it has introduced the solid-state storage chip set which will make possible the development of 8-Mbyte PCMCIA flash memory cards costing less than \$50 within five years. Any lack of ambition in that target is largely due to uncertainty over the cost of high density flash memory.

Cirrus' first devices, based around a recently introduced 16-Mbit flash chip from Hitachi, are the ST1000 PCMCIA/ATA flash memory controller and the ST2000 space manager, which is needed for card capacities greater than 2 Mbyte.

The controller implements the flash addressing and mapping protocols which are stored on 4-Kbyte on-chip ROM. It has the state machines for flash memory read, write and erase functions. A single controller can be used to address up to 10 16-Mbit flash memories. The PCMCIA card interface is compatible with the ANSI X3T9.2 ATA interface and supports four card configuration registers and there is on-chip generation of the 12 V required for high voltage erase.

The main application is expected to be removable storage in notebook PCs. (Source: *Electronics Weekly*, 9 November 1994)

### **Blind spots eliminated**

Siemens Semiconductors and US-based Autosense have jointly developed an electronic automotive mirror system, which alerts drivers of vehicles in their blind spot.

The system employs two infrared sensors that detect vehicles within 3.5 m range around the rear-side of a car.

Each sensor, typically situated in the tail-light, sends and receives focused infrared rays through a special optical system. The system is triggered when the car's traffic indicators are activated and it warns the driver of any object within the blind spot. The warning lamps are located inside the car and at the outside mirrors. The system's cost is estimated at \$50 when in volume production. (Source: *Electronics Weekly*, 2 November 1994)

### **Researchers find use for buckyballs**

Researchers at the California-based US Department of Energy Lawrence Livermore Laboratory say they have found a practical use for "buckyballs" — a novel form of carbon created at high temperatures when carbon atoms group together to form tiny spheres.

Formally known as buckminsterfullerenes, the football-shaped carbon molecules could help in manufacturing sili-

con carbide substrates and lead to new forms of semiconductor devices. Researchers discovered that heating silicon wafers and then bombarding the silicon with buckyballs caused the creation of silicon carbide in controlled patterns.

Silicon carbide is normally difficult to produce yet it holds promise for new types of semiconductors that are resistant to high temperatures and more robust than silicon-based chips. Its attractive, robust properties stem from the material being very inert. However this makes it difficult to use in conventional chip manufacturing procedures. By directing beams of buckyballs, Livermore researchers say they can bypass the problems encountered using conventional etching techniques. (Source: *Electronics Weekly*, 12 October 1994)

### **Moderately priced 1.3- $\mu$ m wavelength LED and photodiode**

NOK EG&G Optoelectronics Corp. has succeeded in commercializing moderately priced 1.3- $\mu$ m wavelength LEDs and photodiodes usable in optical communications. Light of 1.3- $\mu$ m wavelength has a low attenuation in optical fibres, so 1.3- $\mu$ m chips are used in trunk communications networks and systems for measuring the oxygen density in blood. However, they are expensive, so the range of utilization had been limited up till now. Cost reduction was achieved through chip structure modifications, so that these chips are now available at a price of less than ¥100 apiece, about one-thirtieth compared with before. Up till now, these chips were used only in trunk communications networks due to the high prices, but the commercialization of these moderately priced chips now enables use in corporate LAN systems and card discrimination systems. Further details from NOK EG&G Optoelectronics Corporation, 1-12-15, Shiba-Daimon, Minato-ku, Tokyo 105. Tel.: +81-3-3437-5910. Fax: +81-3-3437-6545. (Source: *JETRO*, October 1994)

### **Light-emitting plastics look better**

Two engineers at the University of Rochester in New York State have discovered why optoelectronic polymers emit light. Better still, they have used that knowledge to quadruple the materials' highest reported efficiency of light emission to 42 per cent, which could make them widely useful.

Optoelectronic plastics, also known as conjugated polymers, are an inexpensive and convenient alternative to light-emitting semiconductors for some uses, such as displays, but it is hard to control the amount and colour of the light they emit, and they are notorious for taking in 10 times the photon energy as they give out in light.

The cause was found by Samson Jenekhe, associate professor of chemical engineering, and his former graduate student John Osaheni, now a research engineer with General Electric Corporate Research and Development in Schenectady, NY. They fault the spacing of the molecular chains within the polymer. Apply a voltage to a polymer containing chains only 0.3-0.5 nm apart, and those chains form pairs of molecules known as excimers that exist for only a few nanoseconds. Excimers do not emit light efficiently.

To remedy matters, Jenekhe and Osaheni simply prevent excimers from forming. That can be done by blending in another polymer or other molecules to keep the original polymer's chains at least 1 nm apart. Properly blended, the chains form not excimers, but another type of material — a short-lived molecular sandwich known as an exciplex, which emits light very efficiently. The two

Rochester engineers believe that conjugated polymer exciplexes signify a new class of optoelectronic materials.

Most exciplexes they have made so far are three to five times as efficient as their pure counterparts at converting input energy into light. But in turning light into electricity (for, say, solar energy), they do strikingly better, being as much as 300 to 1,000 times as efficient.

Jenekhe and Osaheni worked on materials called polybenzobisazoles (PBZAs). They have filed for a patent on the new class of materials and their optoelectronic applications. (Source: *IEEE Spectrum*, October 1994)

### Pointing device for input with fingertips

Alps Electric Co., Ltd. has developed a pointing device in the Glidepoint KGDDBA Series that is ideal for use with portable information processing equipment such as the notebook type personal computer since it is thin, lightweight and requires only a small manipulation space.

This pointing device detects positions by reading out the changes in the load generated by human touch. The electrostatic capacitance system has been introduced in the pointing device for the first time.

Personal computer cursor manipulation can be performed with ease simply by sliding the fingers lightly on the face sheet, so no special burden is impressed on the fingers or hand, and manipulation is possible smoothly and accurately. Since pointing is performed on the face sheet, not much space is required for manipulations. The system is usable ideally in environments where the mouse cannot be used, such as inside automobiles or outdoors. Further details from Alps Electric Co., Ltd., Public Relations Office, 1-7, Otsuka-cho, Yukigaya, Ohta-ku, Tokyo 145. Tel.: +81-3-3726-1211, Fax: +81-3-3728-7609. (Source: *JETRO*, October 1994)

### Electronic refrigeration element withstanding high temperatures

Fujitaka Co., Ltd., a leading domestic automatic dispenser manufacturer, has developed an electronic refrigeration (Peltier effect) element with a heat discharge side capable of withstanding temperatures as high as 150° C.

The Peltier effect element is used to convert electric energy into thermal energy, based on the front and rear sides becoming heated and cooled respectively when a current is passed through it. The element is usable in place of the controversial fluon gas that is linked to destruction of the earth's ozone layer, and has been commercialized for use as a cooling element primarily in the temperature control units of semiconductor manufacturing systems, and cooling elements in medical treatment systems and portable outdoor cooling boxes. Further details from Fujitaka Co., Ltd., 15, Kotari-kanda, Nagaokakyo City, Kyoto 617. Tel.: +81-75-955-9900, Fax: +81-75-954-6122. (Source: *JETRO*, October 1994)

### Between DRAM and disk storage

Intel's new flash strategy positions the two chips as intermediate storage devices between the DRAM and disk storage.

They represent a moderating of Intel's expectations for flash a year or so back when they were anticipating that flash could provide all the memory storage inside portable computers, PDA, and other hand-held equipment.

Both the chips are 16-Mbit flash memories with the option of 3.3 V and 5 V reads and 5 V or 12 V writes. Intel is positioning them as DRAM/EPROM/ROM

replacements for the storing of code and consequently calls them "flash RAM"

The flash RAM comes in two flavours -- the 28F016XS and the 28F016XD. The XS has a synchronous architecture which gives a 30 ns read time. The initial access of the device takes three clocks but thereafter it works at 33 MHz with a 500 Kbyte/s sustained write capability.

The XS flash RAM is aimed at data communications applications such as routers, hubs and ATM switches; at office automation applications such as laser printers, scanners and copiers; and at games applications such as set-top boxes, arcade games and high-end consumers where it interfaces with the system bus controller code store.

The other flash RAM chip, the XD, has a DRAM interface and 85 ns access time and is aimed at replacing DRAM in two application areas: code execution and data table reading.

Applications for XD are seen in telecommunications in PBXs, switches and cellular base stations; and in computing in POS terminals, diskless workstation embedded PCs and wireless communications where it interfaces directly to the system data DRAM.

Both flash RAMs have 32 lockable 64-Kbyte blocks and are claimed to be rewriteable/erasable 1 million times. They are due out in volume in the first quarter of 1995. (Extracted from *Electronics Weekly*, 26 October 1994)

### Optical switching

Optical fibres in principle open up the possibility of building networks with virtually unlimited bandwidth. The transmission range of optical fibres, covering wavelengths between 1.3 and 1.6  $\mu\text{m}$ , gives a frequency bandwidth of some 50 THz, or 50 million MHz.

While 50 THz would never be achievable down any significant length of fibre, today's networks still only make use of a tiny fraction of the bandwidth potential. This is largely because the optical signals transmitted across a fibre network have to be converted into electrical signals for most functions other than simple transmission, such as switching and signal regeneration.

But new optical devices being developed could break this logjam. These devices could be used to build all-optical networks that could make much better use of the fibre's inherent capacity.

So far most attention has been focused on the technology needed to generate and decode optical signals fast. It is now possible to generate optical pulse streams with repetition rates of a few Gbit/s and pulse widths of around a picosecond using mode-locked semiconductor lasers, which emit light in a very narrow band of wavelengths.

In future bit rates of several hundred Gbit/s could be possible using post-connected passive optical multiplexers, where a semiconductor laser is used to generate pulses that are interleaved to multiply the bit rate before the signal is put into the fibre.

Today's fibre networks use time division multiplexing (TDM) to squeeze many signals into one fibre. It has only recently become possible to build fast optical demultiplexers based on optical amplifiers using intra-band effects. An optical control signal pulls out the relevant pulses from the multiplexed input stream. Researchers at the Heinrich Hertz Institut in Germany, which is working on optical switching for Germany's telecommunications operator Deutsche Bundespost Telekom, believe such devices could handle signals up to 100 Gbit/s.



Tunable lasers have been used to generate signals at different wavelengths, with receivers that pick out the right wavelength using a tunable filter. But, while tunable lasers and filters are available, it is not clear if they could be made precise enough to let many closely spaced carriers be used and cheap enough for consumer equipment.

Some devices needed between the transmitters and receivers in optical networks are also available. For example erbium-doped fibre optical amplifiers that boost the intensity of light at regular intervals along a fibre, allowing it to travel much greater distances, have been around for some time.

As well as amplifiers, signal regenerators are needed to compensate for the distortion introduced into signals as they travel down fibres. All-optical semiconductor signal regenerators have been built in laboratories. They can operate at up to 10 Gbit/s, with the promise of 40 Gbit/s soon.

Switching signals in the optical domain is a thornier problem. Three types of switch are required—space switches, frequency switches and time switches. (Extracted from *Electronics Weekly*, 21 September 1994)

### **Flexible friend to get smart prepaid purse**

MasterCard, the world's second biggest credit card organization, will present the first chip-integrated smart credit card on the US market by 1996 with a European introduction expected by the end of the decade.

The smart card will have a prepaid electronic purse feature as well as standard credit card functions.

The chip embedded in the card will let the consumer download the amount of money required onto the card and use it for small transactions up to \$20.

The card will not be very different to the debit cards currently in use. The technical specification of the chip is still being discussed between MasterCard, Visa International and Europay, which are working together to develop standards for smart credit cards.

PIN numbers will initially be used for smart card security, but biometrics will probably be used soon after.

With a selection of smart card test trials held in the US over the next year and the first introduction of the prepaid smart card in 1996, the three organizations are paving the way for other smart services. (Source: *Electronics Weekly*, 14 September 1994)

### **Good vibrations**

Japanese electronics group NEC has opened the first installation of its walking guide system for the blind outside Japan, in the Swedish town of Växjö. Already in use in 100 sites in Japan, the Hanmyo system uses ferrite particles embedded in paving slabs to guide partially sighted people, who follow the tracks using specially adapted white canes. A magnetic sensor in the cane causes it to vibrate when it is in contact with the magnetic slabs. The vibration stops if the user strays from the path. At key points, the cane activates loudspeakers which offer information such as street names or hazard warnings. (Source: *Electronics Weekly*, 14 September 1994)

### **Automobile navigation systems**

For drivers who find it difficult to glance at a map and navigate while keeping both hands firmly on the steering wheel, there is good news just around the corner. Driving through cities may never be the same again as more and different types of dynamic route guidance systems are

being mass-produced and implemented even in the most basic car models.

According to BIS Strategic Decisions, the international consultancy group, by the year 2002 automotive manufacturers will be fitting more than 6 million vehicles a year with navigation systems as they leave the factory.

Route guidance is becoming a vital part of an integrated traffic management system. Well coordinated traffic management improves fuel efficiency, reduces pollution and eases congestion on the roads and the workload on the driver.

During 1996 and 1997, more European and North American automotive manufacturers will start to offer standalone navigation systems as options on their models. With standalone systems, an external support or communications infrastructure is not always necessary.

But the lower-cost, infrastructure-supported automotive information systems are the ones expected to appear on the market before the turn of the century. These systems need an external infrastructure for communication, signalling information and/or location reference support to pass on accurate information to the driver. (Extracted from *Electronics Weekly*, 21 September 1994)

### **Chip identifies DNA patterns**

Affymetrix, a US semiconductor designer, has developed a blood sampling silicon chip which can help in diagnosis and treatment of human diseases.

The chip, which can contain up to one million DNA fragments, is also to be used in detecting genetic mutations and in confirming paternity.

Affymetrix and Molecular Dynamics, its partner company which developed the laser scanner used in identifying malignant genes, have been supported by the US Commerce Department.

The chip stores the DNA information which is brought into contact with the patient's blood. A DNA matching process takes place and the DNA pattern is identified using a laser scanner. The first chip is expected on the market in 1996. (Source: *Electronics Weekly*, 2 November 1994)

### **First mass-produced car has multiplexing bus**

Ford Motor exhibited at this year's Motor Show in Birmingham a production car with a difference. The majority of the latest Scorpio model's electric wiring has been replaced with a two-wire multiplexing bus, via which many control systems in the car can communicate.

This makes the Scorpio the first mass-produced vehicle to have a multiplexing bus on board. Its very first commercial use will instigate a trend which will increase the demand for electronic components and modules.

The most obvious advantage of using multiplexing buses in a car is that it significantly reduces the size of the wiring harness which is a saving in weight and cost. Another advantage is that in-car electrical equipment is controlled centrally which increases reliability.

But one important aspect of using multiplexing in the car is that diagnostics information is automatically generated. This is achieved though the system itself as part of its normal data checking process.

In the Scorpio the bus controls the central and double locking systems, remote entry, anti-theft devices, the electric windows and mirrors, the electric sunroof and the seat and mirror memory settings with personalized entry control. Additional units can be connected to the bus if required. (Extracted from *Electronics Weekly*, 9 November 1994)

## F. SOFTWARE

### **COLD is hot! (COLD systems)**

The advantages of computer output to laser disc (COLD) systems as a means of archiving large volumes of data include long storage life, easy access and low distribution costs. Despite these, however, the take-up of COLD systems was less rapid than anticipated. This can be attributed in part to proprietary hardware and a lack of standards. Recent developments in hard- and software, however, mean that inexpensive COLD systems writing data to a standard CD-ROM using a CD-Recorder (CD-R) have become feasible.

The reasons for the attractiveness of CD-R are various. The technology now has standards for the hardware interface and the data interchange. CD-ROM drives are available for under \$200. CD-R prices have fallen by 50 per cent in the last year, and recorders from suppliers such as Philips and Sony now sell at less than \$1,500 (with some models priced at under \$1,000). Blank CD-R discs cost about \$10. A 74-minute CD can store about 680 Mb of data without compression, the equivalent of 272,000 pages of text. Finally, there is already a huge installed base of CD-ROM drives, making this a viable means of distributing archival data.

There are some limitations to the medium, however. One is the slow access time compared with magneto-optical drives. The latter is more suitable for applications such as video servers, retrieval of very large images or online transaction processing run directly off the disc in real time. Another limitation may be that of the 680 Mb capacity, but this can be overcome by data compression, which effectively increases the capacity to more than 4 Gb. (Source: *CD-ROM Professional*, February 1995).

### **Software life cycle cost and risk reduction**

Life cycle studies have in general focused on ensuring hardware support costs are taken into account in the design process. The increasing significance of software in providing systems solutions and the ever increasing software costs have necessitated a new approach.

In response to this issue, BMT Reliability Consultants has been sponsored by the UK MOD to undertake a programme of research into software support costs, assisted by London's South Bank University and involving the participation of a number of software organizations across the UK.

The programme findings to date have provided insight into the software process in practice rather than from a theoretical point of view, and the available data has been found to be sufficient to enable analysis and modelling to be conducted.

The relationship between the software developers, the software development process, the intermediate products of the software development process and the cost of supporting the end products has been found to be highly complex.

The desire to simplify this relationship to provide a generic representation must be balanced against its inherent complexity and the validity of an over simplistic approach. By increasing understanding of this complex relationship, it becomes possible to highlight areas where effort can be targeted to reduce software support costs.

In summary, the aim of this research programme is to develop methods which will reduce the risks associated with projects where there is a significant software content, in the specific area of software support costs. Spin-offs are also anticipated which will have an impact on the understanding of a wide range of software project risks. The findings of the programme to date have supported the position that software projects are complex and quite unique, requiring specialized techno-economic methods to achieve success. (Source: *BMT News*, November 1994).

### **The smart factory**

The use of Artificial Intelligence (AI) in industry is now reaching its maturity stage. The first attempts to use AI in an industrial environment were, for the most part, long in promises and short on delivery.

The stage being now reached is one in which the techniques of AI are understood both in terms of their strengths and weaknesses and is seen as yet another tool which, properly used, can enormously improve the performance of human experts.

In the field of automation, the next few years will see a quiet revolution which will, by the use of AI, automate the automation process itself.

For example, during the design of a plant the design engineers produce paper documents specifying the behaviour of every component in detail. Simulation tools may be used to check the logic of this description, but the data for the simulators is supplied by hand and there is no assurance that what is simulated is what was specified, even less that it was what will be programmed.

A test plan is drawn up, particularly for safety critical areas, and the system is assembled, including the set-up of control and monitoring software. There is considerable time pressure at this stage—building a factory is hugely expensive, and every day spent on testing is a day of production lost. Debugging is difficult, compared to applications software.

Plants are not usually provided with any diagnostic software (simple detection of symptoms such as timeouts may be done in critical areas); expert systems require too much setting up, give a low "hit rate", and are almost useless in the set-up and test phase because no expert knowledge yet exists.

Looking at what AI could do to simplify this process, several objectives come to mind:

- To link the design of the hardware and software components, so that the engineer can design functions on a CAD system, causing the corresponding Programmable Logic Controller (PLC) source code to be correctly parametrized and generated automatically;
- To allow the re-use and specialization of well-tested libraries of components;
- To allow the simulation of the design "as built" from exactly the same information as is used to plot the site drawings or to run the PLC's;
- To generate the behavioural descriptions needed for the control and monitoring software from the same information;

- To generate the knowledge-base needed for a model-based diagnostic tool which can examine live data from the PLCs to reason back to faults;
- To provide an open interface that will allow other tools to use the same design information.

Object-oriented techniques emerged in recent years as being the most apt to provide suitable modelling and implementation facilities. An automated plant has a very large variety of hardware components (to the order of 1,000 types of component), and an even greater assortment of software procedures controlling it. The identification of objects in such a plant can start from the elementary components such as actuators or sensors, which are immediately taken in as objects with precise characteristics and attributes.

Higher-level objects can also be identified, where an object is defined when a particular functionality distinguishes it. These could be saved as unique objects, which would then be reusable in another location in the plant or even in another project. Objects stored and subsequently retrieved would carry with themselves the elementary components of which they are composed, plus the software methods necessary to control them.

The information collected for each object, whether elementary or compound, could be used profitably by all the downstream run-time tools, such as the diagnostics or simulation systems. These tools would make use of the information concerning, for example, the functionality of a cluster, its composition, and the way it interacts with other clusters.

With this knowledge it would be possible to automatically create a deep-knowledge model of a factory to diagnose a plant standstill situation, or to simulate plant reactions. (Source: *BMT News*, November 1994)

### **"Smart" electric motors could save a hydroelectric power plant**

"By replacing or rebuilding thousands of ordinary electric motors, which are used in pumps, refrigeration and ventilation units, in order to turn them into speed-controlled motors, we could save one TWh of energy (equivalent to the output of the controversial Alta hydroelectric plant in northern Norway)", says Professor Tore M. Undeland of NTH.

Most industrial and domestic electric motors in use today have been designed to run at more or less constant speeds. Many of them are overdimensioned, perform unnecessary work and thus waste energy. Only a small proportion of these motors are speed controlled. "Smart" motors of this type use only as much energy as they require to do their job.

It is estimated that in the USA, 60-65 per cent of industrial energy consumption goes into running electric motors. Industrial electricity consumption by the aluminium industry uses about 200 GWh a year on electric fans alone. The equivalent figures for the paper and chemical industries are about 180 and 110 GWh respectively. If we assume that the rest of industry operates at about the same level as the USA, i.e. that about 60 per cent of the energy used goes to electric motors, the ventilation market alone accounts for some 500 GWh, or 10 per cent of the Norwegian market.

The most important difference between an ordinary electric motor and a speed-controlled motor is that the latter is fitted with an electronic control unit which supplies

the motor with as much energy as it needs. It carefully allocates energy in step with requirements. The control unit can thus be compared with an automatic gas pedal.

"The asynchronous motor (induction motor) is the most common type of industrial electric motor. It is cheaper and more robust than other types of motors. Rapid developments in power electronics and microprocessors have made it possible to develop cheap 'mini-brains' or converters that are capable of meeting industrial standards of precision and acceleration. In a lift, for example, such a converter can apportion energy according to the weight the lift is carrying, giving more gentle starts and stops. 'Smart' electric motors can also be coupled to systems that recover energy on the way down. The problem has been that converters have produced both acoustic and radio noise and have interfered with other electronics in their vicinity."

At Brakerya in Drammen (Norway), ABB Energy is carrying out full-scale tests on the motors that drive the compressors that will "push" gas from the Troll field towards the Continent. Each of the five motors has a maximum capacity of 41 MW, the biggest speed-controlled electric motors in the world. This the first full-scale test of motordrives of such dimensions, and a great deal of work has been needed to minimize the effects of the test on the electricity grid in the district. (Source: *Gemini*, November 1994)

### **Virtual reality and the entertainment industry**

Virtual reality, or VR, is playing an important role in setting goals and changing expectations for designers of various computer systems, including those for entertainment and information. Virtual reality systems employ advanced methods for human-computer interaction to provide a feeling of immersion or presence in a simulated environment. Input devices such as gloves or motion detectors and output devices including head-mounted displays (HMDs) and large protection screens are connected to sophisticated multimedia computers to make a virtual environment, which can range from approximations of real places, such as buildings and airplanes, to presentations of multidimensional data to imaginary worlds.

Entertainment applications which have benefited from VR technologies include video arcade games, home video gaming systems and interactive CD-ROM applications. Many video games have grown to incorporate three-dimensional effects. These do not include HMDs, but typically use well-known tricks of shadowing, texturing and lighting to produce a fuller feeling of three dimensions than is achieved without those techniques.

Several major US cities have full-fledged VR game parlours, with HMDs and 3D input devices. Typically, participants pay nearly as much as they would for a movie ticket, but only for a few minutes in the game. The cost of these systems is prohibitive for most markets, so gaming enthusiasts will need to be content with flat-screen versions. Interactive CD disks provide games, education, travel, stories and so forth. The relation to VR is the reliance on a human perspective and choices to determine the outcome.

The involvement of information scientists in VR development can be either as a consumer or producer or both. As consumers, they can benefit from VR technologies and create information systems which, in the past, they could only imagine. As producers they can join with developers of information systems of all types who are

taking an interface-driven, rather than problem-driven, approach to their work. (Source: *Bulletin of American Society for Information Science*, October/November 1994)

### **Multimedia on the internet**

The Internet is growing at a phenomenal rate with an estimated 25 million users and traffic, in terms of bytes passed across the Internet, is increasing at a staggering speed not only as a result of more connections but as a direct result of the increasing quantity of images being transferred. Although much of the information, opinion and communication on the Internet is still text-based, there are a large number of very beautiful high-quality graphics available. Several US museums and the Library of Congress have photographic images of selected items in their collections available over the Internet. Weather maps are available from a number of sources, and soundclips on the Internet include the Japanese national anthem and the calls of whales. Much publicity has been given to Internet Talk Radio, a commercial radio, which is claiming an audience of 100,000 in 30 countries. With respect to video, the amount of moving images available on the Internet is small and confined to small clips. More serious applications are made of video links across networks. Video conferencing over the Internet is another developing area with the MICE (Multimedia Integrated Conferencing for Europe) project based at University College London looking into the interworking between European researchers and connecting them to sites in the USA.

Much of this is still futuristic, although it is possible for individuals with the right equipment and software to put short sound and video clips on the Internet. Interactive multimedia games are available, though generally for downloading to an individual computer or small local area network. When it is possible to send images down just a telephone line, the realities of available bandwidth for these applications cannot be ignored. There have been criticisms that too much money has been invested in fancy multimedia projects to the detriment of open access, mainly text, for the wider community, the Third World, and former Eastern bloc countries. Researchers on the frontier of the Information Superhighway seem to have forgotten that, even with good network links, accessing multimedia on the Internet requires the correct software, both for Internet access and for downloading files. Multimedia on the Internet will come and the amount of money being spent on research is significant, but like the first electric lights and the first televisions, the technology is still uncertain and access limited to a privileged few. (Source: *ITs News*, No. 30, September 1994)

### **Retrieving art images by image content: the UC Davis QBIC project**

The Art and Art History Department Slide Library at the University of California, Davis, has over 200,000 slides and is a visual resource for the campus. There was interest in creating an electronic database which could find images based on content. A pilot database of 1,000 images was built following a survey of the faculty to identify areas that might be used in teaching. QBIC (Query by Image Content) was selected as this software is designed to work in a more visual way than text-based image retrieval software. It attempts to find things that look similar to a selected shape, colour, or texture, and provides an enhancement to text indexing. Items were selected for

inclusion based on the survey, scanned for inclusion, and classified in terms of colour, texture, shape and location of objects. There are nine possible searches that can be conducted: scene text; scene histcolour; scene RGB colour; scene texture; shape search; and query by example.

Preliminary findings are variable with searches for shapes in fine art being problematic. Shadows and light, differences between drawing, painting, sculpture, photography, prints and textiles can make too much difference in the same subject to allow the software to pick up similar conceptual subjects that have slightly similar shapes. Shapes in fine art overlap and have ambiguous contours. However, it can be interesting to note what other shapes the computer finds in images that look different at first. The most accurate searches are in the areas of colour and texture which are not related to a specific shape, or within the rectangular shape that was used for the classification sample. Images and outline objects are being added to the database, in addition to slides of recent work by artists teaching in the department. Current research is examining the possible use of compression to expand storage while still using images at 24 bits of colour. Methods of image preparation, object outlining, image query, and combining content-based queries with text are also being studied. (Source: *Aslib Proceedings*, October 1994)

### **Images in context: multimedia initiatives at museum**

The Victoria & Albert Museum is the UK's national museum for art and design, and contains around 4 million items. The National Art Library (NAL) is a department and accounts for about 1 million of the total. The Museum has been making increasing use of electronic media, notably in the new galleries. A Multimedia Working Group was established in June 1992, to provide guidelines for the installation of multimedia systems and to monitor technological developments. The Group has also established various criteria for assessing proposed projects, and it considers copyright aspects. The new Glass Gallery, which opened in April 1994, incorporates an automated catalogue system which is maintained on a PC Q&A database.

In addition to gallery-related projects, the V&A is participating in a number of initiatives with other institutions. These include the EC-funded Electronic Library Image Service (ELISE) which started in January 1993, and the Camille Silvy's River Scene project. The NAL has recently begun to transfer photographs of items in the collection to Photo CD as part of its imaging project. The V&A intends to join SuperJANET later in the 1994/95 financial year. Although the NAL is a national library, it does not benefit from legal deposit. However, electronic publications have been actively collected in recent years, as material is often acquired for its physical form as well as its content, so there are now some early examples of electronic publications in its collection. (Source: *ITs News*, No. 30, September 1994)

### **Movies-on-demand may significantly change the Internet**

Current popular discourse views the information superhighway as an enlarged and faster Internet. In this view increased content, primarily in the realm of entertainment, will create economies of scale that drive down costs and increase market penetration. Yet, the

requirements of widespread online entertainment are likely to promote an infrastructure and culture that look quite different from today's Internet.

Because distributors will view their audience as a mass audience, a number of results are likely. First, information distributors will favour non-controversial programmes to avoid alienating part of their audience. For similar reasons, programmes designed for mass consumption will be favoured over those perceived as having relatively narrow appeal. The result is likely to be a lack of diversity and an emphasis on mass-appeal items.

Though mass consumption entertainment-oriented content will speed the development of the information superhighway, it is possible that many of the elements that current Internet users consider vital will disappear in the new infrastructure. Though the average reader will have many more options than now available from home television, attempts at mass distribution will likely favour mainstream, big-budgets programmes. The adoption of an asynchronous architecture would pose a significant barrier to those seeking to be information providers, and would favour a model of relatively passive consumption. (Source: *Bulletin of the American Society for Information Science*, October/November 1994)

#### **Multimedia information collection system**

NEC Corp. has succeeded in developing a multimedia information collection system "Live on Demand" that enables multimedia information from diverse sources to be collected and then transmitted effectively at very low cost.

Due to the recent progress in multimedia technology, there is a need for transmitting several kinds of multimedia information simultaneously, primarily image information. The development of a system capable of collecting optional information from diverse sources without being influenced adversely by various kinds of signals is especially required, and is indispensable for the realization of a futuristic multimedia society. At present, information is transmitted through independent cable systems after being converted into electric signals, making the use of several cables indispensable depending on the specific types of information, with the result that the entire system becomes massive due to the use of many large cables.

The new system allots specific frequency bands with respect to the access points on the optical fibre cable system and introduces a subcarrier multiplexed multi-access optical transmission technology for transmitting the information from diverse sources on light waves by utilizing the independent frequency bands, by which information from optional sources can be collected in multiplex with a single optical fibre and at optional timing.

When transmitting signals with a single optical fibre cable, there is the disadvantage that noise is generated by light interference at various frequencies. To cope with this problem, the subcarrier repeater multiplex transmission system was introduced that receives optical signals at the respective repeater points, regenerates the signal levels and then retransmits these optical signals.

With this new method, noise generation is suppressed and the signals can be amplified in the process of conversion into electric signals, which enables long-haul transmission of information. Using this new method enables the number of optical fibre cables to be decreased substantially, and permits multimedia information collection at much lower cost.

Conceivable applications of the new system as an information collection system include the collection and transmission of regional events, regional weather forecasts, traffic information, shopping information, and sport event relays. More immediate applications include the remote monitoring of diverse infrastructure such as dams, power stations, power transmission lines, roads, railway lines, railway crossings, and tunnels, and supplying information relating to the safety of railway stations, airports, harbours, industrial plants, theatres, stores, financial institutions, and on the state of parking lots and recreation centres.

The company observes that the new system is highly effective for a broad range of applications, and plans to further research for early commercialization. Further details from: NEC Corporation, Public Relations Office, 5-7-1, Shiba, Minato-ku, Tokyo 108-01. Tel: +81-3-3798-6511, Fax: +81-3-3457-7249. (Source: *JETRO*, November 1994)

#### **Process control software targets multi-tasking, reporting requirements**

Validation, recipe generation and multi-tasking appear to be key trends in process control software for genetic engineering applications. Many new programmes supervise and control multiple bioreactors or fermenters, log and display real-time data, modify recipes during the process, collect data and generate reports to meet FDA requirements.

Process control software producers are attempting to make graphics interfaces as easy as possible while maintaining real-time data integrity, controlling more bioreactors or fermenters from one site, enabling increased networking capabilities between people involved in the process and simplifying validation procedures. Most manufacturers emphasize that their software packages are upgradable to allow for eventual plant-wide automation.

Several new programmes have moved to the Windows platform or have been upgraded to Windows 4.0 for easier networking, multi-tasking, exporting and graphing. Other process control software programmes run on Windows NT, proprietary or multiple platforms, and a few are DOS-based. (Extracted from: *Genetic Engineering News*, 1 September 1994)

#### **Advanced encryption method for CD-ROM presented**

By means of an original method of encryption, this system protects the programmes contained in a CD-ROM.

The question: how can the piracy of computer programmes be prevented now that these are more and more frequently being distributed on CD-ROMs? The answer: by Marx, a small startup Bavarian enterprise, has developed an extremely reliable encryption-decryption system with its Crypto-Box.

The system features two innovations. The first is the use of an entirely new encryption algorithm: IDEA. The second: to provide total data protection. Crypto-Box uses a double key system. A data processing key that enables the decoding of the encrypted data is supplemented by an "electronic key", a card containing a microprocessor. This card is inserted at the PC's printer output.

The programme is encrypted by the joint action of two distinct encryption algorithms. One (IDEA) is implemented within the programme itself. The other is contained in the electronic key's microprocessor.

During coding, control is systematically passed to the microprocessor, which then applies its own algorithm. Completion of this procedure produces an initial key 14 octets (8-bit bytes) long, and a coded version of the programme. The encrypted programme can then be distributed.

To read this programme, the purchaser must have the data key and the electronic key, both personalized. He will not be able to access his programme unless he uses both these keys simultaneously. His personalized electronic key is useless to anyone else, even to anyone with knowledge of the secret encryption key.

These keys are personalized by the distributor of the programme. The distributor has a utility programme that, using the programme's 14-octet key and a 4-octet code identifying the client, produces a new personalized 18-octet key, and configures the electronic key.

Marx is currently marketing 2,000 to 3,000 Crypto-Boxes monthly in Germany.

### **IDEA: An asymmetric encryption algorithm**

Since its standardization in the United States in 1977, the Data Encryption Algorithm (DEA) has become the world's most widely used encryption algorithm. But the experts no longer consider it sufficiently secure, especially because the DEA is a "symmetric" algorithm. The encryption and decryption are therefore based on one and the same 56-bit key. Publishers and clients share this key and must keep it secret! These reasons, combined with the desire to free Europe of too burdensome a dependence on licences, motivated the Zurich researchers (X. Lai and J. Massey) to develop IDEA (International Data Encryption Algorithm), which operates on the basis of two keys: an encryption key and a decryption key. (Source: *L'Usine Nouvelle*, 27 October 1994)

### **CAD conference network**

Under the TeamSolutions family of products, Spectragraphics GmbH of Germany in Hanau, together with TeamExchange, is supplying a software that allows production, transmission and storage of compiled documents. On the basis of X-Windows this tool is supposed to yield a link among CAD/CAM systems, professional graphics programmes, DTP, text processing and tabular calculations. The result is a computer-aided ability, for example, for parts to be discussed and optimized during the design process by participants at various locations, saving time and costs.

Together with TeamConference, the same manufacturer is supplying another software solution independent of any platform that facilitates real-time conferencing entailing CAD/CAE applications. In this way it is possible for data from graphics or CAD/CAE applications like Professional CADAM, AIX-CATIA, Unigraphics, Pro-Engineer, I-DEAS, Bravo or AutoCAD to be made available simultaneously to a rather large number of participants. To clarify ideas, any participant can copy an image-clip on a white-board window that automatically appears on all participants' displays. (Source: *Ingenieur Digest*, October 1994)

### **A software sluice for electronic mail**

With oceans of electronic mail now deluging their desktops every day, engineers are being overwhelmed by digital documents of one kind or another and struggling to find a labour-saving means of controlling the binary tsunami.

Any of three methods—algorithmic, linguistic, or heuristic—can be used to automate document classification and retrieval. The simplest is also the crudest, namely, the algorithmic, or rule-based, approach. Key words and topics in documents are identified by a family of rules and thereby equipped to determine where to store each document. The technique is unsatisfactory, however, because people write in ways that are too subtle and too complex stylistically to be analysed by a finite set of rules.

The linguistic, or database, method is the most complex approach to archiving documents. Text in any given documents is examined by means of a database of words plus their meanings, their relationships to other words, and their recommended storage locations. But there are problems—creating the database is costly and searching through one of usable size takes a long time.

The heuristic, or self-teaching, approach is a workable compromise between the algorithmic and linguistic approaches. The user sets up an initial file structure and walks the programme through the classification and storage of a small number of documents. Each time the user stores a document, the programme learns a little more about how he or she wants to handle the different kinds of documents in need of storage. After training, the programme can handle most of the documents the user may wish to archive. It is more accurate than the algorithmic solution and faster than the linguistic approach.

The heuristic approach works because most users tend to store similar documents with a limited list of keywords linked by a few relationships. A programme implementing the heuristic approach can be simplicity itself. It need learn only the rules relevant to the kinds of documents the user wishes to store and need search only for key words of interest to the user.

Island InTEXT, a Windows-based information management product by Island Software, adopts the heuristic style of analysing and storing as well as retrieving documents. After training, the programme will automatically sort and categorize Word for Windows and WordPerfect for Windows documents. Engineers who are trying to keep their heads above water when it comes to managing documents will find it a lifesaver. Contact: Island Software, 715 Sutter St., Folsom, CA 95630. Tel.: 916-985-4445. (Source: *IEEE Spectrum*, November 1994)

### **Too many cooks spoil processor broth**

Most PC AT-compatible manufacturers have released multiprocessor versions of their top-of-the-line personal computers, or have said that they will soon do so. Their aim is to take over workstation and client-server applications with these processor-rich models. Some of the content of these designs, though, is proprietary. So to cut down on this variable element, Intel Corp. is pushing MP Spec, its multiprocessor specification.

MP Spec describes how generic, DOS-compatible, PC AT-capable, multiprocessor systems should be built when using Intel chips. It is intended, obviously, for original-equipment manufacturers and, less obviously, for developers of primary and built-in operating systems (BIOS) software.

MP Spec is an extension of the PC AT standard used on single-processor systems. It is based on Intel's instruction set and advanced programmable interrupt controller (APIC) architecture. A stand-alone chip that implements the APIC architecture is available for 80486-

based systems. The Pentium chip already incorporates the APIC architecture.

Under MP Spec, the operating system obtains its information about hardware configurations from the BIOS. Information about the default hardware is kept by the BIOS in the data-area address space that is home to its multiprocessor floating-pointer structure. Data in the pointer structure indicates if the system conforms to MP Spec and points to the optional multiprocessor configuration table (if implemented), where information about non-default hardware is kept. The configuration table may be stored in nonreported system RAM or in the BIOS's read-only memory space. Contact: Intel Corp., 2200 Mission College Blvd., Box 58119, Santa Clara, CA 95052-8119. Tel.: 408-765-8080. (Source: *IEEE Spectrum*, November 1994)

### **Developing a successful network disaster recovery plan**

The secret of survival in a network disaster situation is preparation—there are five elements to a successful recovery which are business impact analysis; secure offsite storage; disaster management planning; equipment replacement; and a standby site. The purpose of disaster planning is to ensure that the business survives, not just to recover computer systems. The recovery of the data centre and computer operations as the first phase will result in a viable strategy being documented in a reasonable time-frame. Three essential areas need to be studied and documented. These are the network configuration; current operating procedures; and offsite data storage. The starting points for developing a recovery strategy are the identification of the critical applications and the impact of their loss on the business. This should show the dependency of systems on these applications and the maximum time that the business can survive the loss of each application system. Other factors are the ease with which computer and communication equipment can be replaced, and the provision of alternative premises.

Teams of people responsible for implementing the recovery strategy need to be identified and they should cover command functions; standby site activities; communications; operations; administration; user liaison; PC recovery; equipment replacement; and building recovery. Each team should work out set overall procedures and check these against team responsibilities. People must know their task responsibilities and how to get information about these, and the recovery plan must be maintained and tested. Recovery planning should be restricted to the provision of emergency computer network operations as the first phase. Once a plan has been written to recover computer systems, the organization can build on the skills learnt to create plans for other business functions. (Source: *Information Management and Computer Security*, Autumn 1994)

### **Policing the Internet**

Much of what passes through the Internet is trivial, and most of it is entirely innocent, but what happens if criminals get onto the Net, distributing pornography or sending stolen records from one company to the next? Should the police and other law enforcers be allowed to intercept this new electronic traffic, just as they are allowed to tap phones and open the mail?

There is a further twist. If you allow official snoopers onto the global networks, how do you keep out the

unofficial ones? With a little ingenuity, each of the those millions of computers linked to the net can be made to listen in to the flow of messages, sift out useful grains of information and amass them into a private database that perhaps reveals an individual's lifestyle or company's business plan.

Governments are scrambling to keep up with the technology that is feeding such ideas, and admit to having an increasingly difficult time with monitoring. One of the reasons is that with information moving faster and farther than ever and in huge quantities, Governments despair of keeping tabs on everyone they would like to. Private cryptography makes this headache much worse, and Governments have desperately sought to clamp down on it. Some countries, such as France, now require that all cryptography be licensed, that the licensee has a legitimate reason for using it, and that the Government be given a copy of the private key.

The US took a different tack: cryptography is fine, the Government decided, as long as it held the key to a trapdoor in every system. It sponsored a computer chip called Clipper as an industry standard for telephone cryptography, and its cousin, Capstone, for computers. However, recently a cryptography expert took 28 minutes on a common workstation to render the Clipper trapdoor unusable. (Source: *New Scientist*, 8 October 1994)

### **Search tools at the European Patent Office: a new approach**

The European Patent Organization (EPO) has modified its approach to computer-aided searching with the introduction of EPOQUE First Page for identifying and eliminating documents and the BACON system. The existing system, EPOQUE I, enables search examiners to interrogate various internal and external databases from their work stations to obtain an initial list of possible relevant documents. This procedure will now be extended by EPOQUE II to narrow this list down to an average of 20 documents per search. The new approach will improve the selectivity of the examiner's main document identification tool; provide online access through EPOQUE II to relevant information; and create an electronic library. Access will be to the complete text in machine-readable form for a substantial amount of patent documentation. In addition, every drawing will be made available online. It will be possible to identify sub-sections within the text of a document through a navigation tool which is under development. EPOQUE II will become available to search examiners during the second half of 1994.

The BACON Numeric Service (BNS) will be an electronic library server containing the EPO's complete patent search collections which will be able to deliver on demand documents for printing and display. Containing over 20 million documents captured under the trilateral BACON project, the total data volume will be 13 Terabytes. It is conceived as a near-line system with response time up to 15 minutes. BNS is to be built and installed in the 1995-1996 time-frame. Over the past few years, the approach has evolved from trying to emulate in an electronic way the present paper-based search to the development of tools for supporting the basic steps in the search procedures. In the development of these tools, much emphasis has been given to involving users as this is the best guarantee that the tools will be what are needed in the technical fields. (Source: *World Patent Information*, September 1994)

### Non-stop speech recognition

Philips has developed what it claims to be the world's first continuous speech recognition system.

The system is made up of a set of software modules running under the Windows operating system. Philips says users do not have to pause between words and the software can attain a 98 per cent recognition success.

The software has to be trained to recognize specific users and employs an application-specific vocabulary which is targeted at specific environments such as hospital patient diagnosis.

Philips plans to offer the software modules, which require a high-end PC with about 16 Mbytes of RAM, to system developers. (Source: *Electronics Weekly*, 5 October 1994)

### Cleaning up your windows

All programmes written for Windows can be installed with a click of the mouse. But getting rid of a programme you no longer want can pose a challenge, because Windows installations often spread bits of themselves all over your hard drive. UnInstaller from MicroHelp Inc. is a handy utility that tracks down the components of unwanted Windows programmes to free disk space. When you tell UnInstaller what software to dump, it searches your hard disk and offers a list of files it thinks should be deleted. UnInstaller does not make deleting a programme as easy as on a Macintosh, where all you have to do is drag an icon to the desktop trash can. But it is a valuable addition to the Windows user's tool kit. (Source: *Business Week*, 26 September 1994)

### Designing with FPGAs

Engineers interested in learning how to design with field-programmable gate arrays may enjoy a kit from Xess Corp. For less than \$150, you will get both a basic text and a small circuit board that may be used to perform the experiments described in the book.

The text, titled *FPGA Workout: Beginning Exercises with the Intel FLEXlogic FPGA*, introduces the principles of digital logic design using the Intel NFX780 FPGA. Each chapter presents working examples of logic circuits that the reader can load into this FPGA and experiment with. Chapters include The Digital Design Process, Combinational Logic, Modular Designs and Hierarchy, Flip-Flops, Counters, State Machine Design, and Memories. In addition, several other chapters detail the architecture and design of a simple 4-bit microcomputer.

The board can stand alone or be mounted on a larger prototyping board. It has a socket for a single NFX780 FPGA, a 1-digit readout for displaying results, an interface cable for loading new circuits through a PC printer port, a 5-V regulator, and an interface for connecting multiple boards to create multiple-FPGA systems.

The complete kit, including an NFX780-15 FPGA, sells for \$149.95. Without the FPGA, it goes for \$99.95. The text alone is \$19.95. Contact: Dave Van den Bout, Xess Corp., Department SP, 2608 Sweetgum Dr., Apex, NC 27502. Tel.: 919-387-1302; toll-free, 800-549-9377 (800-549-XESS); e-mail, devb@vnet.net. (Source: *IEEE Spectrum*, September 1994)

### Engineering bulletin board

The Engineers' Club (TEC) is an electronic bulletin board system for engineers and other members of the tech-

nical community. In addition to providing a forum for the exchange of ideas, TEC evaluates software and has compiled several technical libraries of professional quality shareware and freeware, according to Robert Griffith, the club's founder.

Over half TEC's capacity is dedicated to engineering software. The remainder is devoted to utilities and DOS file-handling software. A small amount, perhaps 10 per cent, is taken up by games. Besides the on-line files, TEC also maintains many files on tape, which subscribers may access by request. All told, more than 4,000 files are available.

Electronic mail is a large part of any bulletin board system (BBS) service today, and TEC is no exception. It offers Internet e-mail access and many technical news groups for subscribers. It also operates a technical mail area and a job hunters' conference.

Two kinds of membership to TEC are available. Paying members pay \$35 a year, for which they get up to 90 minutes a day of download time. Contributing members contribute shareware and freeware files or else provide help to the board and its members. Either way, the more they contribute, the more download time they earn.

At present, TEC has over 1,500 members from over 20 countries. The service is available 23 hours a day via four telephone lines. (The BBS is down every day from 0300 to 0400 PST for maintenance).

Interested parties are invited to call and hang around the board for a few weeks to check it out. Contact: The Engineers' Club, San Jose, Calif.; BBS, 408-265-3353; e-mail, TEC@engineers.com; CompuServe, 73061.3406@compuserve.com. (Source: *IEEE Spectrum*, September 1994)

### E-mail made simple

While just about everyone acknowledges the value of e-mail, some find it more trouble than it is worth—especially for brief notes. Accessing the e-mail program, in some cases, requires more steps and takes longer than writing the message. Not so with QuickFlash.

A Windows-based network messaging system, QuickFlash requires no log-in steps to send or receive communications. All it involves is clicking on the QuickFlash icon, typing the message, and clicking SEND. Using QuickFlash does not even require leaving the current application.

As well as text, QuickFlash messages may contain graphics, either captured from any part of the screen or drawn using a built-in drawing routine. The program also lets users send prefabricated messages like "Can we meet today?" and "You have a package" by clicking on a PREFAB menu.

Normally, received messages pop up as bright yellow "Post-It"-type notes. Users who wish not to be distracted by such notes may invoke a "Do Not Disturb" feature, and retrieve messages at their convenience.

QuickFlash is priced at \$249 for 10 users and \$399 for 25. Contact: ADM Group, 477 Madison Ave., New York, NY 10022. Tel.: 212-750-7400; Fax, 212-750-7419. (Source: *IEEE Spectrum*, September 1994)

### Filters in tune with fuzzy logic

Electrical engineers at A&M University College in Texas have developed an expert system exploiting fuzzy logic that they claim is a simple way to bring out-of-spec filters back into line.



Butterworth and Chebychev approximation techniques are often used to fit a frequency response of an analogue filter into a specified window constraint, but when approximations are implemented in hardware, component variations can mean the filter may not meet its specification. Inclusion of a tuning system can adjust some of the components. But adjustable components usually produce non-linear changes in filter frequency response; variations in one component can modify several characteristics of the filter; and the implemented circuit will contain parasitic components and have other non-ideal effects.

The Texas approach (*Electronics Letters*, Vol. 30, No. 11, pp. 846-847) takes advantage of the fact that a filter window specification can allow any curve—as long as it is in the window. Once achieved, the system can optimize the filter to approximate the desired function.

The fuzzy logic involved was designed to approximate a Butterworth filter with maximum attenuation in the stopband.

By measuring the output at certain frequencies, the system modifies the filter parameters accordingly, applies the test signals and repeats the same process until the frequency response is within the window.

Texas's system has been successfully tested on a low pass filter implemented with transconductance op-amps and the researchers say that fuzzy logic has now been proved as a useful technique for tuning filters and should be a usable method for other electronic circuits or systems. (Source: *Electronics World + Wireless World*, September 1994)

### **Below the half-micron mark**

Aggressive development within the semiconductor industry keeps electronic products moving on a brisk course forward. Typically, ICs today contain more than three million transistors, plus three to five layers of metal interconnects that supply power and transport signals. Already, silicon circuit features of less than half a micrometer are the technology of choice for memories.

The same device geometry is fast being developed for highly integrated processors, application-specific ICs (ASICs), and other types of logic chips. Projections for the year 2000 include 1-Gb dynamic RAMs, 256 Mb static RAMs, and ASICs and microprocessors with 40-50 million transistors, frequencies of 400-500 MHz, and pin counts of up to 2000.

The enabling technologies that will permit these ICs to be realized are having to advance, too. Enhanced device structures, interconnects, and circuit design, as well as reduced power, are all vital to success. Consequently, the upcoming generation of computer-aided design (CAD) tools will feature more accurate transistor models and parameter extractors, as well as more efficient timing and power analysis—capabilities that will be pivotal to design, simulation, and diagnosis in all the key technologies.

To summarize, deep submicrometer designs require a deeper understanding of semiconductor device physics as well as changes in a broad range of disciplines, including fabrication technology, IC design, and CAD tools and methodology. CMOS will continue as the technology of choice, and device performance and circuit density will continue to improve at least down to 0.1- $\mu\text{m}$  levels and may be even beyond.

CAD technology will focus on low-power concerns and also reliability analysis. With less dependence on

simulation, alternatives like static analysis and formal verification will enter the mainstream. A merging of top-down and bottom-up approaches is probable as extraction and interconnect analysis move away from the verification phase into the design phase. Advances in all areas are facilitating these developments, and even though there are still a few hurdles left, there is universal agreement that scientists and engineers will succeed in making the transition to the generation of ultra-large-scale integrated systems and devices. (Source: *IEEE Spectrum*, November 1994)

### **Active data analysis: advanced software for the '90s**

More often than not these days, sales brochures from software vendors state that their data analysis products do visualization. Anything from computer-aided design to molecular modelling seems to warrant the description. So the curious reader is left wondering what visualization really means, how the features of the different products compare, where the technology is going, and how much need be spent on a visual data analysis package. What in fact is the difference between a US \$100 package and one that costs \$10,000 if either may claim to let the user "see" data and analyses graphically instead of, or as well as, numerically?

The first programs for visual data analysis (VDA) were the preserve of an elite group of engineers and scientists dealing with the toughest problems, such as the moon landing. The programs became generally available only about a decade ago and cost hundreds of thousands of dollars. They had limited functionality and required state-of-the-art workstations costing more than \$100,000. In contrast, many of the latest VDA programs cost less than \$1,000, run on PCs, and have much greater analytic powers yielding far more insight into the data than did the leaders of only five years back.

The fact that most improvements in scientific and technical software are incremental does not point to any lack of creativity in its developers: as VDA software demonstrates, some of the most spectacular and unexpected advances cap an accumulation of many small improvements. Nor are the uses and benefits of VDA software obvious at first. The uses later found for VDA may count for as much as those for which a particular program was originally designed.

Today's science and R&D generate tons of data in myriad formats that can no longer be analysed by conventional techniques. Who can make heads or tails of reams of statistics describing a process or problem? What is needed are tools to reduce the tens, hundreds, or even thousands of megabytes of data into a format that can be comfortably processed by the human brain. That is the reason why more and more scientists and engineers are adopting VDA tools.

Today's visualization programs offer a wealth, perhaps even a superfluity, of options. Not so many years ago, their primary technique was the graphical representation of data; little importance was given to data analysis. In a similar vein, numeric analysis software lacked interactive graphics and graphical user-interfaces (GUIs). Now most numeric analysis programs have GUIs and graphics, and many visualization products have added strong analytical capabilities, blurring the distinctions between them and presenting buyers with many confusing choices.

VDA is a multidimensional form of data analysis. Some users see it as synonymous with interactive graphics. Others view it as a new way to do data analysis. But all are unanimous in agreeing that VDA software, regardless of how or why a person starts using it, will accelerate the analysis and discovery process.

True VDA products reveal several characteristic features. Among them are data presentation tools to graphically analyse data, support for large multidimensional datasets, and a high degree of interactivity. Other VDA tools offer fast data access, subsetting and output; numeric and statistical analysis; and graphics, imaging, tabulating, and animation for data display.

The best products add a programmable language or macro capability, which automates repetitive tasks and helps developers build complete applications for end-users. The best products also have excellent and flexible presentation graphics, to enable the user to present the findings with traditional analytical graphics.

More and more scientists, engineers, and researchers in almost every field from astronomy to zoology are using visual data analysis tools and techniques. (Extracted from *IEEE Spectrum*, November 1994)

### **BT software agents revive master and slave scenario**

The start of the next century could witness a revival of an institution virtually wiped out in the UK in the early years of this century—personal servants. Their 21st century counterparts will not be people but pieces of software called "intelligent agents", doing our bidding across tomorrow's data superhighway.

Researchers at BT's Martlesham laboratories in Suffolk are leading the world in the development of intelligent agents that can negotiate on behalf of their "masters". In tomorrow's multimedia world of broadband networks, such agents could take on everything from organizing the cheapest route for a long distance telephone call to buying a car.

Part of the motivation for developing intelligent agents is the fear that dealing with the sheer volume and complexity of services available on the superhighway will be too complicated for most human beings. Intelligent agents will act as friendly intermediaries between us and the network, allowing us to interact with the network in a natural way. The idea is to enable us to talk to our agents as though they were human beings.

Ironically, BT's work on intelligent agents is part of a move by BT to restore something to the telephone network which was lost at around the same time as domestic servants bowed out in the United Kingdom. Their replacement with automated exchanges made the network fast but stupid. Intelligent agents could bring back the intelligence while retaining today's high switching speeds.

The software used in BT's intelligent agents differs from ordinary pieces of code in two key ways. First, it is not a set of detailed instructions on how to respond to every situation, but rather a general description of the way the agents should behave.

Secondly, the software can learn from its experience and adapt the way it behaves to perform better.

### **The specialists**

The next few years are likely to see the digital signal processing system market fragment. There will be application sectors reliant on conventional software-programmable DSPs, others that need the horsepower of hard-wired silicon, and yet others that merge microcontrollers and DSPs on a single chip. All the while customers will take advantage of the integration potentiality of silicon processes and surround a commercially-available DSP core with their own special functions.

The image processing sector, though never really an advocate of the programmable DSP, has swung heavily toward the hardwired approach. Spurred on by the burgeoning popularity of the Mpeg-1 and Mpeg-2 image coding algorithms, semiconductor firms will flood the market over the next 12 months with chips that offer little or no programmability in their basic processing functions. (Interestingly many of these chips are being developed by firms not considered traditional DSP vendors.)

The reason for specialist Mpeg coders is cost; the dedicated piece of silicon is almost always cheaper than a programmable part. This is the over-riding factor in a market needing to keep the entire system's component costs to less than \$150.

From a wider system perspective, though, a great deal of programmability may be required in some image processing applications. A videotelephone, for instance, may need to accommodate both proprietary and ITU- standard H320 compression formats.

From the engineer's point of view, the prime benefit of floating point DSP is convenience. The development cycle of a signal processing application often follows a well defined pattern. First, the engineer ensures the processing function can be performed on the target DSP at the required rate. This step is followed by an off-line simulation phase to refine the algorithms for optimum performance. The algorithms are then ported to the DSP to complete the implementation. All of this is much easier on the floating point DSP.

A DSP's performance is frequently expressed in terms of its maximum execution rate of machine instructions. Simply dividing the number of instructions needed to implement an operation by the execution rate will provide a rough indication of the time taken to complete the operation. An overhead will have to be added to this to account for memory access clashes, looping, data movement and other housekeeping functions.

However, there is a further overhead for a fixed point DSP because the data has to be kept within the allowable dynamic range of the chip. The severity of this task is highly dependent upon the application and, consequently, the implementation requires considerably more detailed consideration. Time critical operations, for example, may need to be written in the DSP's assembly language.

This burden is amplified by the way algorithms are usually developed on a general-purpose computer in a high-level language using floating point arithmetic. Hence, the simulation has to reflect the capabilities of the fixed point target with a careful analysis of the instantaneous dynamic range of intermediate results. Parameters may also have to be constrained. (Source: *Electronics Weekly*, 30 November 1994)

## G. COUNTRY NEWS

### Australia

#### **Australia's path to nanotechnology established**

A cheque for \$3 million, to be used to establish Australia's Nanotechnology Network, was presented to the research groups responsible for setting up the cooperative network. The Nanotechnology Network is one of the first key initiatives of Australia's White Paper on Employment and Growth to be implemented.

Particular areas of study by groups in the Nanotechnology Network include applications relating to: contact lenses; implantable pacing electrodes; high resolution molecular filters; sensing electrodes for human diagnostic devices.

Cooperative research centres (CRCs) aim to link research groups and research users in long-term high-quality scientific and technological research and education. The Commonwealth will provide almost \$700 million to the existing 51 centres while participants will contribute around \$1.5 billion, including approximately \$340 million from industry.

Areas of study of CRCs in nanotechnology include:

1. CRC for molecular engineering and technology: sensing and diagnostic technologies;
2. CRC for waste management and pollution control;
3. CRC for cardiac technology; and
4. CRC for eye research and technology.

(Extracted from *Australasian Biotechnology*, Vol. 4, No. 4, August 1994)

### China

#### **Chinese cracker**

The Chinese city of Shanghai plans to "commercialize" its State-owned electronics and instrumentation firms, aiming to achieve annual sales growth of 40 per cent a year to the end of the decade.

Shanghai plans to establish 21 "enterprise groups" to make its electronics industry more competitive.

The target is to reach electronics and instrumentation sales worth between \$9 billion and \$11.5 billion by the year 2000.

The planned enterprise groups will also cover the telecommunications, computers and household electric appliance sectors. (Source: *Electronics Weekly*, 30 November 1994)

#### **DuPont advanced mask-making to China**

DuPont Company (Wilmington, Del.) is investing \$16 million in a mask-making facility in Shanghai, the largest city in China. The new joint venture, partnered with Shanghai Precision Photomask Corporation Ltd., is called DuPont Photomasks Company Ltd. Shanghai. It will use an existing facility of Shanghai Precision Photomask in the Chao He River High Tech Park area. Renovation work will include the installation of electron beam facilities capable of advanced photomask manufacturing.

Applying DuPont's technology used at six other mask fabrication facilities in the USA, Europe and Asia, this new

joint venture will enhance production technology of the electronics and communications industries in the Shanghai area.

The new plant is expected to begin operation by the end of 1995 and will employ over 100 people in full operation. (Extracted with permission from *Semiconductor International Magazine*, October 1994. Copyright 1994 by Cahners Publishing, Des Plaines, IL, USA)

#### **China to build information superhighway**

The establishment of an information superhighway in China has begun with the founding of the Shanghai Golden Bridge Network Engineering Company, which is going to be responsible for the design, building, management and maintenance of a network that is expected to form the first leg of a national system.

The project, named Golden Bridge, was jointly set up by 10 investors. Its aim is to provide a wide base for electronic networks covering Chinese trade and financial institutions. (Source: *Electronics Weekly*, 26 October 1994)

### France

#### **Third private telecom operator selected**

The consortium led by the Bouygues group was designated as operator of the third mobile telephone network using the DCS-1,800 standard in France by the Ministry for Industry, Telecommunications and Foreign Trade.

The group has teamed up with Jean-Claude Decaux (urban equipment), Cable and Wireless (UK), Veba (Germany), US West, Paribas, and the BNP (Banque National de Paris) for this project. Other than Bouygues, two other groups were among those hoping to obtain this network, notably Alcatel and Lyonnaise des Eaux.

The operators of the two existing mobile telephone networks, France Telecom and SFR (Générale des Eaux), will concurrently operate a DCS-1,800 network in a regional city on an experimental basis: Toulouse for France Telecom and Strasbourg for the SFR. The construction of a third French DCS-1,800 mobile telephone network should take about one year, with commercial operation starting on 1 January 1996 at the latest in Paris and subsequently in Lyon, Marseilles, Lille and Nice.

The consortium headed by Bouygues has a 15-year concession to operate the network with a 4-year exclusiveness in the five above-mentioned cities. This should cover 15 per cent of the French population within 18 months of granting the authorization, in other words at the beginning of 1996, and 25 per cent of the population two-and-a-half years later.

According to specialists, the cost of extending the network is estimated at between 10 and 15 billion (French) francs (Fr) over a period of six to seven years. However, it should be highly profitable, given the development prospects for mobile telephones. The market is currently growing by about 50 per cent a year in Europe. (Extracted from *AFP Sciences*, 6 October 1994)

### **France Telecom improves speed of data transmission service**

The Minitel service Teletel has been established in France for a long time. In the future, it will offer an increased transmission speed. Instead of the previous 1,200 bits per second, Teletel Vitesse Rapide (TVR) (High-Speed Teletel) will operate at 9,600 bits per second by the end of the year throughout France. Then, graphics and photographs could be transmitted within seconds, reports France Telecom.

The French telecommunications company wants to provide more potential for expansion of their information services, primarily to commercial users such as travel agencies, real-estate offices and the banking industry.

France Telecom, however, also wants to make multimedia applications possible. In this way, access to computer-aided services has been made possible with the Teletel Accès Numeris service with a transmission rate of 14.4 kilobits per second, and to photo videotext running at 64 kilobits per second. The use fees for the videotext service are classified into five groups and run from Fr 0.59 to Fr 9.29 per minute. In addition, the Djinn Flash Adapter has been announced. Using this adapter, the TVR service could be used on personal computers.

The French videotext service now has seven million connections. Of these, 6.5 million are Minitel units and one half million are personal computers, totalling about 14 million users. In 1993, Teletel achieved revenues of Fr 6.7 billion, as much as all French daily newspapers combined, it was claimed. (Source: *Frankfurter Zeitung*, 13 October 1994)

## **Germany**

### **Standards for German CAD/CAM**

In 1988 in the USA, leading customers and institutions banded together to prepare the industrial introduction of the future STEP (Standard for the Exchange of Product Model Data) standard and respective products. To achieve this, in the same year the Product Data Exchange Using STEP (PDES) Inc. was established with an annual budget of \$1.7 million. Next came the Nippon STEP Centre in Japan in 1990 (\$1.5 million).

The Germans joined up in 1991. The ProSTEP combined project arose as a joint initiative by the BMW, Bosch, Daimler-Benz, Opel, Siemens and VW/Audi companies. The partners endowed the joint project with DM 10 million, with the Federal Economic Ministry kicking in DM 3.4 million in support funding.

While all the various STEP organizations do operate on the basis of ISO (International Standards Organization) 10303 for the exchange of product data, they are pursuing different goals. Germany's STEP initiative takes into account the entire range of all data information as they accrue in the process of developing and manufacturing vehicles and electronic components, compiled in Application Protocol AP-211. Various other subprotocols take into account only subsets. The US STEP initiative, in particular, at least originally, targets only AP-203 that does not include essential information such as input on dimensions, group structures or CSG geometric models. Still, AP subsets have to be processed fully compatible with higher level APs.

Active as research and development partners in the German project are the Society for the Integrated Database

Applications (GIDA) of Berlin, the Karlsruhe Nuclear Research Centre (KfK), as well as the Institute for Computer Applications in Planning and Design (RPK) of Karlsruhe University. Nearly 40 large industrial outfits and leading CAD software suppliers have joined together in the Coordinating ProSTEP Association for the Promotion of International Product Data Standards, Limited (eV) in Darmstadt. (Source: *Ingenieur Digest*, October 1994)

### **Fraunhofer Institute builds microelectronics research production facility**

Initiatives directed at creating new semiconductor centres are growing. The Federal Government and the *Land* of Schleswig-Holstein are putting up the new Fraunhofer Institute of Silicon Technology in Itzehoe in record time. The first chips are scheduled to leave the 2,000-sq-m clean room area as early as next autumn.

A new trend analysis by the VDI (Association of German Engineers) Microelectronics Society forecasts a marked increase in the use of microelectronics circuits in industry over the next few years. According to the survey, the market will be worth 12 billion German marks (DM) in the year 2000, as compared with its current DM 6.7 billion.

The outstanding earner is the telecommunications sector, followed by data systems and automobile electronics. Microelectronics is increasing its share in all three branches, triggering a boost in demand for cheap silicon components over the next few years.

The experts are also predicting good prospects for sophisticated customized circuits (ASICs—application-specific integrated circuits) and microsystems, which combine optical and mechanical functions on a single chip. Producing high-grade silicon components of this type requires considerable know-how and the latest design and technology tools.

Against this background, the Fraunhofer strategists are not only stepping up their research activities, but are also enhancing their transfer services, particularly those directed at small and medium-sized enterprises. The newly-built institute, which is being financed by the Federal Government and the *Land* of Schleswig-Holstein, is no thoroughbred research laboratory: plans for its use envisage outside firms that require microelectronic circuits or systems in small runs having access to its clean room capacity. The modular structure of the clean room means that electronics firms can rent particular manufacturing sections, complete with development team.

The fledgling high-tech scene in this northernmost federal *Land* will benefit most. Immediately behind the Fraunhofer Institute there begins a 20-hectare, fully-developed site where the town council intends to locate new high-technology businesses. The Itzehoe Innovation Centre (IZET), under whose roof 20 firms will take their first tentative steps with microsystems engineering products, opens its doors in 1996. (Source: *Computer Zeitung*, 29 September 1994)

## **Hong Kong**

### **Supporting the free market: information technology policy in Hong Kong**

Economic policy in Hong Kong is frequently cited as a shining example of the laissez-faire model for development, with minimal government intervention. However, the

Government has played a bigger role in the economy than is often recognized, responding to market failures, social problems, and the needs of the business community. Information technology (IT) policy in Hong Kong has mirrored the colony's laissez-faire economic strategy, with little government effort to promote the production or use of IT products and services. Hong Kong has become an advanced user of IT in several economic sectors and an assembly site for personal computer hardware.

However, like much of the manufacturing sector, the computer industry is moving much of its production to China, causing concern about the future of Hong Kong's economy. While some people feel that Hong Kong can flourish as a financial and business services centre, others feel that this role will be diminished as the Chinese economy liberalizes and other centres develop in mainland China. They argue that Hong Kong needs to upgrade its technological capabilities and develop technology-intensive activities such as R&D and software development to complement China's manufacturing activities. The Government has begun to respond with limited measures to encourage R&D, train more scientists, engineers and managers, and support technology start-ups. Hong Kong has the potential to develop software and information services to serve the Chinese market. It also can apply IT to other sectors to maintain its leadership as a financial, business services, transportation and communications centre. (Source: *The Information Society*, Vol. 10, October-December 1994)

## India

### **The ultimate in indigenous research**

PARAM in Sanskrit means "the ultimate", and the Centre for Development of Advanced Computing (C-DAC) has rightly chosen that name for its series of multi G FLOP, massively parallel supercomputers.

The unveiling of PARAM 9000, the latest in the series, is a matter of cheer for the entire computer industry in India. In a country that is virtually craving for advanced computing technologies, this processor-independent open frame supercomputer is indeed a giant forward leap.

Political and financial factors had made the acquisition of advanced computing equipment from outside a difficult proposition. The foreign exchange crunch was always there, and the protectionist COCOM rules denied purchase of supercomputers from the West or Japan, except under very controlled situations.

It was in these circumstances that efforts to develop indigenous parallel computers using commodity processors took shape in India.

Parallel processing uses off-the-shelf components, and is more suitable to the level of technology currently available in India.

That the destiny of supercomputing in India would be carved through the route of parallel processing was accepted right from the beginning. With this objective, in 1988 the Department of Electronics launched a mission mode project in the form of C-DAC, as an autonomous society.

The first project mission of C-DAC was to design, develop and bring into commercial production, a high-performance parallel computer with a peak computing power exceeding 1,000 M FLOPS.

The project had three main components, namely technology, applications and research.

The earliest system was based on T 800 transputers. A prototype of the target machine was achieved in 1990, by grouping the T 800s into a cluster of 64 nodes. By mid-1991, a 256-node system was running. A creditable achievement, considering that there were no cost or time overruns. Next on the line were PARAM 8000 and 8600, named after the fundamental processors used. This marked a clear movement away from the original transputer-based design toward Intel and RISC processors. The emphasis has been to develop a general-purpose parallel computer with good cost performance by using off-the-shelf inexpensive hardware and industry standard interfaces wherever possible.

The launching of PARAM 9000 is timely because the country at the moment is embarking upon several strategic projects in areas like biotechnology, superconductivity, telecommunications etc., which require tens and hundreds or more of G FLOPS of computing power. This can be harnessed only through supercomputers.

C-DAC has transferred the technology for PARAM and other related products to Thermax, Keltron, ITI and Tata-Unisys, with the aim of commercializing the technology developed. In addition to this, from June 1992, it started its own business activity. By moving away from government funding, C-DAC hopes to commercialize a variety of its products. Correspondingly it has structured a product line not only including complete systems, PARAM 8000, 8600 and 9000, but also accelerators, systems, communication products, etc. (Source: *Deccan Herald*, 23 January 1995)

## Japan

### **Japanese S&T information**

The Japan Information Centre of Science and Technology (JICST) has published a new fully descriptive brochure containing details of its wide range of information services. The Centre is part of the Prime Minister's Office.

JICST is the access point to one of the world's largest and most complete sources of scientific and technical information. Unique is the comprehensive collection of Japanese information (some in the English language). The JICST-E database, available on-line direct from Tokyo or via the STN host service, is of major interest to users in Western Europe, North America and elsewhere. This database now scans the contents of some 8,300 Japanese S&T journals and incorporates citations and, in many cases, abstracts in the English language.

Copies of all the original journals are held in Tokyo, and reprints can be provided on request for local translation. Alternatively, the JICST translation service can provide translations into English and other European languages. Updates on developments in S&T are offered through the SDI (Selective Dissemination of Information) service. (Source: *Outlook on Science Policy*, July-August 1994)

### **Japan plans chip alliance to win back world lead**

Fears for their future competitiveness in chip-making have propelled the top Japanese semiconductor companies to propose an industry/government-academe consortium to develop production equipment for the Gigabit chip generation.

The move is a response to the successes of America's SEMATECH consortium, the European JESSI collaboration and the Korean and Taiwanese industry-government uni-

versity collaborations in developing advanced chip processes and equipment. Japan's top companies are looking for a similar arrangement to defray the heavy financial burden.

Although Japan has an ongoing industry-government programme called Sortec which provides for shared R&D effort in advanced technology, this is thought to be the first collaborative effort to be focused narrowly on chip-making since the famous "VLSI Project" of the early 1980s.

The VLSI Project resulted in the Japanese putting a 256-K DRAM into production a full year before the Americans and directly led, in the 1985 recession year, to the exit of all US companies (except TI and Micron) from the DRAM business and Japan's market share lead in chips after 1989.

The new Japanese consortium is expected to start its work in 1996, aimed at developing cost-effective equipment to be used in chip-making from the year 2000 onwards for manufacturing chips with feature sizes down to 0.18-micron. (Source: *Electronics Weekly*, 23 November 1994)

### **NTT to cooperate with Chile for B-ISDN development**

Nippon Telegraph and Telephone Corp. (NTT) announced that it will cooperate with Chile on a B-ISDN (broadband integrated service digital network) development project, to be led by the University of Chile. The NTT Communications Network Research Laboratory (in Musashino, Tokyo Prefecture) concluded an agreement with the University of Chile on the same day. This is NTT's first overseas cooperative B-ISDN project.

The "Access Nova Project" that NTT will be collaborating on will continue from 1995 to 1998, and will attempt to set up a next-generation communications network (an experimental network) that will provide Chile with an ultra-high speed transmission capacity of 2.4 gigabits per second (gigabit=billion bits). (Source: *Nihon Keizai Shimbun*, 19 November 1994)

## **Republic of Korea**

### **Koreans plan chip advance**

The Republic of Korea could become the world's number three producer in semiconductors and liquid crystal displays (LCDs) by the year 2005, according to the Republic's Committee on High-tech Industries.

In a report submitted to the country's Ministry of Trade, Industry and Energy, the pundits say that the country's electronic industry is expected to outstrip world growth, with a 21.3 per cent growth in opto-electronics, 18.5 per cent in semiconductors and LCDs, and 17.3 per cent in telecommunications.

According to the report, over the next 10 years the world's high-tech industries will grow at an annual rate of 8.5 per cent, creating a market of \$6 trillion in 2005. The

optical sector is forecast to grow at 13.5 per cent a year and the semiconductor business at 10.4 per cent.

The Committee's recommendations in the case of semiconductors and LCDs include the establishment of a semiconductor design training centre, and development of core technologies, components and equipment for LCDs. (Source: *Electronics Weekly*, 30 November 1994)

## **United Kingdom**

### **Green levy threat to electronics industry**

Electronics equipment in the UK could have a levy slapped on it, by the Government, to pay for the cost of recycling it.

This is one of the options put forward by the industry body charged by the Government with developing a UK plan to boost recycling of electronics goods. ICER, the Industry Council for Electronic Equipment Recycling, has circulated its report throughout the electronics industry and is seeking responses.

Who pays, and how, is the key issue for electronics recycling. Apart from a levy, other options include increasing VAT, loading the cost onto council tax bills, requiring manufacturers to take their products back and recycle them and requiring end-users to take equipment to recycling depots and pay the recycling costs.

The Government has been prompted to act on recycling in the face of impending EC legislation.

ICER plans to run three pilot electronic recycling schemes during 1995 in West Sussex, Cardiff and Lothian and Edinburgh, involving 250,000 households and businesses. Equipment collected at kerbside "electronics banks" and other collection points will be classified and recycled. (Source: *Electronics Weekly*, 2 November 1994)

## **United States of America**

### **SEMATECH funds PFC projects**

Two research projects aimed at reducing harmful emissions from semiconductor manufacturing will be funded by SEMATECH, Semiconductor Research Corp. (SRC) will manage the studies to be undertaken at the Massachusetts Institute of Technology.

The first project will focus on perfluorocompound (PFC) emission and abatement. It will include measuring and modelling the kinetics of PFCs released from plasma processes used in manufacturing. The second project will focus on non-PFC replacements for wafer etching and plasma-enhanced CVD chamber cleaning.

SEMATECH said it will have spent approximately \$20 million in 1994 on environment technology development programmes. (Reprinted with permission from *Semiconductor International Magazine*, December 1994. Copyright 1994 by Cahners Publishing Co., Des Plaines, IL, USA)

## H. AUTOMATION

### **World industrial robot population reaches 610,000; potential for further growth enormous**

More than 610,000 industrial robots are now at work, according to a new annual publication by the secretariat of the United Nations Economic Commission for Europe (UN ECE) and the International Federation of Robotics (IFR). "World Industrial Robots 1994—Statistics 1983-1993 and Forecasts to 1997" contains unique data collected from more than 20 national industrial robot associations, making it the world's most comprehensive reference work on robotics statistics.

#### **The slump in robot investment bottomed out in 1993**

The world's robot population grew by about 6 per cent in 1993 compared with 8 per cent the year before. These growth rates fall significantly short of those of 16 to 23 per cent recorded in the booming late 1980s and early 1990s. However, in view of the deep recession, which commenced at the end of 1990 in robot-using countries and resulted in large reductions in investment and industrial employment, growth in the robot stock, of 6-8 per cent, is still quite impressive.

Japan accounts for more than half of the world's robot stock. However, the net increase in Japanese robot stock fell sharply in both 1992 and 1993. In 1993, the net increase in the robot stock was only about a third of the record year of 1990, underscoring the depth of the Japanese recession. On a worldwide basis the net increase in the robot stock amounted to some 36,000 units in 1993 compared with the record 73,000 units in 1990.

In terms of volume, worldwide sales (shipments) of industrial robots in 1993, as compared with 1992, fell by 3 per cent. The trough, however, occurred in 1992 when sales fell by almost 26 per cent.

#### **Increasing robot density in industry**

With 325 robots for every 10,000 persons employed in manufacturing, Japan had by far the world's highest robot density followed by Singapore with 109, Sweden with 73, Italy with 70 and Germany with 62. As a result of falling employment in the manufacturing industry in 1992-1993, robot density increased rapidly in many countries even though the robot stock increased only modestly.

#### **The motor vehicle industry is the largest robot user**

The motor vehicle industry is the largest robot user in France, Poland, Singapore, Spain, Sweden, Taiwan

robots are now being installed in the electrical industry. Province of China and the United Kingdom, where its share of the total robot stock varied between 35 per cent (Sweden) and 57 per cent (Spain). In Japan, however, more than in the motor vehicle industry.

In the transport equipment industry there were about 1,000 robots for every 10,000 persons employed in Japan. In France, the United Kingdom and Sweden the numbers in the transport equipment industry were 110, 63 and 167, respectively.

#### **Welding is the predominant application area**

In most countries, welding is the predominant application area for robots, particularly for major motor vehicle producing countries, accounting for a share of the total robot stock exceeding 20 per cent. In a few countries machining was the largest application area. Assembly was the largest application area in Japan, accounting for 40 per cent of the total stock of robots. It is worth noting that in Japan assembly accounted for 50 per cent of the net increase in stock while welding only had a share of 9 per cent.

#### **After a solid recovery in 1994, the robot market is forecast to boom in the period up to 1998**

Based on macroeconomic forecasts of the development of world economies the UN ECE and IFR forecast that the world stock of industrial robots will increase from some 610,000 units at the end of 1993 to over 830,000 units at the end of 1997. As in the same time the number of personnel in industry in the best of cases will be stable or only grow modestly, the density of robots measured as the number of robots per 10,000 workers will continue to surge. In terms of units, shipments are estimated to increase from about 54,000 units in 1993 to over 103,000 units in 1997.

While the robot market will continue to be somewhat hesitant in Japan in 1994 and 1995, it will boom in the United States, western Europe and the dynamic Asian economies. As from 1996, the market will also gain momentum in Japan, following rapid increases in gross fixed capital formation in industry. Under the assumption that world economic growth and world trade gain momentum as from 1995 as forecast, the prospects for robotics business seem extremely bright.

The potential for expansion of robotics is enormous. If other industrialized countries were to approach the robot densities of Japan and if industry in general were to reach only half the robot density of the motor vehicle sector, the robot stock would increase many fold and this is not counting the potential for robots in the service industries. The following examples give an illustration of the potential. If industry in France and the United Kingdom were to achieve a robot density half that of the motor vehicle industry in those countries, the robot stock would more than double. If it reached half the density of the Japanese motor vehicle industry, the robot stock in those countries would increase more than 20 times.

\* World Industrial Robots 1994—Statistics 1983-1993 and Forecasts to 1997. Sales No. GVE 94.024, New York and Geneva 1994, United Nations Sales Section, Palais des Nations, CH-1211 Geneva 10, Switzerland. Price US\$ 120. For more information about the publication contact United Nations Economic Commission for Europe (UN ECE), Industry and Technology Division, Palais des Nations, CH-1211 Geneva 10, Switzerland, tel +41-22 9173285, fax +41-22 9170178 or the International Federation of Robotics (IFR), Box 5506, S-114 85 Stockholm, Sweden, tel +46-8 7838218 and fax +46-8 6603378.

**Table Forecast:** Gross yearly supply (shipments) of industrial robots and stock at year-end in selected countries and regions, 1989-1993 and forecast for the period 1994-1997

	1989	1990	1991	1992	1993	1994	Forecast 1995	1996	1997
<b>Gross yearly supply (shipments):</b>									
Japan	43,700	60,118	56,775	36,874	33,502	41,000	48,600	56,000	63,500
United States	3,977	4,327	4,466	4,561	6,048	7,000	8,000	9,000	10,000
Western Europe	10,052	12,064	11,920	11,818	10,334	14,000	16,000	16,000	19,000
Other countries	6,029	2,983	2,107	2,766	4,334	5,000	7,000	9,000	11,000
<b>Total</b>	<b>63,758</b>	<b>79,492</b>	<b>75,268</b>	<b>56,019</b>	<b>54,218</b>	<b>67,000</b>	<b>78,500</b>	<b>90,000</b>	<b>103,500</b>
% yearly change	19.5	24.7	-5.3	-25.6	-3.2	23.6	17.2	14.6	15.6
<b>Total stock at year end:</b>									
Japan	219,700	274,210	324,895	349,458	368,054	388,000	411,000	442,000	478,000
United States	37,000	40,000	44,000	47,000	50,000	56,000	62,000	70,000	78,000
Western Europe	54,173	67,762	79,682	91,500	101,834	113,000	125,000	138,000	153,000
Other countries	74,894	77,903	84,188	86,362	90,717	96,000	103,000	111,000	122,000
<b>Total</b>	<b>385,767</b>	<b>459,875</b>	<b>532,765</b>	<b>574,320</b>	<b>610,605</b>	<b>653,000</b>	<b>701,000</b>	<b>761,000</b>	<b>831,000</b>
% yearly change	19.7	19.2	15.8	7.8	6.3	6.9	7.4	8.6	9.2

Sources: UN/ECE and IFR secretariats.

**Figure Forecast-1:** Gross yearly supply (shipments) of robots 1989-1993 and forecasts 1994-1997

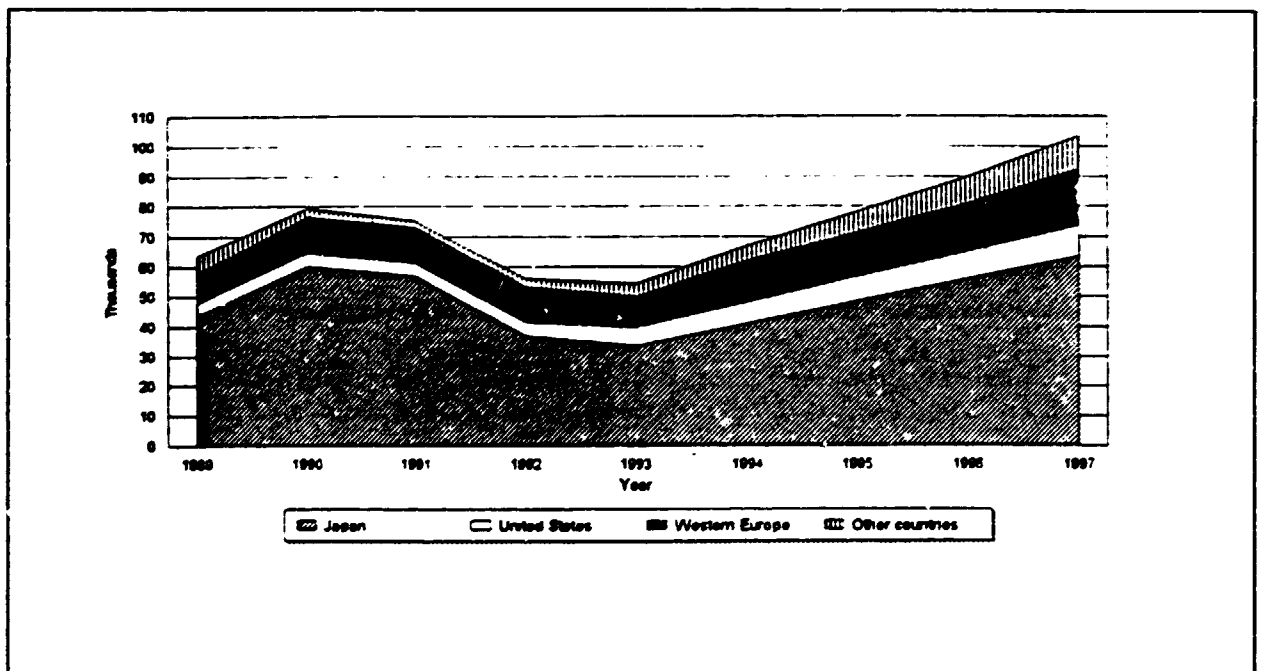
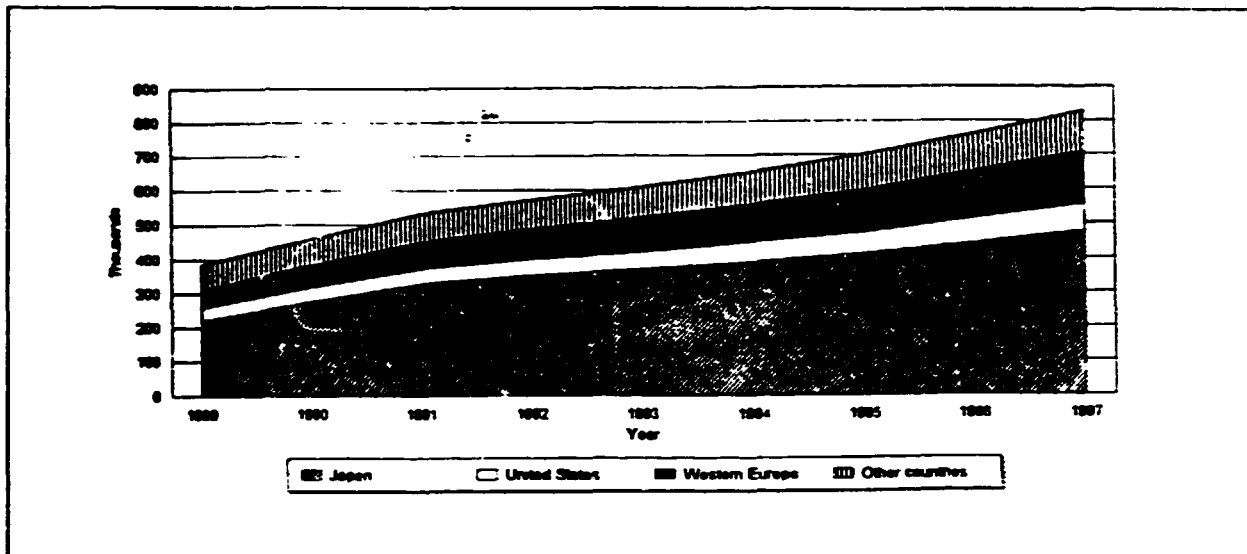




Figure Forecast-2: Total stock of robots at year end, 1989-1993 and forecasts 1994-1997



(Source: UN/ECE Press Release, 4 October 1994)

#### Wireless robot for gas pipe inspection

The Tokyo Gas Co., Ltd. has developed the world's first wireless type robot for inspecting conditions in gas pipes without interrupting the gas flow.

Images taken with a TV camera are transmitted by radio signals to assess the piping condition on the surface by monitoring. Compared with conventional types of wired systems, the inspection cost is slashed to less than one-half and the robot is manufactured at a lower cost. The robot is to be put into practical use in Japan by the end of FY 1995.

This robot system consists of a TV camera unit, radio communications unit, including an antenna, a robot system mounting a battery, and a ground system equipped with a manipulation unit and an image display monitoring system. This system is run along the gas pipes with a diameter of about 150 mm at a speed of 3m/min; and the images of the pipe walls photographed by the TV camera are transmitted to the radio communications unit of the ground system.

Conventional counterparts equipped with a signal transmission cable are movable only over a distance of about 50 m, but the new robot system mounts a battery and uses no power supply cable, so it has a working range as wide as 150 m. In addition, the cable-free design enables the system to be worked with less power, and a compact power conservation type DC brushless motor is mounted. As a result, there is no hazard of sparks generated by the motor, so inspection can be accomplished safely without having to interrupt the gas supply.

The robot system is designed for working with metal pipes with a diameter of 150 mm, but the plan is to improve the system to enable application to pipes ranging in diameters from 100 mm to 200 mm. Further information from Tokyo Gas Co., Ltd., Corporation Communications Dept., 1-5-20, Kaigan, Minato-ku, Tokyo 105. Tel.: +81-3-3433-2111, Fax: +81-3-3437-9130. (Source: JETRO, November 1994)

#### Miniature marine welding robot for sharply curved surfaces

Hitachi Engineering and Shipbuilding Co., Ltd. has developed and will soon market a miniature marine welding robot HI-CURVE for sharply curved surfaces.

Conventional types of welding robots are usable only for welding surfaces which are linear or consist of gentle curves. The new robot uses a laser sensor that measures the angle, position, and curvature of welding surfaces in real time, allowing automated welding of a ship's bow and stern parts, which have till now been difficult. This is the first welding robot capable of welding, for example, the bow and stern outside blocks consisting of plate blocks curved three-dimensionally and the joint parts consisting of flanges.

The hulls of tankers and cargo carriers built at shipyards generally have linear central parts, but the bow and stern parts are tapered increasingly at the ends. At the central parts, the shape is simple, so the welding work has been automated and welding robots are used, but at the bow and stern where the steel plates are curved and sharply rounded, the automation of welding had been quite difficult.

HI-CURVE is fitted with a sensor at the tip for measuring the positions, angles and curvature of the welding faces, which change along the surfaces. The measurement data are sent to a 32-bit controller that controls and adjusts the welding current and speed as well as torch position to appropriate values. The robot consists of a welding power source, control panel, cable feed system, welding torch and carrying vehicle. The robot weighs only 17 kg, and is linked to the power source with a cable 50 m long, so can be moved about conveniently along the hull. Further details from Hitachi Engineering & Shipbuilding Co., Ltd., Public Relations Dept., 1-1-1, Hitotsubashi, Chiyoda-ku, Tokyo 100. Tel.: +81-3-3261-0511, Fax: +81-3201-0522. (Source: JETRO, October 1994)

## I. STANDARDIZATION AND LEGISLATION

### **Standard data evaluation software**

The head of the principal department in the data processing sector for product development with BMW in Munich, Lothar Heggmaier, estimates that annually, Germany's auto industry has to finance well over DM 100 million in additional costs because the exchange of data between manufacturers and suppliers does not operate trouble-free. Simultaneous engineering, for example, the trouble-free access to data for internal and external partners in an optimized development alliance, is not feasible without mastery of product data technology.

At present, however, the exchange of CAD systems electronic design and production data is possible only with qualifications and often entails sizeable problems. According to Dietmar Trippner, the nearly 900 suppliers that are increasingly developing and producing on their own entire modules and subassemblies for Audi, BMW, Mercedes-Benz, Opel and Volkswagen are generating their data with no fewer than 110 different CAD products. Trippner is managing director of PROSTEP GmbH in Darmstadt, the joint German auto and electrical engineering company that was established at the end of 1993. Its aim is the development and introduction of standardized data interfaces for the exchange of all sorts of electronic product data.

Currently what is being used for that purpose is the international standards IGES (Initial Graphics Exchange Specification) for the exchange of graphically-oriented data such as design data and VDAFS (Automobile Industry Association Surface Interface) for the exchange of data on free-form surfaces, for example, on car body parts. They convert only the pure geometric and design data; in the exchange of technological information important attributes and product data like tolerances, materials inputs, computational data and organizational data easily fall through the cracks.

Trippner is aware that such standards are "obsolete and are no longer adequate". According to Detlef Bielohlawek, in charge of CAD/CAM/CAE (Computer-Aided Design/Computer-Aided Manufacturing/Computer-Aided Engineering) coordination at Adam Opel AG in Ruesselsheim: "Better today than tomorrow", and that is the reason for STEP. The acronym stands for "Standard for the Exchange of Product Model Data". It was adopted in mid-1993 by the International Standardization Organization (ISO) as ISO standard 10303. STEP is a neutral format that is independent of producer-specific CAD systems data formats. The exchange requires standardized and comprehensive interfaces, data converters or processors, to translate the data into the uniform and standardized neutral format that any CAD system can read and simultaneously interpret.

It is just this function of the STEP processors, the fact that they not only reproduce data in a specified syntax using the internationally standardized metalanguage EXPRESS but also unequivocally transfer the significance of the data that makes them superior to IGES- and VDAFS-based data converters. Besides graphic and geometric data, STEP processors also convey technological data in designs, for instance, dimensions, tolerances or surface inputs and even master files and organizational

information, subassembly and materials data, computational data up to and including recycling data, job plans and parts lists.

The STEP processors consist of two components: ProSTEP GmbH of Darmstadt is developing and selling as a normalized and standardized interface the neutral component that is identical for every CAD system. For the development of STEP processors, the firm is supplying CAD systems producers, software outfits and end-users a special toolkit program as a tool for software development. The ProSTEP data viewer is customized for the requirements of the auto industry. It entails a viewer for data files in the IGES, VDAFS and STEP standards for UNIX workstations, for example, for input control of exchange data.

CAD software outfits are developing on their own the second component that is specific to the respective CAD systems. The majority of important suppliers are working on ProSTEP processors or already have them on the market. Intergraph, for example, intends to offer a ProSTEP translator for its EMS CAD software package. Siemens-Nixdorf will put on the market a STEP integrator, and in 1995 Hewlett-Packard (HP) will put on the market a ProSTEP-compatible product for the HP PE Solid-Designer. CAP Debis is offering a STEP processor for CATIA (Computer-Aided Three Dimensional Interactive Applications), and Tecnomatix is selling AP-214 based products for the robot simulation software ROBCAD. (Source: *Ingenieur Digest*, October 1994)

### **PowerPC trio to agree standard PC platform**

Sources close to Apple, IBM and Motorola say the firms will produce special chips that will adapt current PowerPC designs to the new PowerPC platform standard announced by the trio in late 1994 and will enable a variety of operating systems to run on the platform.

The three US companies have agreed to develop a single PowerPC-based computer architecture in a bid to make the PowerPC a credible alternative to the Intel-powered personal computer.

The open reference platform, which will be available to any PC and software company, uses aspects of the Apple Macintosh and the current IBM and Motorola PowerPC reference platform and will support the Mac OS 2, AIX and Windows NT operating systems.

The specifics of the architecture will be released to key partners over the next year. (Extracted from *Electronics Weekly*, 9 November 1994)

### **Extensions for MPEG-2**

MPEG committee chairman Dr. Leonardo Chiariglione says four extensions to the MPEG-2 video compression standard are being developed for the end of 1995.

Groups are working to add: 10-bit video coding for improved picture quality; a non-backward compatible mode to allow, for example, non-MPEG audio compression techniques such as Dolby Labs AC-3 to be used; protocols for the control of remote storage media such as video-on-demand servers; and a real-time MPEG interface. (Source: *Electronics Weekly*, 5 October 1994)

### **Discs away!**

Never has high-speed local area network (LAN) technology promised so much. Well-timed technical data transmission breakthroughs have forced the influential US standards bodies to create a number of standard technical specifications for the next generation of 100-Mbit/s LANs.

With many of the largest networking suppliers hedging their bets and developing a number of different products to different standards, the ball is very much in the user's court again.

It now looks almost certain that the LAN market will have around half a dozen standard technical specifications. By the second quarter of 1995 the IEEE in the US will be well on the way to ratifying two different, and non-compatible, protocol standards for 100-Mbit/s on unshielded-twisted pair (UTP) LANs.

The first is a 100-Mbit/s upgrade to the existing 10-Mbit/s Ethernet 10Base-T protocol (IEEE802.3) dubbed fast-Ethernet. This is coming under pressure from an alternative proposal, the 100VG-AnyLAN protocol (IEEE802.12), backed by Hewlett-Packard and AT&T, which, like 100Base-T was put to a letter ballot of the IEEE members in August 1994. Only minor refinements are expected and both standards should be fully ratified within six months.

Both standards have significant support and both are intended to get quickly into the market to meet a need for greater data throughput on existing Ethernet and Token Ring LANs.

But their adoption must happen quickly if they are not to lose out to the first low-cost LAN systems based on the ATM (asynchronous transfer mode) broadband protocol which is rapidly gathering momentum.

At the same time there is the alternative for LAN managers with capacity problems to upgrade their networks with switched network technologies. These remove the bottleneck problems of the shared Ethernet protocol, by installing a network switch which allocates a virtual

10-Mbit/s bandwidth to each user. The network is partitioned into a number of virtual smaller networks each with the full 10-Mbit/s available. Collisions and network contention are arbitrated at the switching hub.

The key to the success of the 100-Mbit/s to the desktop is going to be the ease with which the new protocols can be blended into existing LANs of which around 70 per cent are 10Base-T Ethernet running on unshielded twisted pair (UTP) cables. (Extracted from *Electronics Weekly*, 6 October 1994)

### **Superhighway needs 14 standard interfaces**

DAVIC, the "superhighway" standards grouping involving more than 150 telecoms, consumer electronics, computer and broadcast firms, has identified 14 standard interfaces which need to be specified to enable open video-on-demand systems. DAVIC has issued a formal call for proposals for these interface standards and also proposals on how the work could be extended to cover other interactive services such as home banking and shopping. (Source: *Electronics Weekly*, 21 September 1994)

### **CRADA for probe microscopy standard**

VLSI Standards (San José, CA.) and the National Institute of Standards and Technology (NIST, Gaithersburg, MD.) have formed a Cooperative Research and Development Agreement (CRADA) for the development of advanced calibration standards for scanning probe microscopes.

The work on this project is related to the development by NIST of a calibrated atomic force microscope (C-AFM) and the multi-generation evolution of surface topography standards developed by VLSI Standards. The development team at VLSI Standards will be led by J. Jerry Prochazha, director of metrology, while the NIST group will be headed by Drs. Jason Schneir and Thomas McWaid. (Extracted with permission from *Semiconductor International Magazine*, September 1994. Copyright 1984 by Cahners Publishing Co., Des Plaines, IL, USA)

## J. RECENT PUBLICATIONS

### ***Journal disposal or, what can I do with all these journals?***

Librarians should actively seek alternatives to throwing away duplicate journals. First of all, they should make a list of duplicates and send them to other libraries, who can select ones they want, and refund the postage. Lists can be sent to libraries or distributed over the Internet.

There is also the option of sending journals to developing countries, via two schemes. The International Campus Book Link (ICBL) matches up demand for journals from university libraries in Africa to the surplus materials held by libraries and individuals in the UK. It is administered by Book Aid International. A database of needs is kept and offers are matched to that database.

A second option is the International Exchange of Duplicate Medical Literature (IEDML). This is a scheme administered by the library of the World Health Organization in Geneva. Libraries which are members of the scheme send their duplicates lists to the WHO in Geneva. The WHO copy the list and send it to other members, who then contact libraries directly. Another option is the British Library operated Booknet which, though geared to books, can handle journals, seeming to concentrate on annuals or runs of a title.

### ***Three of a kind: new information-providing technology***

Three packages have recently been released designed to make providing scientific and technical information easier. All three are designed to make the process easier to the users of their respective systems, hoping to broaden their appeal and attract professionals and non-professionals alike.

ESA-IRS, the European Space Agency host which helped to pioneer on-line information, has launched Windows software to make its service much easier to use. BRAQUE (BRowse And QUery) complements existing Common Command Language and menu-driven search options. Initially after logon, the system displays a list of subject categories or sectors. Selection of a sector launches a window in the lower half of the screen which contains the list of all relevant databases. Once this has been done, a list of fields relevant to the files that have been chosen is displayed. Search terms can then be typed in for each particular field.

SciFinder, a graphical user interface and search application for accessing its databases, was announced by Chemical Abstracts Service. Designed to work on either a Windows or Macintosh platform it is intended to make CAS data much more easily accessible than previously to end-user scientists. There are three metaphors for searching which correspond to the majority of search strategies needed by end-users: "Explore", "Browse" and "Keep me posted". If, for example, a researcher wanted to know the papers available and written by a particular author, the Explore function could be invoked to check the CAS databases for a list. The Keep Me Posted function is a basic current awareness service which the user can customize to personal requirements.

### ***Internet starter guide***

The basic tools to access resources on the Internet are Telnet and ftp (file transfer protocol). Telnet provides the

ability to log on to a remote computer by emulating a terminal on that computer, and ftp provides the ability to move files between the user's computer and the remote computer. Both suffer from the problem that they are command-driven and therefore require the user to know the exact names of Internet hosts, and the directories and files on those hosts.

One of the first of a new generation of software tools was Gopher, developed in 1991. It provides a simple menu-driven front-end to resources. Newer is the World Wide Web, which provides a graphical interface to the Internet. The Web is a client-server system, that is, it requires users to run client software, such as Mosaic or Lynx, on their computer. A disadvantage for users with dial-up access is the time taken to download the large number of graphics often provided by Web servers.

Publishers have begun to recognize the potential of the Internet. In addition to publishers of computing or information titles, such as Learned Information or O'Reilly, non-specialist publishers such as Cambridge University Press (CUP) and Pluto Press are providing information services. The CUP Gopher provides general information about CUP, including how authors should present typescripts and to whom they should send them, and lists of agents and stockists. Both the gopher and the Web provide access to a database of the CUP complete catalogue.

### ***The Internet in 1994: new interfaces and databases***

The options for access to the Internet have grown by leaps and bounds. Major consumer on-line services have made moves towards offering increased Internet services, following Delphi's success. America Online has been moving the most quickly in that direction, but CompuServe has also announced plans for offering Internet services. Many smaller Internet access providers have doubled in size, and new providers have appeared. SLIP, PPP, and ISDN connection options are becoming more common, as are customized interfaces. The easier and more diverse Internet access options have been complemented in the past year by more robust network interfaces and new network applications.

In terms of interfaces, 1994 has been the year of Mosaic and the World Wide Web, but Mosaic is by no means the only option for World Wide Web clients. Cello, developed at the Cornell University Legal Information Institute, runs on MS-Windows and does not require the 32-bit add-on that the latest version of Mosaic needs. Other companies and organizations have also been busy developing new W3 clients, for example EIn-It's WinWeb.

New databases, FAQ's, Gopher servers, newsgroups, mailing lists, and Web pages have all appeared in the past year. Many organizations that previously offered a Gopher server have now brought up a Web home page. One of the most exciting developments of the past year came from the UnCover company, in the shape of its Reveal current awareness service. The Reveal service sends ASCII versions of table of contents entries to an individual's e-mail address. The message can then be used to order individual articles from UnCover.