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**EMERGING  
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***Information  
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## EMERGING TECHNOLOGY SERIES

**INFORMATION  
TECHNOLOGY**  
3/1997

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*Intelligent Technologies: New  
Opportunities for Modern Industry*  
by Alexander R. Kornilov

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## TO OUR READERS

The special article of this issue of **Information Technology** is presented to our readers as an experiment. It deals with four approaches in "soft computing". The form of presentation, however, is the subject of the experiment. Usually, this journal provides articles on applications of a technology, without attempting to enter into details of the methods on which those applications are based. This time, however, the article contains brief and popular descriptions of each method along with presentations of applications the method facilitates. Even a popular presentation of these new methods requires some knowledge of mathematics, which would not necessarily be expected from all our readers. For those who find it boring to go through mathematical details and would like solely to be informed on the applications, I would recommend skipping over the more formal parts of the text. Those parts are grouped in separate paragraphs.

On the other hand, it is not so easy to find a compact publication presenting all these methods together. I know from my contacts as a UNIDO staff member that a keen interest exists for "soft computing" methods. In particular, the spectacular success of Japanese industry in the applications of fuzzy sets has focused the attention of policy makers and researchers in developing countries on the subject. This article therefore contains an extended bibliography that enables further reading for those who need more detailed information. In this context, it should be added that the rough sets 15 years junior to fuzzy sets seem to be extremely promising. The methods overlap and a comparison of those can be found in the Dubois and Prades paper published in 1992 by Kluwer Academic Press in the book "Intelligent Support Systems". In my opinion, a distinct advantage of the rough sets over the fuzzy sets is the lack of fuzzyfication/defuzzyfication procedures (presented in brief in the issue paper).

Genetic algorithms is a unique technique. It derives its uniqueness from the process of evolution that is different from all other known processes. Although similar to biological evolution, one cannot say *a priori* whether a solution through evolutionary process will be found through this process that would not have been achieved through other methods. Once a solution is found, one cannot say whether it is an optimal solution. Nevertheless, turbine optimization was a spectacular success of genetic algorithms.

By publishing an experimental article such as this, we would appreciate receiving some feedback from our readers. Any comments on this form of presentation would be welcomed and may be sent to the address given, or by e-mail to [drhind@unido.org](mailto:drhind@unido.org)

Konrad Fialkowski  
Scientific Editor

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tables  
graphs  
diagrams

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## A. SPECIAL ARTICLE

### INTELLIGENT TECHNOLOGIES NEW OPPORTUNITIES FOR MODERN INDUSTRY

Alexander R. Kornilov

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Computer Science Department of  
the Technical University

#### 1. Introduction

Over the last few decades the industrial community's attitude to the ability of computer science to deal with data uncertainty in a human manner has changed from unlimited optimism to a more realistic and pragmatic approach. Ambitions have shifted from the creation of artificial intelligence towards the development of intelligent technologies. The latter are usually considered to be computer methods for solving problems that require any intellectual efforts. The scope of possible applications of intelligent technologies is very wide: automatic control, decision-making, learning, natural languages, scheduling, speech and pattern recognition, games, etc.

A study of recent trends in intelligent technologies reveals the increasing role of "soft computing" as the main methodology for the design and analysis of intelligent systems. The term "soft computing" introduced by L. Zadeh [1] means an approach based on computer algorithms driven by their own inseparable guiding principle, in contrast to traditional "hard computing" driven by a deterministic algorithm (program). The main activities in "soft computing" are centred around the following principal areas: fuzzy logic, neural networks and genetic algorithms (GAs).

The general objective of soft computing methods is to provide a means for adapting to changes in the analysed object behaviour, which is inherent to many real-life problems. Here abundance, fuzziness and incompleteness of knowledge are not disadvantages to avoid, but essential parts of a domain model to obtain the optimal or a sufficient solution within a shorter time period and with less efforts (expenditure) when compared to traditional methods.

The relationship between microelectronics and intelligent technologies can be specified as being special or mutually beneficial. There are two reasons for their partnership. On the one hand, microelectronics as an industry and science, requires carrying out R&D and production methods to match its sophistication. Indeed, the following specific features of microelectronics prove it:

- Microelectronics systems (these are either their products, technological equipment, technological processes or processes of R&D) are so complex that there are no precise deterministic or stochastic mathematical models available. It can occur when some factors affecting a process or their contribution are unknown;
- Time consumed by precise mathematical methods are intolerable;
- Critical importance of the human factor in microelectronics manufacturing that can hardly be captured by traditional methods;

- Extremely high reliability of microelectronics products makes it practically impossible to obtain data samples in a sufficient quality;
- Some parameters of the microelectronics technological process only allow qualitative representation;
- At the beginning of a design process a great deal of expert estimation, discourses in the form of tendencies and heuristics are available without the need for accurate decision-making at this stage.

On the other hand, the progress of microelectronics opens up new opportunities for the application of microelectronics hardware; it stimulates the development of new methods of complex systems analysis and provides manufacturers and designers with the appropriate hardware to implement modern intelligent technologies.

#### 2.1 Fuzzy logic

##### 2.1.1. Basic concepts

Fuzzy logic was initiated in 1965 by Lotfi A. Zadeh [2], a professor of computer science at the University of California in Berkeley, and it is probably the most developed part of intelligent technologies. This theory is based on the extension of traditional (Boolean) binary logic, which is considered inadequate for capturing a domain uncertainty, ambiguities, or a number of exceptions.

Fuzzy logic is basically a multivalued logic that allows intermediate values to be defined between conventional evaluations, such as yes/no, true/false, black/white, etc. Notions such as high or pretty high can be formulated mathematically and processed with a computer. For example, is 50° Centigrade a high or a low temperature of an integrated circuit performance environment? In the real world, the answer "it depends" is common, and in fuzzy logic "some of both" might be the answer, which is that 50° Centigrade is a partially high and a partially low temperature. In this way, an attempt is made to apply a more human-like way of thinking in the programming of computers. Fuzzy logic in this sense provides the designer with a powerful technology for presenting expert knowledge in a more natural and explicit way, almost as in daily life.

This is reached by a more general notion of a set, compared to the classical set theory. In the classical or conventional set theory, the set  $S$  is defined by a function  $f_s$ , called a characteristic function of  $S$ . It maps elements of  $S$  to  $\{0, 1\}$ , so that for  $x \in S$ ,

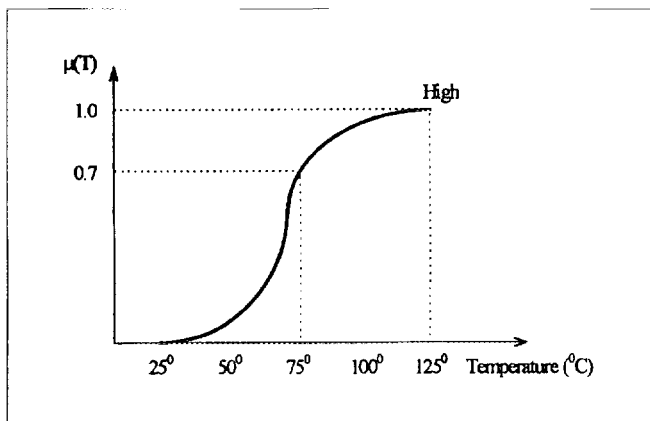
$$f_s(x) = \begin{cases} 1, & \text{if } x \in S \\ 0, & \text{if } x \notin S \end{cases}$$

Therefore, for any element  $x$  of  $S$   $f_s(x)=1$ , if  $x$  is an element of  $S$ , and  $f_s(x)=0$ , if  $x$  is not an element of  $S$ .

In contrast, in fuzzy set theory the set  $S$  is defined by a function  $\mu_s$ , called a membership function of  $S$ . This function maps elements of  $S$  to  $[0,1]$ , so that for  $x \in S$ ,  $\mu_s=1$  means that  $x$  totally belongs to  $S$ ,  $\mu_s=0$  means that  $x$  does not belong to  $S$ , and  $0 < \mu_s < 1$  means that  $x$  belongs to  $S$  with a degree of membership of  $\mu_s$ .

Therefore fuzzy logic recognizes not only "pure" cases (belongs/does not belong), but also infinite gradations in between, assigning numbers (degrees of membership) to them. So, if the membership function of "high temperature" is as in figure 1, then 75°C might be classified as high with a degree of 0.7. Such numbers can be used to obtain exact solutions using imprecise information.

Figure 1. Fuzzy set "high temperature"



2.1.2. Fuzzy decision making (control) process

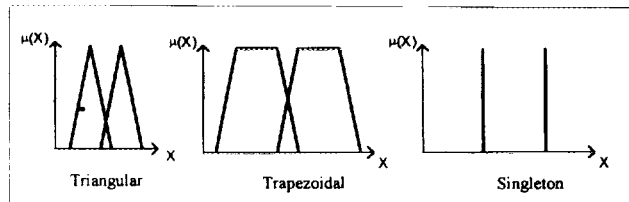
Within the fuzzy approach expressiveness and inherent flexibility are reached by special logic inference on a set of "IF-THEN" rules, which combine antecedents (inputs) and consequences (respective outputs) in such a way as to match a domain—or at least an expert knowledge of it. A set of such rules is called a knowledge base. A control (decision-making) procedure in fuzzy systems usually consists of the following steps: fuzzification, rule evaluation, defuzzification [3].

**Fuzzification** is a procedure for obtaining fuzzy representation of crisp values using a predefined set of membership functions. As soon as such a set is defined, the procedure of fuzzification compares crisp values with the membership functions to determine corresponding fuzzy values. So the first step in the fuzzification procedure is to define linguistic variables [4], i.e. variables with values form a set of artificial or natural language sentences. These sentences are considered as labels of fuzzy sets. For example, a linguistic variable "temperature" can have values "small"—S, "less than medium"—nM, "medium"—M, "more than medium"—pM, or "high"—H.

At the next step of fuzzification for each label of fuzzy sets, corresponding membership functions are defined. Each membership function identifies the range of input values that correspond to a label. Although a precise deterministic procedure is used to process fuzzy rules, fuzziness is introduced by configuring overlap between the antecedent's membership function domain. Therefore, crisp input values can belong to more than one fuzzy set. Fuzzy outputs also have membership functions. Describing crisp inputs in fuzzy terms allows the system to gracefully respond to gradual changes in input. The

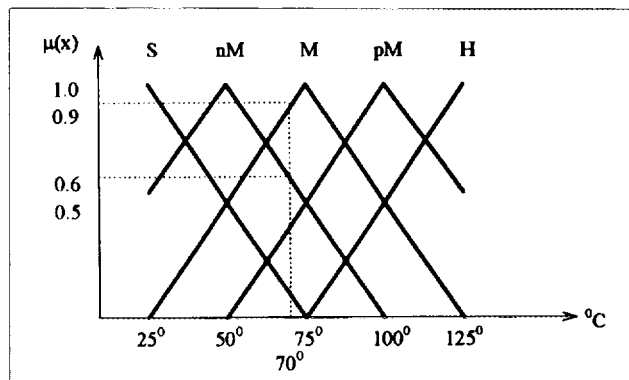
shape of the membership function reflects the subjective opinion of an expert on the system behaviour, or states and affects the fuzzy process in a subtle way. For example, the function's shape directly affects the time and space requirements for a microcontroller performing fuzzification and defuzzification. Membership functions can be of several different shapes (figure 2).

Figure 2. Membership function shapes



Trapezoidal and triangular shapes of membership functions are most frequently used. Membership functions of arbitrary shapes may be more representative, but they require more complicated equations or large lookup tables to be represented accurately. Singletons are easily represented on the computer and require more simple defuzzification algorithms. They are therefore frequently used to represent fuzzy outputs. An example of membership functions of fuzzy sets for the linguistic variable "temperature" is shown in figure 3.

Figure 3. Membership functions for linguistic variable "temperature"



Depending on the shapes of membership functions, various methods are used to represent the functions in a microcontroller. A point-slope representation allows trapezoidal, triangular and singleton functions to be represented with a minimal amount of space and time. A lookup table is a common representation for an arbitrary shaped function. It is the fastest representation in terms of fuzzification, but it requires a lot of memory. Studies have shown that reasonable performance and significant time savings can be obtained using singleton outputs, but the resulting output actions may not represent the response as closely as desired.

**Rule evaluation (fuzzy inference)** is the second stage of the fuzzy logic processing, where linguistic rules are used to determine what fuzzy outputs (control actions, decisions) should occur in response to a given set of input values. In processing of a set of rules, the fuzzy system (algorithm) fires rules with antecedents whose membership functions indicate a non-zero degree of membership corresponding to a fuzzy input generated by a current crisp value of a system input on



the stage of fuzzification. Thus, several rules can be fired at the same time. Fuzzy rules are usually IF-THEN statements that describe the action to be taken in response to various fuzzy inputs. Linguistic rules are confined to a predefined set of linguistic terms and a strict syntax:

IF antecedent 1 AND antecedent 2 ..., THEN consequence 1 AND consequence 2 ...,

where AND is one of the fuzzy logic operators, and the antecedent and the consequence are in the form of:

Antecedent: Input variable is label,

Consequence: Output variable is label.

Rules describe the behaviour of a system and are written in terms of the membership function linguistic labels. For a two-input one-output system, the rules can be represented in the form of a table as in figure 4, where an algorithm of the evaluation of mean-time to the failure of integrated circuit metallization is presented. Here  $\bar{i}$  and  $\bar{T}$  mean the linguistic variables "current density" and "temperature", respectively.

Figure 4. Fuzzy algorithm for evaluation of mean-time to failure of metallization

$\bar{i}$	$\bar{T}$	S	nM	M	pM	H
S						
nM						M
M				M		
pM			pM			H
H						

This fuzzy algorithm consists of four linguistic rules:

- (1) IF current density is pM AND temperature is nM, THEN mean-time to failure of metallization is pM.
- (2) IF current density is pM AND temperature is H, THEN mean-time to failure of metallization is H.
- (3) IF current density is nM AND temperature is H, THEN mean-time to failure of metallization is M.
- (4) IF current density is M AND temperature is M, THEN mean-time to failure of metallization is M.

The next step in the procedure of fuzzy inference is to evaluate the relevance or degree of membership of each rule antecedent. The relevance of an antecedent is determined as a degree of membership of an input crisp value to a fuzzy set of the corresponding antecedent. This is performed for each antecedent of a rule.

Let the linguistic variables for the fuzzy algorithm of evaluation of mean-time to failure of integrated circuit metallization be defined as in figure 4, with fuzzy sets of variables "current density" and "mean-time to failure of metallization" presented in figure 5. Then for the linguistic variable "current density" and inputs of  $6 \cdot 10^2$  A/mm<sup>2</sup> of current density the relevance of antecedents are 0.7 for the fuzzy set "pM", 0.3 for the fuzzy set "nM" and 0.8 for the fuzzy set "M" (figure 5). Following the same procedure for the linguistic variable "temperature" and input of 70° C, the relevance of antecedents are 0.6 for the fuzzy set "nM", 0.9 for the fuzzy set "M" and 0.0 for the fuzzy set "H" (figure 3). At the following step, the degree of truth (rule strength) for each rule is to be determined as the smallest strength value (relevance) of the rule antecedents. The strengths of the rules of the algorithm presented above, when crisp input values are  $6 \cdot 10^2$  A/mm<sup>2</sup>, a current density and 70° C for temperature, are:

- (1)  $\min\{0.7, 0.6\} = 0.6$
- (2)  $\min\{0.7, 0.0\} = 0.0$
- (3)  $\min\{0.3, 0.0\} = 0.0$
- (4)  $\min\{0.8, 0.9\} = 0.8$ .

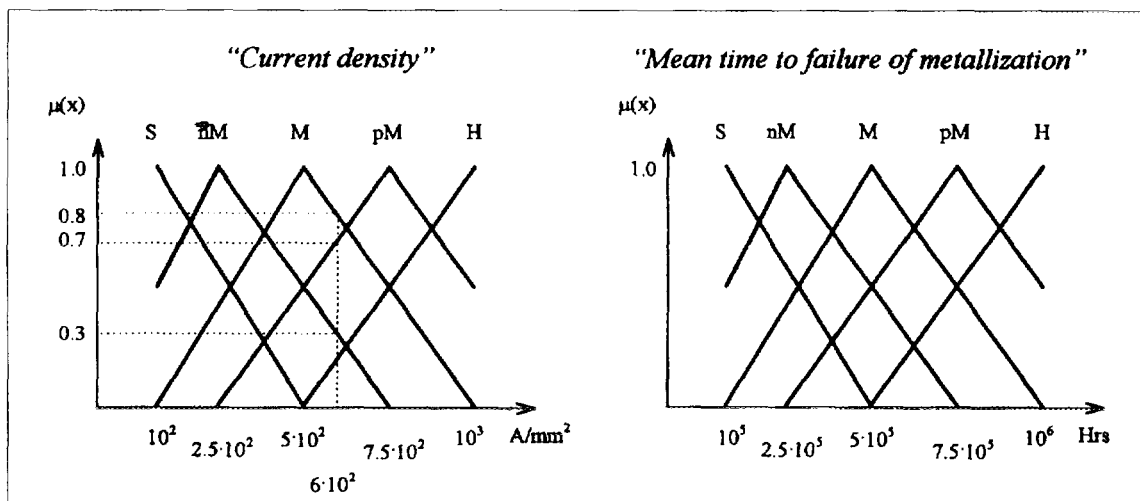
The next step is to determine the fuzzy output by comparing the rule strengths of all rules that represent the same consequent label (output action). When there are several rules with the same consequent label, the fuzzy output is determined as the largest rule strength of all such rules. This procedure produces one fuzzy output membership function label. For the fuzzy algorithm presented in figure 4, the fuzzy output for the given crisp inputs ( $6 \cdot 10^2$  A/cm<sup>2</sup>, 70° C) will be mean-time to failure of metallization is pM

(0.6) OR M (0.8).

So the main steps of the rule of inference described (min-max inference) are the following:

- Describe the system behaviour in terms of IF-THEN rules;
- Apply fuzzification procedure for current crisp input values to determine the degree of truth of each antecedent;
- Determine the strength of the entire rule as the minimum of the antecedent degrees of truth;

Figure 5. Fuzzy sets used in algorithm of evaluation of mean-time to failure of metallization

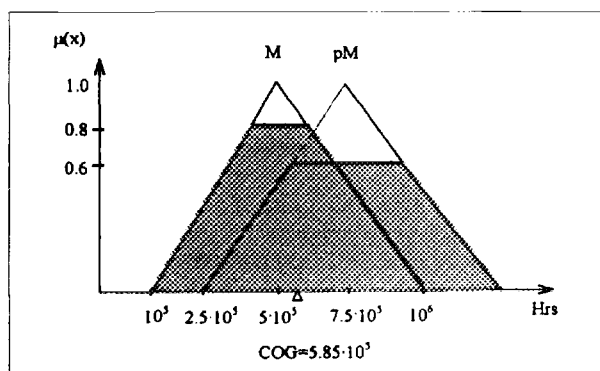


- Find the fuzzy outputs which are equal to the maximum rule strength for each consequent label.

During the last stage—**defuzzification**—a single crisp output action is obtained. There are mainly two algorithms: the mean of maxima and the centre of gravity procedures. The first one takes the smallest  $x_1$  and the largest  $x_2$  of the elements which give the maximum membership value, and calculates the mean of the two.

One of the most frequently used defuzzification methods is the centre of gravity (COG) or centroid method. According to this method each output membership function is truncated above the value determined by its respective fuzzy output. Since all resulting membership functions are determined, they are combined according to OR (operator) as the union of corresponding fuzzy sets. The union of two fuzzy sets A and B with membership functions  $\mu_A(x)$  and  $\mu_B(x)$ ,  $x \in U$  is a fuzzy set  $A \cup B$  with the membership function  $\mu_{A \cup B}(x) = \max(\mu_A(x), \mu_B(x))$ ,  $x \in U$ . In the example under consideration, the output membership function appears as shown in figure 6 (the shaded area).

**Figure 6. Output membership function of mean-time to failure of metallization**



The next step is to find the centre of gravity of the shaded area as:

$$COG = \frac{\int_a^b \mu(x)x dx}{\int_a^b \mu(x) dx}$$

More practically, an estimation of COG is calculated over a sample of points in the output domain with a step size large enough to achieve the appropriate accuracy:

$$COG = \frac{\sum_{x=a}^b \mu(x)x}{\sum_{x=a}^b \mu(x)}$$

Frequently used singleton output membership functions considerably simplify the defuzzification procedure. In this case truncated singleton values of output membership functions are combined using a weighted average.

By applying the COG method to the output membership function of mean-time to failure of metallization, the crisp value of  $5.85 \cdot 10^3$  hours is obtained (figure 6).

**2.1.3. Fuzzy control**

The development of the fuzzy logic theory has stimulated alternative ways of solving automatic control problems. Based on ideas of fuzzy logic, Mamdani and Assilian [5] proposed fuzzy controllers that describe human control in a linguistic form. As a result the first applications of fuzzy control were to replace human operators, but it is only recently, since about 1990, that the interest in fuzzy control has strongly increased, because of the successful fuzzy control of industrial processes, and the success and advertisement of Japanese consumer products. Table 1 [6]

**Table 1. Degrees of sharpness and vagueness for main elements in process automation. Intensity of a property: +++large; ++ medium; + small**

Automation elements	Degree of sharp and vague information	
	Crisp	Fuzzy
<b>1. Input Variable</b> - Usual sensor - Low-cost sensor - Non-directly measurable variables - Linguistic	Precise Values +++ + ++	Imprecise Values ++ + +++
<b>2. Process Classes</b> - Mechanical processes - Electrical processes - Thermal processes - Chemical processes - Biological processes	Quantitative Knowledge ++ ++ ++ + +	Quantitative Knowledge + + + ++ ++
<b>3. Automation function</b> - Control - Supervision - Management - Man-machine interface	Precise Algorithms ++ + + +	Rules + ++ ++ ++
<b>4. Output-Variable</b> - Actuator - Operator	Precise Values +++ +	Imprecise Values ++

contains estimations of degrees of sharp and vague information for the main elements in process information: the input variables, the process classes, the automation functions and the output variables indicate the reasons for applying fuzzy logic to control.

According to [6], some advantages of fuzzy control can be summarized as follows:

- For processes where no sufficient control performance can be reached with PI- and PID-controllers and parameter adjustment by tuning rules, fuzzy control may be an alternative. This is especially valid for processes with difficult to understand behaviour, if only qualitative knowledge is available and strongly non-linear properties exist.
- If manual control is possible the operator's knowledge can be formulated in fuzzy rules with linguistic inputs and outputs.
- An additional advantage of the fuzzy control concept is a fast prototyping by a few rules, if the classical standard controller is not suitable.

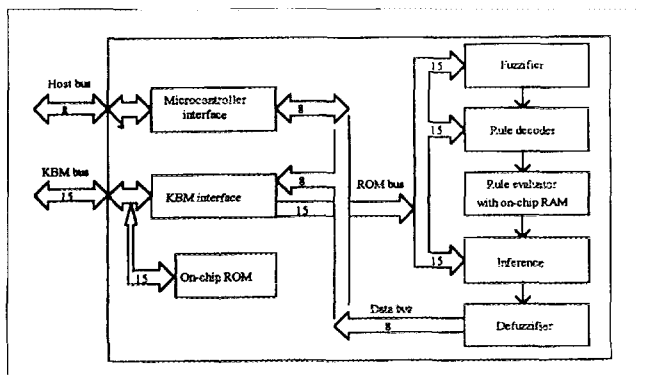
A comprehensive review of different fuzzy control architectures can be found in [6].

#### 2.1.4. Fuzzy logic applications

Nowadays fuzzy logic algorithms are widely used in microcontrollers, e.g. fuzzy coprocessor SAE 81C99 of Siemens [7]. The coprocessor is able to process within one control cycle up to 256 8-bit inputs and to form up to 64 output control signals using a programmable knowledge base containing up to 16,384 rules. The coprocessor is manufactured by 1 micron CMOS technology, and having a frequency of 20 MHz, it is able to process 7.9 million rules per second. The coprocessor is shown in figure 7.

Fuzzy logic has emerged as a profitable tool for controlling subway systems and complex industrial processes, as well as for household and entertainment electronics, diagnosis systems and other expert systems.

Figure 7. Architecture of a fuzzy logic coprocessor



The following is a short list of examples of fuzzy logic applications sourced from the World Wide Web (<http://www.mitgmbg.de/erudit>):

- Automatic control of dam gates for hydroelectric power plants (Tokyo Electric Power).
- Preventing unwanted temperature fluctuations in air-conditioning systems (Mitsubishi, Sharp).
- Efficient and stable control of car-engines, cruise-control for automobiles (Nissan, Subaru).
- Positioning of wafer-steppers in the production of semi-conductors (Canon).

- Optimized planning of bus timetables (Toshiba, Nippon-System, Keihan-Express).
- Prediction system for early recognition of earthquakes (Institute of Seismology, Bureau of Metrology, Japan).
- Medical technology: cancer diagnosis (Kawasaki Medical School).
- Recognition of handwritten symbols, objects, voice (Sony, Hitachi, Hosai University).
- Recognition of motives in pictures with video cameras; back light control for camcorders; compensation against vibrations in camcorders (Canon, Minolta, Sanyo, Matsushita).
- Automatic motor-control for vacuum cleaners with recognition of surface condition and degree of soiling (Matsushita).
- Controlling machine speed and temperature for steel-works (Kawasaki Steel, New-Nippon Steel, NKK).
- Controlling subway systems in order to improve driving comfort, precision of halting and power economy (Hitachi).
- Improved fuel-consumption for automobiles (NOK, Nippon Denki Tools).
- Improved sensitivity and efficiency for elevator control (Fujitec, Hitachi, Toshiba).
- Improved safety for nuclear reactors (Hitachi, Bernard, Nuclear Fuel Division).

Practice of fuzzy logic application reveals that it results in a better performance, lower power consumption, higher degree of adaptability and higher autonomy. Its current state makes it possible to say that the "fuzzy logic industry" really exists.

## 2.2. Neural Networks

### 2.2.1. Basic concepts

In the 1950s, many aspirations for artificial intelligence researchers dealt with the conception of perceptron developed by F. Rosenblatt [8,9], but at the end of the 1960s, they were ruined by M. Minsky and S. Papert [10]. Since the end of the 1970s, there has been a growing interest among scientists for neural models, which are the further development of artificial intelligence.

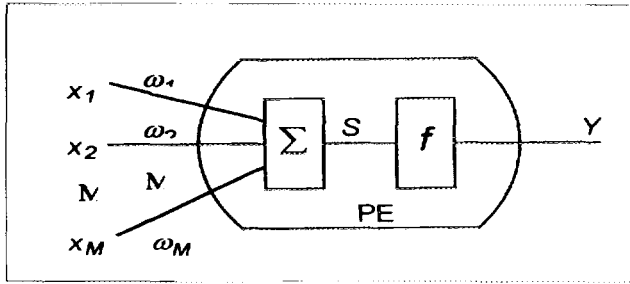
Neural networks, unlike fuzzy systems, do not require explicit representation of process knowledge in a set of rules. Being a highly interconnected non-linear system, neural networks elicit knowledge (learn) directly from a set of input/output data examples (training data) that represent the process behaviour. This is an important feature, which perfectly matches the problem of developing complex systems that are adaptive to changing input conditions. Moreover, neural networks are very helpful when dealing with incomplete or noisy input signals because they can extract knowledge from incoming data which is only partially similar to the training data.

The areas most suitable for neural network applications are:

- Pattern recognition (classification);
- Function estimation;
- Feature extraction and filtering;
- Data compression and decompression;
- Statistical analysis.

Neural networks, as one of the intelligent technologies, were inspired by the human brain and neurones. Neural network models consist of neural elements (figure 8) and are based on the activities of processing elements (PE)—"nodes", strengths of connections among the nodes ("weights"), and techniques for adapting the connection strengths in order to improve network performance over time [11].

Figure 8. Neural element



A processing element (PE) in a neural net can receive many inputs:  $x_1, x_2, \dots, x_M$  (or an input vector  $X$ ), and generates one output  $y$  that is some non-linear function  $f$  of its inputs. The operations performed by the processing element depends upon the type of neural network algorithm used. Usually it aggregates its inputs as a weighted sum with weights:

$$S = \sum_{i=1}^M w_i x_i$$

$w_1, w_2, \dots, w_M$

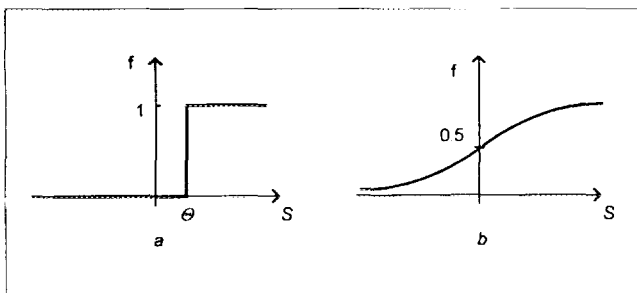
where weights are associated with the interconnections between processing elements and generates an output  $y=f(S-\Theta)$  if this aggregation is above some threshold value  $\Theta$ . Usually the simplest non-linear functions are used: binary function (threshold function, hard limiter) (figure 9a) that provides the PE with a digital output:

$$y = \begin{cases} 1, & \text{if } S > \Theta \\ 0, & \text{if } S \leq \Theta \end{cases}$$

or sigmoid function that provides an analog output (figure 9b)

$$y = \frac{1}{(1 + e^{-(s-\Theta)})}$$

Figure 9. Typical non-linear functions

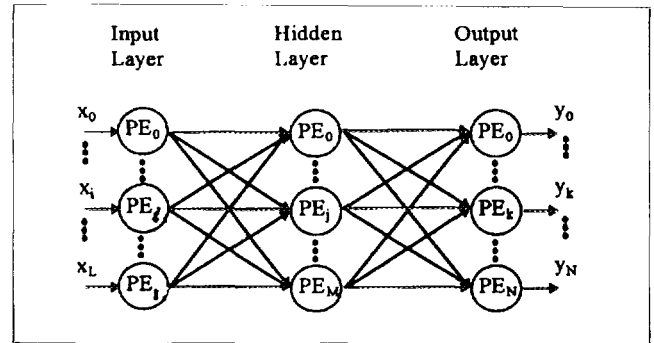


The processing element is said to “fire” if sufficient excitation is applied to its inputs.

Processing elements are connected into complex arrangements depending on the type of neural network architecture implemented. The most common neural network architecture is the three-layer network (figure 10), which usually consists of an input layer (one node for each input variable), an output layer (one node for each output) and a

middle or “hidden” layer in which the number of nodes is a configurable parameter that has a significant influence on the performance of the network.

Figure 10. Neural network with three layers



One of the main features of neural networks is their self-organization and self-adaptivity. Some training is required before a neural network can be used. During this training process, input data (also called training data) is presented to the network and the connection weights at each PE are adjusted based on a mathematical algorithm called a learning law. Learning can be supervised or unsupervised. In supervised learning the network is presented with inputs and the desired outputs. The weights are then adjusted to minimize the error between the actual output and the desired output. An example of supervised learning is the backpropagation network.

In unsupervised learning only input data is presented to the network. Here, the learning law provides information that allows the network to modify itself based solely on features in the input data. Examples of unsupervised learning are self organizing maps and learning vector quantization networks.

The most widely used learning laws are listed below.

*Hebb's rule* states that if the connected neurones fire, the connection should be strengthened. This learning rule is the foundation of most learning techniques used in artificial neural networks.

*Generalized delta rule.* This rule is also known as the least mean square (LMS) learning rule since it minimizes the mean square error. It is based on the idea of modifying the strengths of connections to reduce the difference between the desired output value and the current output value of a processing element. The back-propagation technique is the most commonly used generalization of this rule.

*Kohonen's learning law.* This law is used only in unsupervised learning. In this law, processing elements must compete for the opportunity to learn. The PE with the largest output will be the winner and can then either inhibit its competitors or excite its neighbours. Only the winner can have an output and only the winner and its neighbours can adjust their weights. Since the winning element is defined as the one that has the closest match to the input pattern, Kohonen networks model the distribution in the inputs.

After the training process is finished, and the neural network has learned a proper output response, it can be used in its “normal” operating mode in the target application.

### 2.2.2. Neural network model.

Many training algorithms were developed for different neural network models, some of which are described below in more detail.

*Multilayer perceptron*

While the simple (one layer) perceptron defines borders of a decision area in a form of hyperspaces, the two layer perceptron can define any convex area in a space of output signals. As for multilayer perceptrons, they are able to realize any input-output mapping. The back-propagation network (BPN), also known as a multilayer perceptron (MPL) network, is one of the most popular neural network algorithms of this type.

The BPN is a multilayer network requiring that at least two of the layers contain adaptive weights. The input layer distributes the inputs to the hidden layer. The network is typically fully connected, that is, every PE in a layer has a connection to every PE in the subsequent layer (figure 10).

A processing element in a BPN performs a weighted sum of its inputs:

$$S = \sum_{i=1}^M w_{ji} \cdot x_i$$

where:

$x_i$ : is the input to the PE, and

$w_{ji}$ : is the weight from input  $i$  to PE <sub>$j$</sub>  of the following layer.

An output function (a transfer function, threshold function or squashing function) is then applied to the sum of weights. This non-linear function is used to limit the output of the PE. Otherwise, the potential could have a value significantly larger than the input value. This can cause an explosion in the output value when PEs are connected in a cascade manner.

The BPN requires a training data to be presented. The data sample consists of pairs of patterns between which a relation should be determined. In a multilayer perceptron there can be many hidden layers between input and output ones. Each neural element can be connected to any element of neighbour layers, but not to the elements of the same layer. The training of the BPN includes two phases: a forward-propagation or a processing phase, and a back-propagation or learning phase.

During the processing phase, an input vector is presented to the network. The input layer simply passes the inputs to the first hidden layer (multiple hidden layers are allowed, although a single layer is most common). Each PE in this hidden layer performs the weighted sum of its inputs, applies an output function to this aggregation, and passes the result to the following layer. The process is repeated for all layers in the network until the output layer generates an output.

In terms of pattern recognition, an input vector means a set of characteristics (symptoms), but an output vector corresponds to a class of patterns. Here a hidden layer is used for knowledge representation.

During the learning phase, an output error is computed and then propagated back through the proceeding layers. The weights in the layers are adjusted to minimize the error between the actual output and the desired output of each PE.

At the beginning of the learning phase all weights are preset to small random values and a training input vector is presented. Then an output error for each PE in the output layer is computed:

$$e_k = (d_k - y_k) \cdot f' \left( \sum_{j=1}^N w_{kj} \cdot y_j \right),$$

using previously determined values of outputs  $y_j$  for every PE in the hidden layer:

$$y_j = f \left( \sum_{i=1}^M w_{ji} \cdot x_i \right)$$

and the outputs  $y_k$  for every PE in the output layer:

$$y_k = f \left( \sum_{j=1}^M w_{kj} \cdot y_j \right)$$

This error is then propagated back through the proceeding layers by calculating the error for each PE in the hidden layer:

$$\tilde{e}_j = f' \left( \sum_{i=0}^L w_{ji} \cdot x_i \right) \cdot \sum_{k=1}^N e_k \cdot w_{kj}$$

The weights at the output layer and the hidden layer are updated after each presentation of a training input vector:

$$w_{kj}(t+1) = w_{kj}(t) - \xi e_k y_j$$

$$w_{ji}(t+1) = w_{ji}(t) + \xi \tilde{e}_j x_i$$

Here the following notations are used:

- $x_i$ : input  $i$ .
- $w_{ji}$ : weight connecting unit  $i$  in the input layer to PE <sub>$j$</sub>  in the hidden layer.
- $y_j$ : output of PE <sub>$j$</sub>  in the hidden layer.
- $w_{kj}$ : weight connecting PE <sub>$j$</sub>  in the hidden layer to PE <sub>$k$</sub>  in the output layer.
- $y_k$ : output of PE <sub>$k$</sub>  in the output layer.
- $f()$ : output function (typically a sigmoid).
- $e_k$ : error of the output layer.
- $d_k$ : desired output of unit  $k$  in the output layer.
- $\tilde{e}_j$ : error at the hidden layer.
- $f'()$ : derivative of the PE's output function
- $f() \cdot f'(x) = f(x)(1-f(x))$  for a sigmoid function.
- $\xi$ : learning rate (usually a small number between 0.05 and 0.25)

All steps are repeated for all training vectors until the error for all the training vectors is acceptable. With the back-propagation algorithm, multiple presentations of the training set are usually necessary.

In some situations the back-propagation algorithm may not find an optimum solution due to local minima. A local minimum occurs because the BPN learning law is based on a gradient descent function. There can also be other reasons why the BPN may not converge. In this case there is an option to modify any of the design parameters (network architecture: number of layers; number of PEs in a layer; number of inputs/outputs; connectivity between layer bias terms; learning parameters: weight initialization; learning

rate; momentum; training data) and to try the procedure again.

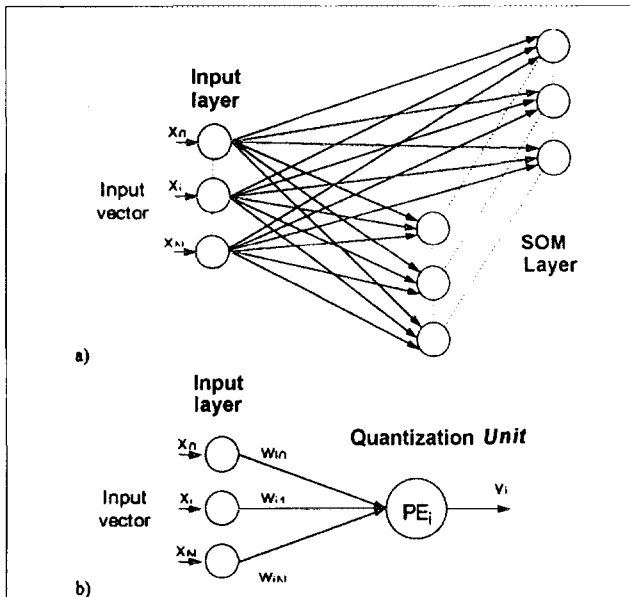
If the network is properly trained, it can be used in its processing phase in the target application. Design flexibility in modifying any number of BPN parameters along with the ability to learn a tremendous variety of complex input-to-output mapping functions from training data make the multilayer perceptron very efficient in different applications.

However, for adequate training, the training data consisting of system inputs and proper outputs must be available and should be carefully selected. Moreover, the learning algorithm is computationally intensive, and for it sometimes to converge to an optimal solution, the multiple presentation (hundreds) of all training data are required. Anyway, this is probably the most popular model of a neural network and is often used for control and optimization.

*Self-organizing maps*

Self-organizing maps (SOM), also called feature maps, were first used by T. Kohonen [12,13] for pattern recognition and classification applications. The SOM is usually a two-layer network (figure 11).

Figure 11. Self-organizing map



The input layer is fully connected to the second layer, which is also called the quantization layer, competitive layer or SOM layer. The input layer passes the input values to the SOM layer. The PEs in the SOM layer are sometimes called quantization units and are organized into a two-dimensional array. The number of PEs in the input layer determines the dimensionals of the input space. The figure depicts an N-dimensional input layer and the weights associated with quantization unit  $j$  in the SOM layer (figure 11b). The weights connecting to a quantization unit also form an N-dimensional vector  $W$ , which is sometimes called a quantization vector.

SOMs use an unsupervised learning law based on competitive learning. Competitive learning allows the units in a layer to compete amongst each other for the right to adjust their weights. The "winning" unit will then make its weights more similar to the input vector. Training of the SOM allows the weights in the SOM layer to fall into clusters (groups)

based on relationships in the input data. The similarities between patterns in the input space are thus mapped into closeness relationships in the weights of the SOM. This has the effect of "projecting" the relationships among patterns in the large-dimensional SOM layer. Patterns in the input space can then be easily visualized in the weights of the two-dimensional SOM layer.

The SOM training algorithm starts with initializing of the weight vector  $W$  and applying a training vector  $X$  to its inputs. Training vectors are presented sequentially to the network. When the input vector is received, the distance  $d_j$  between the input vector and each weight vector is computed:

$$d_j = \sqrt{\sum_{i=0}^n (x_i - w_{ji})^2}$$

The winning PE in the competitive layer, having the smallest distance  $d_j$ , is then selected. The training algorithm then selects the PE that best matches the input vector by finding the weight vector  $W$  that is the closest (in N-dimensional Euclidean space) to the input vector  $X$ , which is declared the winner. After that the weights of the PEs in the neighbourhood  $N_c$  are adjusted

$$w_{ji}(t+1) = w_{ji}(t) + \xi(x_i(t) - w_{ji}(t)),$$

while the weights of other PEs (outside  $N_c$ ) remain unchanged

$$w_{ji}(t+1) = w_{ji}(t).$$

The training algorithm is repeated for all training vectors.

The following symbols are used:

- $x_i$ :  $i$ -th component of input vector  $X$ .
- $w_{ji}$ : weight connecting input unit  $X$  to PE $_j$  in the SOM layer.
- $d_j$ : distance between an input vector and the weights of PE $_j$  in the SOM layer.
- $\eta$ : the learning rate.
- $N_c$ : the neighbourhood around the winning PE.

Kohonen recommends that the learning rate  $\eta$  and the neighbourhood size  $N_c$  around the winning quantization unit be decreased as training progresses. Usually, the pattern is to begin with a larger definition of the neighbourhood and then narrow it as the training continues.

After training is completed, an input vector presented to the network is classified by the PEs that fire in the SOM layer. The SOM network can thus be used for pattern recognition and classification applications.

Self-organizing maps are able to classify large and complex input spaces and its fast training algorithm requires just a few presentations of the training set, but sometimes the SOM can lose some important information in low occurrence pattern. These neural networks are good for problems that require classification of faults and other process states. They can directly capture probability distributions, temporal relationships and other important characteristics of manufacturing systems.

The latest neural systems for manufacturing can train themselves to predict process behaviour using examples obtained directly from on-line process data. All this utility

brings only a modest requirement to specify the internal workings of the system—the system itself is largely able to organize the parameters that it needs to classify on-line data, recognize process states and make predictions. This means that process specialists can implement and manage model-based applications that they never would have attempted using traditional statistical or modelling approaches.

### 2.2.3. Applications of neural networks

At present there are many practical realizations of neural systems in different forms: software products for personal computers or workstations [14,15,16], neural coprocessors connected to a personal computer (or workstation) which increase the size of a modelling network and the system productivity.

Considerable attention is being paid to R&D of hardware for neural systems using modern VLSI technology. Here are some examples of recent VLSI implementations announced at the IEEE International Conference on Neural Networks (ICNN '95):

Self-Learning Analog Neural Network LSI with computational power of 10 MCPS and weight updating rate of more than 40 kHz has been fabricated using 1.3- $\mu$ m double-poly CMOS process [17].

Hardware implementation of multilayer neural network with on-chip learning. Experimental circuit runs with 25 MHz clock, and delivers  $14.6 \times 10^6$  CPS and  $10.9 \times 10^6$  CUP [18].

The compact CMOS VLSI design for recursive neural networks with the capability of hardware annealing which can solve optimization and signal processing problems [19].

Leading electronics companies and research centres (AT&T Bell Labs, Intel, Nestor, JPL, MIT Lincoln Laboratory) also show their significant interest to hardware implementation of neural networks for a wide range of applications. The greatest potential of neural networks is the high-speed processing that can be provided through massively parallel VLSI implementation.

The scope of neural system applications range from pattern recognition and image processing (fully digital VLSI neural system for motion detection from image sequences [20], machine vision for obstacle sensing in cars [21], realization of high-order CMAC model for colour calibration [22]), supervision and control of technical processes (prediction of end conditions of basic oxygen steel-making process [23]) to biomedical applications (ECG classification [24], analysis of multivariable medical images [25]) and business (bankruptcy predictions [26]).

Neural networks and fuzzy logic systems can be combined to capture the best of both approaches, and can therefore be considered as complementary intelligent technologies.

## 2.3. Genetic algorithms

### 2.3.1. Basic concepts

The need to solve optimization problems is a dominant theme in the engineering world. A great number of analytic and numerical optimization techniques have been developed, and yet there are still large groups of functions that present significant difficulties for numerical techniques, and moreover, for analytical methods. These are not continuous or differentiable everywhere, functions which are non-convex, multi-modal, and functions which contain noise. As a consequence, there is a continuing search for more robust optimization techniques that are able to overcome such problems.

Genetic algorithms (GAs) have attracted a great deal of attention regarding their potential as optimization techniques

for complex functions. GAs are a heuristic search method based on the mechanics of natural selection and natural genetics, a form of stochastic production systems. They combine the survival of the fittest among string structures with a structured yet randomized information exchange to form a search algorithm. While randomized, GAs efficiently exploit historical information to speculate on new search points with expected improved performance [27].

Prior to the use of genetic algorithms for search in artificial systems, a number of biologists used computers to perform simulations of natural genetics in the early 1960s. The first mention of the words "genetic algorithm" and the first published application of a genetic algorithm to a game-playing program both came in Bagley's (1967) dissertation. In 1970 Cavicchio in his dissertation "Adaptive search using simulated evolution" applied a genetic-like algorithm to the design of a set of detectors for a pattern-recognizing machine. The first application of GAs to a pure problem of mathematical function optimization was Hollstien's (1971) work "Artificial Genetic Adaptation in Computer Control Systems". Techniques under the name *Evolutionstrategie* were independently developed at the Technical University of Berlin (Rechenberg, 1965).

The present understanding of the term "genetic algorithm" came from a milestone work by John Holland "Adaptation in natural and artificial systems" [28] and De Jong's dissertation "An analysis of the behaviour of a class of genetic adaptive systems", as well as Grefenstette's software GENESIS [29]. These works have formed a theoretical base for artificial system designers that retains the important mechanisms of natural systems.

To solve an applied task, GAs maintain a set of strings (population of "chromosomes"). Each string represents an encoded parameter set, a solution alternative, or a point in the search space. Usually, the natural parameter set of the optimization problem is coded as a finite-length bit string. GAs evaluate a population based on application-dependent criteria, and generate a new one iteratively. A new population of chromosomes is generated using a probabilistic genetic-like operator, called crossover and mutation, with the intent of generating chromosomes that map to high fitness values. In other words, beneficial changes of parents are combined in their offspring, and the GA adapts to the problem being solved. The commonly used generational model of GA is shown below:

#### Procedure GA

##### begin

Generate initial population,  $P(0)$ ;  $t=0$ ;

Evaluate chromosomes in  $P(0)$ ;

##### repeat

$t=t+1$ ;

Select  $P(t)$  from  $P(t-1)$ ;

Recombine chromosomes in  $P(t)$  using genetic operators;

Evaluate chromosomes in  $P(t)$ ;

until termination condition satisfied;

##### end.

GA starts with an initial population of chromosomes chosen at random. By contrast to other search techniques, GAs have no need for auxiliary information about features of search space, they only require the value of an application-dependent objective function to be associated with an individual chromosome. Each member of the initial population must be evaluated using this function. Objective function associates a numerical value (also called a fitness value) with a chromosome, which serves as some measure of goodness that is to be maximized. Further steps of GA are

repeated iteratively until either all chromosomes have the same associated fitness value (convergence condition) or the desired number of iterations is reached. Each iteration of the algorithm consists of two basic steps: selection and recombination. Selection is a process in which chromosomes are copied to the next population according to their objective function values. The recombination usually proceeds in two steps. First, members of the new population are mated at random. Second, each pair of chromosomes is recombined using a crossover operator. Optionally, the mutation operator may be applied to some members of the newly-generated population. Finally, each chromosome in the obtained population undergoes the evaluation.

2.3.2. Example of GA application to optimization problem

Consider the following real parameters optimization problem:

$$\text{Minimize } f(x_1, x_2, \dots, x_N),$$

where each  $x_i$  is a real parameter subject to  $a_i \leq x_i \leq b_i$  for some constants  $a_i$  and  $b_i$ .

The objective of the problem is to find the values of  $x = \{x_i\}$  to obtain the minimal possible value of function  $f$ . GAs have been successful at solving problems of this type that are too badly-behaved (such as multi-modal and non-differentiable) for more conventional hill-climbing and derivative-based techniques.

For example, let the problem under consideration be minimization of the function  $f(x_1, x_2) = x_1^2 + x_2^2$ , which  $-1 \leq x_1 \leq 1$  and  $-2 \leq x_2 \leq 2$ . The first step is to code the parameter vector  $x$  as a finite-length bit string using either a standard binary coding or a Gray coding. The bit strings for the parameters are concatenated together to give a single bit string (or "chromosome"), which represents the entire vector of parameters. Thus, the problem is transformed into a combinatorial problem where the points of the search space are the corners of a high-dimensional cube.

The  $m$ -bit binary code for real parameter  $x$  can be obtained as a binary representation of an integer  $k = [(x-a)/(b-a) * 2^m]$ , where  $[E]$  denotes the closest integer less than  $E$ . Let there be four bits representing each parameter. Then the point  $(0.25, 1)$  would be represented by the bit string 1010 1100 using binary coding.

Gray coding is another way of coding parameters into bits, which has the property that an increase in one step in the parameter value corresponds to a change of a single bit in the code. The conversion formula from binary coding to the Gray one is:

$$\gamma_k = \begin{cases} \beta_1 & \text{if } k = 1 \\ \beta_{k-1} \oplus \beta_k & \text{if } k > 1 \end{cases}$$

where  $\gamma_k$  is the  $k$ -th Gray code bit,  $\beta_k$  is the  $k$ -th binary code bit, bits are numbered from 1 to  $N$  starting from the left, and  $\oplus$  denotes addition mod 2. The conversion from Gray coding to binary coding is:

$$\beta_k = \sum_{i=1}^k \gamma_i$$

where the summation is done mod 2. So, the binary code 1010 1100 corresponds to the Gray code of 1111 1010.

GA starts with an initial randomly generated population of strings and thereafter generates successive populations of strings. Let the initial population of the size  $N=4$  be the following: (1010 1100), (1101 0101), (0011 0110), (0100 1011), where the binary coding is used. To evaluate the initial population, it is necessary to decode each chromosome and to apply an objective function to it. The result of evaluation is shown in table 2.

The selection operator may be implemented in a number of ways. The most popular one is based on a biased roulette wheel, where each slot corresponds to a chromosome in the population and its size is proportional to the chromosome's goodness. The corresponding weights of roulette slots  $p_i$  can be calculated according to the following formulas:

$$p_i = \frac{f_i}{\sum_{k=1}^N f_k}, \quad f_k = \frac{\sum_{j=1}^N f_j}{f_k}$$

where  $f_j$  is the fitness value of the  $j$ -th chromosome.

Each spin of the roulette wheel selects an  $i$ -th chromosome with the probability  $p_i$ . Spinning roulette  $N$  times,  $N$  candidates are determined for a new population subjected to further genetic operators. Let  $p_1=0.17$ ,  $p_2=0.34$ ,  $p_3=0.36$ ,  $p_4=0.13$ . Suppose that values 0.15, 0.3, 0.5, 0.7 were obtained as a result of four roulette spins: the value 0.15 belongs to the first sector of the roulette between 0.0 and 0.17; values 0.3 and 0.5 belong to the second sector (0.17, 0.51); and the value 0.7 belongs to the fourth sector (0.51, 0.87). Thus, chromosomes with numbers 1, 2, 2, 3 are selected. The result of the selection is summed up in table 3.

After selection, a recombination operator is to be applied. Members of the new population are mated at random, for instance the following pairs: (1, 2) and (3, 4). Then each pair of strings undergoes crossing over with the crossover site selected at random, see table 3. According to a simple crossover algorithm, two new strings are created by swapping

Table 2. Initial population of chromosomes

No.	Chromosomes	$x=(x_1, x_2)$	Fitness value $f(x) = x_1^2 + x_2^2$
1	1001 0010	(0.125, -1.5)	2.27
2	1110 0101	(0.75, -0.75)	1.125
3	0110 1100	(-0.25, 1.0)	1.0625
4	1011 1111	(0.375, 1.75)	3.203



Table 3. Result of the selection

No.	Fitness $f(x)$	$f^*(x)$	Expected probability $p_i$	Count from roulette wheel
1	2.27	3.37	0.17	1
2	1.13	6.81	0.34	2
3	1.06	7.21	0.36	1
4	3.20	2.39	0.13	0
Total:	7.66	19.78		
Average:	1.91			

Table 4. Results of the recombination

No.	Population after reproduction	Crossover site	New population	Decoded $x=(x_1, x_2)$	New fitness $f(x)$
1	10 01 0010	2	1010 0101	(0.25, -0.75)	0.625
2	11 10 0101	2	1101 0010	(0.625, -1.5)	2.640
3	1110 01 01	6	1110 0100	(0.75, -1.0)	1.560
4	0110 11 00	6	0110 1101	(-0.25, 1.25)	1.625
				Total:	6.450
				Average:	1.610

substrings starting from the crossover site. For example, consider strings 1 and 2 in the population obtained after selection and crossover site is 2:

10 | 01 0010  
11 | 10 0101

As a result of applying simple crossover two strings of a new population are obtained, as follows:

10 | 10 0101  
11 | 01 0010

The result of recombination: the new population decoded  $x=(x_1, x_2)$  and the corresponding fitness values are given in table 4.

The population average fitness has improved from 1.915 to 1.61 in one generation. The minimum fitness has decreased from 1.0625 to 0.625. This improvement is no fluke. The best string of the first generation is copied twice because of its high performance. When it is crossed with the other one, the offspring inherit the best properties of their parents.

The process is repeated iteratively for a new population until the GA termination condition is satisfied, i.e. when the desired number of iteration is reached or when all strings in the population become identical (convergence condition). The best string in the final population represents the best solution to the problem reached at the moment of GA termination.

### 2.3.3. GA's operators

The genetic operators have a key position in GAs. They are so chosen that manipulating the population leads GA away from unpromising areas of the search space and towards prospective ones, without the GA having to explicitly remember its trail through the search space.

The crossover operator plays a central role in the GAs, and in fact, could be considered to be one of the algorithm's defining characteristics. Numerous investigations have been aimed at finding powerful crossover operators. For a finite-length string representation of chromosomes, the crossover operator produces new strings by exchanging substrings from

the parents. The number of crossover points is usually fixed at a very low constant value of 1 or 2. This decision came from early theoretical works and recommended using a 2-point crossover. However, there are situations in which having a higher number of crossover points is beneficial [30]. Perhaps the most interesting and effective operator (uniform crossover) was introduced by Syswerda [31]. In the uniform crossover the allele of any position in an offspring is copied from the first parent with the probability  $P_0$  and from the second parent with the probability  $1-P_0$ .

For a wide variety of problem domains, such as the Travelling Salesman Problem (TSP) and the Job Scheduling Problem (JSP), it is natural to code solutions as a permutation of integers which represent a sequence of visited cities or a sequence of scheduling operations. The traditional recombination operators for bit string representation of solutions do not work when the solutions are coded as sequences. Obviously, the string that represents a tour of cities must contain exactly one instance of each city label, while GAs traditionally assume that the symbols within a string can be independently modified and rearranged. Therefore, a number of crossover operators were suggested for problems of this class, i.e. for permutation of integers [32].

Consider, for example, the Order Crossover which creates two offspring, preserving the order and the position of symbols in a subsequence of one parent, while keeping the relative order of the remaining symbols of the other parent. Let there be two parents selected for recombination:

Parent 1:  
123|456|78  
Parent 2:  
735|128|46

Two crossover points are chosen at random. The symbols between crossover points are copied from Parent 1 into the same positions of Child 1. Then, starting just after the second crossover point, the symbols are copied from Parent 2, omitting symbols that were copied from Parent 1.

When the last symbol of Parent 2 is reached, the process continues with the first one in Parent 2 until all of the symbols have been copied to the child. The second child is formed in the same way by switching the roles of the parents.

Child 1:  
128|456|73  
Child 2:  
456|128|73

A mutation operator is used for finding new points in the search space to evaluate. Suppose a population containing strings which have  $j$ -th bit equal to 1. The crossover operator cannot change that bit to 0 because it operates with substrings present in the population and it preserves the position of any substring. Thus, mutation could introduce some new features to the population. When mutation is applied to a binary coded chromosome, a random choice is made of some of its bits and they are flipped from 0 to 1, or from 1 to 0. Normally, the mutation rate is very low, so that it would be unlikely to have more than one bit mutated for a string. For the permutation of integers, mutation can be applied by swapping two integers at arbitrarily chosen positions.

#### 2.3.4. Analysis of GAs behaviour

Holland has suggested [28] that a better way of viewing GAs is in terms of optimizing a sequential decision process involving uncertainty in the form of lack of prior knowledge, noisy feedback, and time-varying payoff functions. Holland showed, via his Schemata Theorem, that given a number of assumptions, GA is quite robust in producing near optimal sequences of trials for problems with a high level of uncertainty.

While using GA for solving optimization problems, there is a tendency to treat GA as a tool for function optimization. This, however, is not true. The proper understanding of GA behaviour helps to understand their potential application to any particular problem. Several common viewpoints on GA behaviour were clearly pointed out by De Jong.

The genotypic viewpoint is to consider the contents of the population as a gene collection and study proportions of gene value (allele) over time. It is quite clear that if fitness proportional selection is the only mechanism driving the evolution of GA, an initial population rapidly evolves to a population containing only duplicate copies of the best individual in the initial population. Genetic recombination operators counterbalance this selective pressure by providing diversity in the form of new alleles and new combinations of alleles. When recombination operators are applied at fixed rates, the population evolves to some point of dynamic equilibrium at a particular diversity level. Most of the individuals of this population are identical and represent optimal or near optimal solutions to the problem under consideration.

A phenotypic viewpoint is to focus on the physical meaning of genes. In the optimization example discussed above, the phenotype is the set of pairs of reals  $(x_1, x_2)$  defined by binary strings. By plotting over time positions of the population members on the fitness landscape, it is possible to observe that the population rapidly shifts to a region close to a given point. Frequently, this is an optimal point, but not always, especially for multi-modal fitness surfaces.

The optimization point of view focuses on monitoring the average fitness or the best fitness value of individuals. The plot of the best individual fitness over time looks like an "optimization curve", i.e. it shows that fitness values become ever closer to an "optimal" value. Measurements of that sort have encouraged the view of GA as a tool for function optimization. The genotypic and phenotypic viewpoints show

that the population does not, in general, converge to a steady state containing multiple copies of the global optimum. So, comparing GA with other optimization methods is possible only in terms of obtaining the best decision as a function of the amount of effort involved (the number of trials).

#### 2.3.5. Applications of Gas

GAs have been successfully tried on NP-hard combinatorial optimization problems, such as network link optimization and the travelling salesman problem; they are also of interest by themselves as a primitive model for natural selection. GAs have also been applied to such problems as the design of semiconductor layout and factory control, and used in AI systems and neuromorphic networks to model cognition processes, e.g. language processing and induction. Here are some examples of GA application:

- Multiobjective optimization [33].
- Fault coverage test code generation [34].
- VLSI circuit layout and compacting via GA [35, 36].
- Scheduling multiprocessor tasks [37]
- Assembly-line balancing problems using GA [38].
- Adaptation of robot behaviour [39].
- Transportation problems [40].
- Design of system reliability [41].
- Designing telecommunication networks [42, 43].
- Management of isochronous channels reusing in LANs' [44].

GAs are theoretically and empirically proven to provide robust searches in complex areas. Many examples state the validity of the technique in function optimization, control applications, VLSI design and machine learning. Having been developed as a valid approach to the problems requiring efficient and effective search, GAs are now finding a more widespread application in business, scientific and engineering circles. The reason for the growing number of applications is that GAs are computationally simple yet powerful in their search for improvement. Furthermore, they are not fundamentally limited by restrictive assumptions about the search area (those concerning continuity, existence of derivatives, unimodality, and others). Unlike other search algorithms, the probabilistic primitives that GAs use to manipulate their populations are very fast on contemporary hardware [45].

#### 2.4. Rough set theory

Rough set theory is a relatively new mathematical and intelligent technique introduced in the early 1980s by Pawlak [46]. The technique is particularly suited to reasoning on imprecise or incomplete data and discovering relationships in this data. The primary application of the rough sets so far has been in data and decision analysis, databases, knowledge-based systems and machine learning. The main advantage of the rough set theory is that it does not require any preliminary or additional information about data.

In a sense the rough set theory exploits the same approach as the fuzzy set theory, i.e. revision of the classical set theory. The rough set philosophy is based on the assumption that in contrast to the classical set theory, there is some additional information (knowledge, data) about elements of the universe. But if the fuzzy logic allows gradual and continuous transition of logic or qualitative expressions such as "high", the rough set theory, on the other hand, identifies degrees of significance for input and output attributes and, by means of "quantization", discerns vague information. The rough control also allows descriptive or qualitative expressions.

The basic idea of the rough set theory is in the assumption that elements that display the same information

are indiscernible in terms of the available information and form elementary granules (blocks, classes, etc.) of knowledge. These granules are called elementary sets or concepts and are considered as elementary building blocks of our knowledge. Elementary concepts can be combined into compound concepts, i.e. concepts that are uniquely defined in terms of elementary concepts. Any union of elementary sets is called a crisp set, and any other sets are referred to as rough (vague, imprecise).

Within the rough set theory the two crisp sets called the lower and the upper approximation of  $X$  are associated with every set  $X$ . The lower approximation of  $X$  is a union of all elementary sets which are included in  $X$ , whereas the upper approximation of  $X$  is a union of all elementary sets which have non-empty intersections with  $X$ . In other words, the lower approximation of a set is the set of all elements that surely belong to  $X$ , whereas the upper approximation of  $X$  is a set of all elements that possibly belong to  $X$ . The difference of the upper and the lower approximation of  $X$  is its boundary region. Obviously, a set is rough if it has a non-empty boundary region; otherwise the set is crisp. Elements of the boundary region cannot be classified, employing the available knowledge, either to the set or to its components. Approximations of sets are basic operations in the rough set theory and are used as main tools to deal with vague and uncertain data.

The proposed method of data analysis has several advantages. Some of them are listed below:

1. Provides efficient algorithms for finding hidden patterns in data.
2. Finds minimal sets of data (data reduction).
3. Evaluates the significance of data.
4. Generates minimal sets of decision rules from data.
5. It is easy to understand and offers a straightforward interpretation of results.

Precise mathematical formulations of the above ideas can be found in [46].

### 3. Promising future

Many industrial problems can be solved by combining components of soft computing in different ways. In the solution process they complement rather than compete with each other. Thus, fuzzy logic and neural networks are successfully used in pattern recognition, manufacturing processes, control, etc.

Although fuzzy logic was invented in the USA the rapid growth of this technology started from Japan and has reached the USA and Europe as well. Fuzzy logic is still booming in Japan, and the number of patents applied for is increasing exponentially. Fuzzy logic has become a key-word for marketing. Electronic articles with intelligent components have more opportunities for market success.

In Japan, fuzzy logic research is widely supported with a huge budget. In Europe and the USA, efforts are being made to catch up with the tremendous Japanese success. For instance, the NASA space agency is engaged in applying fuzzy logic to complex docking manoeuvres.

In order to support the development of intelligent technologies and to disseminate knowledge and expertise within the European Union between universities and industry, ERUDIT—the European Network of Excellence in “Uncertainty Techniques Development for Use in Information Technology”—was set up by the European Commission (DG III Industry—ESPRIT programme) in 1995.

In summing up, the following main tendencies characterize the current state of application of soft computing in modern industry:

- Leading microelectronics companies (Siemens, Motorola, Texas Instruments) launched manufacturing of electronic devices implementing intelligent technologies and successfully created the respective market;
- Growing interest and support of R&D in intelligent technologies from governments and international organizations;
- Expansion of activities from pure academic research towards development of industrial applications.

These factors combined together form a powerful vehicle to drive the former extremely exotic and mostly academic science to a promising future of real-life applications.

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## B. NEWS AND EVENTS

### **Wired for development**

The maxim "knowledge itself is power", now holds truer than ever.

In the sixteenth century the inability to read Latin kept the masses far removed from a great deal of knowledge and power. Today, it is the cost of connecting to the Internet that limits access to valuable ideas and information.

UNDP set out four years ago to link individuals and institutions through its Sustainable Development Networking Programme (SDNP). Some 20 developing countries have since established SDNP in Estonia, Nicaragua, Pakistan, Poland, Togo and Tunisia. China, Mexico and 14 other countries will soon join them.

As a result of an agreement between UNDP and the Hewlett Packard Company last August, many of these developing countries will receive additional help. The giant computer manufacturer announced plans to donate equipment and technical support valued at more than US\$ 1 million.

SDNP's niche on the Internet focuses on health, education, women's rights, the environment and employment. Villagers living near Mexico's Patzcuaro Lake, for example, will soon be able to download reports on reforestation in Chad or sound fishing practices. Such information may prove critical in helping local residents strengthen their economy, safeguard natural resources and promote social equity.

The network remains one of people rather than computers. "If residents of a particular village do not have a computer, they can telephone the national SDNP office or send their inquiry by letter", says Chuck Lankester of UNDP. "We will download the data they requested and fax it, post it or simply read it to them over the phone. We use every communication tool we can get our hands on, whether it's a 200 MHz computer, a transistor radio or a donkey with three legs." (Source: *Choices*, January 1997)

### **A new faster Internet takes shape in America. For now, sleek system is for scientists only**

A new Internet is available, although access to it is still strictly limited and its users tend to be astrophysicists, engineers and other specialists.

It is a sleek, capacious, second-generation Internet, and about 100 US computer scientists are using it instead of the crowded old network invented just a couple of decades ago.

The new network, called the Very High Performance Backbone Network Service, is sponsored by the National Science Foundation and built by MCI Communications Corp. using some of its existing fibre-optic networks.

The network links the nation's five academic super-computer centres.

Although the federal Government started the network that became today's Internet, the agencies involved, including the National Science Foundation, pulled out as the public logged on and a commercial industry took shape around the technology.

In April 1995, the foundation signed an agreement with MCI to develop the new Internet. As part of an overall "next-generation Internet" initiative announced by President Bill Clinton in October 1996, government defence and energy laboratories will connect to the high-performance network with the help of AT&T Corp. and Sprint Corp.

Most of the fibre-optic lines are already in place, being part of its national long-distance network. What is new are advanced switches (made by Fore Systems Inc. and Northern Telecom Ltd.) and routers (made by Cisco Systems Inc. and Ascend Communications Inc.).

At the moment, the new network is the domain of scientists. Once a project team gets on, however, others at the same campus with a valid need can use it too. Most campuses connect to the Internet now through connections that can carry 45 million bits, or 45 megabits, of data a second. This month, the figure-eight backbone run by MCI for the National Science Foundation is raising its capacity to 622 megabits a second from 155; this is more than 10 times the present Internet's capacity and more than 20,000 times the capacity of 28,800 bits a second on most computer modems.

Besides carrying vastly more data, the new Internet is different from today's in two other ways: first, users can be guaranteed links among two or more sites at once; second, the ability of distant computers to interact in real time makes the process so complex that even scientists cannot understand it without visualization. Thus, video will be integrated with on-line computing on the new Internet.

For example, people can walk around inside visualizations of, say, a molecule in "the Cave", a three-dimensional virtual-reality stage invented by Thomas DeFanti and Daniel Sandin of the University of Illinois at Chicago.

Users stand inside a virtual-reality theatre while two SG Onyx computers project the model of some complex interrelationships, such as those involving a protein's effect on an antibody.

With a virtual-reality headset, the user sees a three-dimensional image of whatever is being modelled and, using an electronic wand, can manipulate the image, steering the computer's computations. The principle is like that behind a product such as Lotus Notes, which lets remote users work on the same document simultaneously. (Extracted from *International Herald Tribune*, 28 January 1997)

### **The European Union database directive sets the world-wide agenda**

The adoption by the European Union (EU) of the Directive on the Legal Protection of Databases on 11 March 1996 promises to entirely change the legal status of databases, not only in the EU, but world-wide. Previously, most countries required that a work display originality and creativity in order to attract protection, and collections of data were not held to exhibit these characteristics. The directive, however, establishes an entirely new intellectual property right ("*sui generis*").

Database creators can obtain protection for their compilations for a period of 15 years. Subcontractors are explicitly excluded from the definition of "database maker". To obtain protection, database makers must be nationals of an EU member State, or have their habitual residence in the EU. The "*sui generis*" right can be extended to databases made in non-EU countries, but this is only expected to happen if the country involved offers a similar level of protection. This gives the EU a lever to induce other countries to pass similar legislation.

The impact of the directive will be extended to other European countries, starting with those in the European Economic Area (Norway, Iceland, Liechtenstein). Countries in Central and Eastern Europe, including Turkey, will also be strongly encouraged to adopt similar legislation under their bilateral agreements with the EU. The appearance of the directive also prompted the introduction of a bill in the USA, the Database Protection and Antipiracy Act of 1996, although the legislative fate of this is as yet unclear. (Source: *NFAIS Newsletter*, 39(1) January 1997)

### **Rx for the Internet: usage-based pricing**

The Internet, which was supposed to make information as accessible as the air we breathe, seems to have developed a bad head cold and it is getting more congested every day. A user population swollen to an estimated 25 million to 30 million, coupled with the virulent spread of bandwidth-hungry multimedia applications points to continued poor network health.

The long-term cure for the Internet's ills goes beyond technology: corporate customers and vendors must rethink their assumptions about Internet pricing. Although the Internet has been transformed from a small group of research networks into a private business, it still uses the same pricing model as the early days. Rather than charging according to use, most information service providers levy a flat monthly fee. This system is extremely inefficient for commercial users because they pay the same fee regardless of how much or how little they use the Internet.

For Internet services to succeed in the long run, a new pricing model must emerge, one that is sensitive to resources consumed. In other words, the solution must be based on revenue from usage. There are several alternative pricing models. Usage-sensitive pricing combines a flat monthly fee with charges for time that packets spend in the backbone, or the number of packets sent through the backbone, or the number of hops (routers the packet is forwarded through) within the backbone.

Second, priority-based pricing is based on the premise that customers who want better service should pay more. The third option is intranet tolls. Many companies are building intranets, but the capacity on these networks is underutilized. Companies could leverage this, allowing outside users to route information through their intranet pipeline to the Internet. In effect, companies would set up secure toll roads through their own intranet territory as a shortcut to the Internet. (Source: *Data Communications*, January 1997)

### **DVD—the digital versatile disk**

There has been much-needed clarification about the various species within the DVD class. The terminology now differentiates among DVD-ROM, DVD-Audio, DVD-video, DVD-R (for recordable), and DVD-E (for erasable) drives. These distinctive qualifiers are very important because the remaining problems relate in varying degrees to the latter four species, but not to DVD-ROM. On the other hand, DVD-Audio and DVD-Video are not computer peripherals.

When copyright protection technology is agreed upon, the audio industry may soon start selling albums, or rather super-albums, of, say, the top 100 songs of the best crooners on a single DVD disk: if DVD-Audio drives and DVD albums are reasonably priced. However, the movie industry itself will likely erect one more hurdle. Studios want to see a standardized electronic solution that prevents the playing of US-released DVD-Video titles in other parts of the world before a version is released for those regions. Implementing a regional code mechanism in the DVD drives and on the

disks themselves will not only delay the standardization process but will increase the price of the DVD drives and titles and hence will also delay acceptance of the technology by consumers.

The information industry can live with the DVD standards that have been accepted already, the ones governing the physical and logical formats. The information industry will not and should not wait until the audio and movie industry moguls settle their turf wars, fighting out the copyright and region coding issues with the hardware producers. (Source: *Information Today*, February 1997)

### **Global One takes its technology to emerging nations**

Global One technology continues to be a catalyst for change in developing countries, with recent announcements of more than US\$ 15 million in contracts to provide advanced Internet and other telecommunications systems and services for organizations in Pakistan and several nations of the Commonwealth of Independent States (CIS).

Among the contracts is the first Internet contract awarded by the 19-nation Commission on Science and Technology for Sustainable Development in the South (COMSATS). Based in Islamabad (Pakistan), COMSATS aims to make its participating nations aware of the centrality of science and technology in spurring economic development. A key first step in this process is the development of an Internet link between existing centres of science and technology in nations in the CIS, Africa and the Far East as a way of promoting networking and scientific collaboration. (Source: *ITU News*, February 1997)

### **Africa ONE Coordination Committee reviews project progress**

The Africa ONE Coordination Committee<sup>1</sup> met in January 1997 to review the status of the Africa ONE project: a fibre-optic undersea cable which will literally encircle the continent. The Committee sent a clear message that the proposed system will be a truly African project to complement planned or existing terrestrial, satellite and submarine cable systems in the region. As such, it will ensure connectivity to coastal and offshore island countries and provide extensions to land-locked countries.

The Committee is taking all the necessary practical steps to ensure that the proposed system is fully integrated, in particular, with the PANAFTTEL terrestrial network and the RASCOM satellite network. During the meeting, the Committee examined the structural and operational integration with RASCOM, and the ways and means of reactivating the PANAFTTEL. It has recommended that the Coordination Committees of these two projects should be revived quickly to foster this integration.

Concerning the integration foreseen with other systems in the global undersea network, the Committee has called for continued negotiations with the operators and promoters of *Atlantis-2*, *SAFE*, *SAT-3*, and the West Africa Cable (WAC). Some of the traffic on the Africa ONE network will originate or terminate outside Africa and will involve international carriers from Europe, the Americas, Asia and the Middle East, who may purchase capacity on the network to facilitate their own traffic needs. A timely commitment will be needed to go ahead with integration.

The Coordination Committee is seeing to it that all those involved in the project gain a detailed understanding of traffic flows. There are two important ways of gaining this understanding: through traffic forecasts and data gathering. In this regard, the Committee has already organized two inter-



national data-gathering meetings (Cairo, September 1995, and Marrakesh, March 1996), and the third in conjunction with its own meeting in Dakar from 14 to 20 April 1997. The event should enable African administrations and operators, together with their foreign correspondents, to clarify their requirements for circuits or for landing points on the cable, paving the way for the development of a new integrated system configuration.

The central goal in the financing structure being designed for Africa ONE is to provide a high degree of flexibility for countries participating in the project. Enabling Africa ONE to be tailored to individual requirements of each participating country is another key ingredient in developing the system's financing plan. To this end, country-to-country business cases and financing plans were being assembled through national coordinators for review. This should allow each country to pay only for the capacity it desires or the services it uses.

Arrangements for financing of the project are also being studied and several banks and financing institutions, including the African Development Bank, have been approached. The idea is to acquire concessionary funding which would ease the financial constraints, especially for countries who find the project viable on a country business basis but have problems in funding the initial investment.

Africa ONE "has technological aspects and opportunities necessary for interconnectivity at the continental and world levels capable of reinforcing planned and existing systems (the PANAFTTEL terrestrial network and the RASCOM satellite network) with a view to fostering the development of the African countries and regional integration".<sup>2</sup> The Co-ordination Committee is now optimistic that the project will be a key contributor in bringing long-term economic and social growth to the region and in opening the door to enhanced international traffic handling in Africa. It has agreed to establish a project team as soon as funds are identified, and to oversee the implementation of the project. It has also approved a comprehensive work plan for 1997 and beyond.

#### Notes:

<sup>1</sup> The Coordination Committee was set up following a recommendation of the Consultative Meeting of African countries Members of the ITU (Tunis, 20-21 November 1995). It is made up of a group of African countries (Cameroon, Côte d'Ivoire, Kenya, Nigeria, South Africa, Tunisia and Zimbabwe) representing the continent's five subregions, as well as the Pan African Telecommunication Union (PATU), the Regional African Satellite Communications Organization (RASCOM), the African Development Bank, AT&T and the ITU.

<sup>2</sup> Resolution 5 of the AF-RTDC-96.

(Source: *ITU News*, February 1997)

### **The WTO Information Technology Agreement**

Twenty-eight economies, accounting for well over 80 per cent of world trade in information technology products, agreed in Singapore to eliminate customs duties and other duties and charges on these products through annual reductions beginning on 1 July 1997 and concluding on 1 January 2000. The implementation of the agreement is contingent on the signing of other participants—by 1 April 1997—that would result in raising the agreement's coverage to approximately 90 per cent of world trade in information technology products.

Recent efforts to liberalize trade in information technology products have gained ground as more countries become aware of the vast market potential in this sector.

Exports of ITA products amounts to more than \$500 billion annually. Trade in this sector is now larger than world exports of agricultural products. It is currently the fastest growing industry and concerns a wide range of items.

Seven countries make up the bulk of imports and exports in this sector: Japan, the United States, the European Union, Singapore, Korea, Malaysia and Taiwan. Talks to eliminate duties on all information technology products by the year 2000 were held throughout 1996 by Canada, the EU, Japan and the USA. In late September 1996, these countries expressed hope that by bringing the IT Agreement to the WTO Ministerial Conference in Singapore in December 1996, they could encourage other importers and exporters to make similar commitments and eliminate all tariffs.

The ITA covers five main categories of products:

- **Computers** (including printers, scanners, monitors, hard-disk drives, power supplies, etc.);
- **Telecom products** (including telephone sets, fax machines, modems, pagers, etc.);
- **Semiconductors** (including chips and wafers);
- **Semiconducting manufacturing equipment; Software** (e.g. diskettes and CD-ROMs); and
- **Scientific instruments.**

In addition, the Agreement covers other products such as cash registers, computer network equipment and certain photocopiers but not electronic consumer goods. (Source: *FOCUS Newsletter* No. 15, January 1997)

### **Panel urges new addresses for Internet**

An international committee has announced plans for an expanded system of Internet addresses that would end the virtual monopoly of Network Solutions Inc. on registering addresses for the global computer network.

The International Ad Hoc Committee said it would introduce a series of endings for Internet addresses—such as .firm for businesses, .store for retailers and .arts for cultural organizations—as alternatives to .com and other so-called domains offered by Network Solutions.

The committee said as many as 28 organizations worldwide would be selected by lottery to register addresses with the new suffixes. Sharing the responsibility "is a useful market control mechanism to reduce the risk of monopolistic trading practices", it said in a report elaborating on comments it first issued last year.

But the committee is seeking to implement its plan in the anarchy of cyberspace. The essentially self-appointed body's initiative is an experiment in governance by consensus.

Domains resemble area codes or telephone numbers for the Internet, enabling computer users to address electronic mail and find sites on the World Wide Web.

The International Ad Hoc Committee also proposed adding the domains .web for Web-related organizations, .rec for recreational organizations, .info for organizations providing information and .nom for people who want their own Internet identities.

Under an agreement with the National Science Foundation, Network Solutions charges \$100 to register a new Internet address. Critics have argued that competition would result in cheaper and better service, and that new domains are needed to ease a shortage of possible addresses.

The International Ad Hoc Committee includes representatives of the International Trademark Association, the World Intellectual Property Organization, the International Telecommunication Union and the Science Foundation, among others. (Extracted from *International Herald Tribune*, 10 February 1997)



### **"Crashing" headache**

With computer use increasing, so is the frequency of computer crashes. In fact, 35 per cent of respondents to a recent survey of corporate computer users reported that their office computer malfunctions or crashes one or more times a month, and another 16 per cent report crashes more than once a week. The survey, sponsored by Fuji Photo Film USA Inc., also reveals that those crashes were not necessarily fatal to the data: 86 per cent of respondents said their data are backed up. Half of those report daily backups; 18 per cent weekly. Still, 33 per cent say their data are backed up infrequently (once a month or less) or do not know the frequency of backup. (Source: *Industry Week*, 6 January 1997)

### **Intranets: just another bandwagon?**

The term "intranet" means the deployment and use of Internet technologies, such as the Web, e-mail and TCP/IP on a closed network. This may be within a single organization or across a group of organizations. Because intranets are based on TCP/IP networking standards they include anything that uses the open TCP/IP protocol, including existing client-server technology and connectivity to legacy host systems.

Because intranets are based on Internet technology they promise a great deal. In principle, an intranet can act as an enabler for all of the following activities: communication and collaboration, information retrieval, sharing and management, and access to databases and applications. None of these functions is new. In fact, they are all probably delivered today in many organizations using a variety of legacy and packaged solutions. The promise of an intranet though, is that it can use Internet and World Wide Web technologies to do all these things better and in a more integrated way than before. For information retrieval, the use of Web technology produces clear benefits in terms of ease of use, speed, efficiency and comprehensiveness.

The open standards used for Internet technology also represent good news for IT departments which have the responsibility of implementing and managing networks. Because of the open nature of Internet tools, intranets could easily be installed across many different platforms and environments with control and administration being centrally managed. As closed systems intranets would present the IT department with none of the security headaches associated with the Internet.

However, intranets are designed to become the next computing platform, but in order for this platform to succeed, it needs applications that utilize its unique capabilities. With these applications powering the new platform, we will see intranets bringing changes to business on a scale last witnessed with the PC revolution, except this time it is going to be faster because intranets are less expensive than personal computers, and larger because intranets rest on a truly global infrastructure.

Because the intranet platform inherently connects people to people and people to information, applications that use the abilities of intranets best involve document management, information retrieval, workgroup productivity and electronic distribution, for example those which are used for finding information, working together and distributing the results.

However, to make an intranet application into more than just a set of unrelated tools, the functionality needs to be integrated. For example, the objects going through a workflow are usually documents and the documents should be managed by the document manager. The fact remains that workflows, documents and projects are all entwined in how people work and how they work together.

Because intranets may contain large amounts of information, and may point to vast amounts of information, efficient searching is a key intranet functionality area and entails full text searching of HTML documents, searching other documents and data types common to the organization. (Source: *Information Management and Technology*, 30(1) January 1997)

### **Exploring the news**

Reuters News Explorer is a personalized alerting service that provides customized news to individuals on an intranet. Users define their interests in a few words or a sentence, then the Muscat search engine selects relevant articles from Reuters global news gathering service that covers some 2,000 sources, including national and international newspapers, trade publications and news wires.

A variety of news feeds, including Reuters IPTC picture and text wires, as well as Reuters Business Alert data, can be searched using this service. These are indexed on the customer's intranet server—when users log in with an ID they are alerted to any fresh news stories that match their profiles. Free text searching can be combined with category filters, such as Country, Topic, Date, Industry. Searches can be saved as a profile, and users can adjust the alert threshold attached to each profile. Alerts can be made either via e-mail or onto the browser screen. News Explorer also offers a live scrolling news alert which can be displayed within Netscape Navigator or Microsoft Internet Explorer.

According to its creators, the Muscat search engine—which forms the backbone of the service—is unique in two ways. Firstly, it ranks the relevance of retrieved documents using a combination of probabilistic retrieval algorithms and statistical techniques. This, says Muscat, raises the standard of the initial hit list. Secondly, for a more focused search, Muscat involves the user marking those documents which appear to be most relevant and then suggests new keywords to retrieve additional documents not sourced in the preliminary search. (Source: *Information World Review*, 121, January 1997)

### **ITU to release report on trade in telecommunications**

The International Telecommunication Union will shortly release the 1996/97 version of its annual market analysis report, the *World Telecommunication Development Report* (WTDR). The report tracks global changes in the telecommunications sector, and includes extensive analysis of market trends as well as comprehensive statistical information on various market segments. Prepared by the organization's Telecommunication Development Bureau and Strategic Planning Unit, the theme of this year's WTDR is *Trade in Telecommunications*.

The 1996/97 WTDR shows that telecommunications trade in 1995 amounted to US\$ 96 billion, compared with less than US\$ 50 billion at the start of the decade, and it will have passed the US\$ 100 billion mark during 1996. Equipment trade is booming, with global exports of equipment reaching US\$ 58 billion in 1995, an increase of more than 20 per cent over the previous year and a more than twofold rise since 1990. Exports now account for around one third of the total telecommunication equipment market, and this share is continuing to rise steadily. The boom in export trade has been largely driven by growth in demand for telecommunication services, which is in turn driving the construction and modernization of networks, both traditional fixed line networks and other types of network such as cellular or the Internet.

The telecommunication services market has grown from just under US\$ 400 billion in 1990 to over US\$ 600 billion in 1995. Until recently, though, opportunities for trade in telecommunication services have been more limited than for equipment, due to governmental regimes which maintained monopoly service provision by a national carrier. The global trend now is towards a freeing up of markets, and this is expected to lead to strong growth in international trade in services.

Four modes of delivery have been identified by which services can be traded: cross-border supply, commercial presence, consumption abroad and movement of staff. Of these, the WTDR shows that cross-border provision of services is by far the most important. International telephone calls have risen from under 4 billion minutes in 1975 to over 60 billion minutes in 1995, representing a growth rate of 15 per cent a year. In 1995, international telephone calls generated US\$ 53 billion in retail revenues, corresponding to 8.7 per cent of the global telecommunication service market.

According to the report, direct commercial presence is the second most important way in which telecommunications services are traded. Opportunities for foreign investment are now increasing as foreign investors take stakes in privatized operators, establish local subsidiaries, or participate in joint ventures. Mobile communications, in particular, has seen spectacular growth in many countries as Governments have permitted the licencing of additional operators and the introduction of new services. Further information from <http://www.itu.ch> or INTERNET [itumail@itu.ch](mailto:itumail@itu.ch). (Source: ITU Press Release, 14 February 1997)

### **Intelligent agent technology**

Intelligent agent technology is one of those concepts with which it is easy to get confused. Ask two or three consultants what intelligent agents are and you will receive three different answers: some will say that they are centred around networking technology, and others will say that they have little or nothing to do with networks at all. The truth lies somewhere in between, and the defining characteristic of an agent is that it is an autonomous program designed to go out and achieve a certain function, usually through a rules-based filtering process.

Web-based agents are particularly interesting for their clever built-in artificial intelligence, which allows them to gather customized information for users. In this circumstance, the agents' job is to filter and correlate information or personalizing information. These kinds of agents enable you to set up particular filters for sending attributes that you want your documents to check: the agent would do the search for you and come back with only those documents that match the criteria.

Many intelligent agents are server-based, meaning that they sit on a host machine. Although they may make occasional runs across the Web to find information, their main function is to collate information from a central point. For example, agents can be used to manage vertical services by collating and filtering information from horizontal areas together, whereas before companies were only able to examine the horizontal components separately. This new method of management uses agent intelligence to put together a broader picture of the IT infrastructure which correlates directly with business operations. (Source: *Communicate*, February 1997)

### **IT integration**

Almost every major company is completely overhauling its information technology (IT) systems. Most realize they

will need to prepare for the year 2000, when their 30-year-old mainframe computers—systems that were not even programmed to still be in service in the twenty-first century—will no longer compute. Billions of dollars worth of computer equipment will need to be replaced or reprogrammed by 31 December 1999.

But most of what is going on in industry is now far more strategic. Companies say they are configuring networks of integrated IT that will facilitate global supply chain management systems. The computers amassed over decades of mergers, acquisitions, and decentralized systems purchasing will either hook into the network or be thrown out. Most will be thrown out.

IT integration is basically the establishment of a tightly linked data monitoring system built around business processes. The catalyst for this integration is enterprise resource planning (ERP) software. ERP systems constitute a single IT network for a global manufacturer because they allow manufacturing, financial and a range of other business processes to share information and be monitored in real time from desktop computers throughout a company.

The effort to build global IT networks, which began at some large chemical companies five years ago, has ushered in a revolutionary change in business computers and business management. It forces companies that have not re-engineered business processes to do so. It facilitates the replacement of mainframe computers with client-server technology and allows companies to monitor the economic efficiency of a manufacturing operation constantly rather than quarterly. IT purchasing strategies have changed fundamentally: After years of developing proprietary operating systems, chemical firms are switching to purchased software. In effect, they are outsourcing system development. And for once there is little question that a big investment in IT has to be made.

The rapid development in ERP software poses a sticky question for managers: "How can a company be sure that a new system will not soon become obsolete?" Some have accepted that the world of IT will never be that safe, but most are banking on the new networks lasting for decades.

Some software industry sources see the marketplace for ERP software gravitating towards two options for users: integrating IT using a single vendor's product; or selecting a "best-of-breed" configuration—mixing and matching software for manufacturing, human resources, financial accounting and other functions. In reality, IT managers and consultants say integration requires selecting one vendor to perform at least the core functions of financial accounting, revenue cycle management and manufacturing. Software for less critical functions, such as human resources management, can be selected from another supplier and custom fit to the network. But the interoperability of multivendor systems is not yet, and may never be, at the point where a totally mixed-and-matched ERP system will be anything other than another high-maintenance computer hodgepodge.

In-house ERP development is prohibitively expensive, if not technically impossible. Home-grown systems are specifically what companies are trying to eliminate with integrated IT. Views on ERP options vary widely, however, especially among vendors and consultants.

Industry sources agree that while the technology exists to fully integrate IT, no company has achieved total integration. The connection of manufacturing and financial systems is a major missing link. Even companies with ERP installed at the financial processes level have a way to go. (Extracted from *Chemical Week*, 12 February 1997)

## C. NEW DEVELOPMENTS

### **The NUMA invasion**

NUMA—an acronym for non-uniform memory access—represents a new method of accessing data that promises to lower the cost of information processing.

Besides lower cost, NUMA offers faster performance, which is important in an era when the average corporate data system always seems to be short of processing power.

A host of new business needs are placing added burdens on data centres, causing erstwhile thoroughbred systems to plod. Activities such as real-time ordering of products and tracking orders through production tend to consume significantly more computing power than simple weekly or monthly batch processing. The problem is compounded by other information-based chores, many of which did not exist a few years ago. These include data mining and on-line transaction processing, e-mail, the Internet, and electronic data interchange.

Five years ago, upgrading to get greater data-processing power meant replacing mainframes, but today, with many companies having replaced some or all of their mainframes in favour of networks of servers connected to desktop machines, upgrading systems is not so routine. Regardless of system size, the same bottom-line rules apply—users want systems that are faster, better and cheaper.

Scalability—the ability of a system to expand as business needs grow—is critical. Most users prefer the ease and economy of sticking with the same hardware and software. The alternative, stepping up to a massively parallel processing (MPP) system, is expensive, requiring specially adapted software applications. This is where NUMA comes in. With NUMA, the microprocessors do not care where the memory is stored. This means that dozens or even hundreds of processors can be strung together.

Data General Corporation's (DG) NUMALiNE, for instance, to be available in the first quarter of 1997, will allow multiple machines to be linked so that hundreds of processors yield the power of a massively parallel system. At the same time, it will continue to run most existing software applications, including standard database management systems, built for the SMP platform. Avoiding the special programming needed for larger systems saves time and reduces costs.

A key feature of NUMA hardware is multiple input/output paths. Systems depending on a heavy volume of information flowing back and forth are less likely to suffer a bottleneck that slows performance.

Fujitsu's ICL is incorporating DG's NUMALiNE technology into its next generation of hardware, due out in the second quarter of 1997. (Extracted from *Industry Week*, 6 January 1997)

### **Smaller micropumps**

A design breakthrough has led to new micropumps that can achieve flow rates of 20-200 microlitres a minute. They could be used in miniaturized blood analysis systems, for drug delivery devices and to cool computer chips.

The concept was triggered by an idea for valves with no moving parts first patented by Nikola Tesla in 1920.

Pumping microlitres of liquid is a challenge because it is extremely difficult to fabricate pumps at such a small scale, particularly with valves that have moving parts. The task is complicated when the fluids to be shifted, such as medicines and inks, carry particles that could clog tiny valves.

Fred Forster at the University of Washington in Seattle and Martin Afromowitz spent two years perfecting computer models to study these conduits and their effectiveness as non-moving valves. Then, with the same etching process used to make computer chips, they fabricated a series of micropumps on silicon wafers.

The pump chamber is 6-10 mm diameter by 120 microns deep and the conduits are 114 microns wide by 120 microns deep. A thin glass membrane is glued over the chamber and a piezo-electric disc attached to it. A voltage to the piezo-electric disc causes the glass to bow and create a pumping action in the chamber.

When the pump draws fluid through the inlet conduit, it also draws fluid back through the outlet conduit. But the computer-aided design ensures more enters through the inlet than the outlet. Similarly, when the pump expels liquid, more exits via the outlet than the inlet. There is a net flow from inlet to outlet with no need for a moving valve. The pump can be pulsed hundreds of times a second and achieves flow rates of 20-200 microlitres a minute with different pressure levels. (Source: *Engineering*, February 1997)

### **US firm makes material with widest range of resistivity**

A US company, Atomic-Scale Design, has produced a material which it claims has the widest range of specific resistivity of any substance.

Called QUASAM, for quasiamorphous carbon, its resistance can be set during manufacture across 18 orders of magnitude.

Benjamin Dorfman, a spokesman for the company, said: "Its specific resistance can be fixed anywhere from  $10^{12}$  to  $10^{14}\Omega$  cm at the top to  $10^{-4}\Omega$  cm at the bottom.

The material combines the structures of the graphite and diamond forms of carbon, having planes of  $sp^2$  (graphite) bonded atoms connected by a random three-dimension  $sp^3$  (diamond) bonded framework. This unusual lattice is stabilized by silica molecules. The assembly is porous on the atomic scale having voids of between 0.2 and 0.3 mm across throughout, which make up around 50 per cent of its volume.

It is these voids that can be filled with metal atoms to conduct electrons.

So far, work on the material has centered around its mechanical characteristics, as it is as hard as diamond, weighs half as much and is stable up to  $450^\circ$  C, but some electrical properties have been assessed.

At very low metal concentrations (highest resistance) QUASAM's resistance varies with outside stresses and sensors may be possible. Then, as concentration increases, it becomes adjustably resistive and stable.

It can also form Schottky barriers with most semi-conductors and superconducts (at liquid helium temperatures)

even in the presence of high magnetic fields. (Source: *Electronics Weekly*, 29 January 1997)

### **Quantum computing: cue the qubits**

The problem of how to construct a quantum computer has exercised the imagination of physicists and mathematicians for a number of years. Now Neil Gershenfeld (MIT) and Isaac Chuang (Los Alamos National Laboratory) believe they are on the track of a solution.

In contrast to a conventional computer, the switches (or "qubits") in a quantum computer would be capable of being both "on" and "off" simultaneously. Each qubit could, in effect, perform two calculations at once. A quantum computer with relatively few computers therefore could be considerably more powerful than the classical variety.

Until now, the constraint has been that disturbing the delicate balance between quantum states causes the system to "decohere", falling into one or other of its possible states. Simply reading the result of a calculation is sufficient to bring this about.

Rather than working with a single, isolated component in the quantum state, the research team employs almost the exact opposite: a sea of molecules. The nuclei of atoms behave as tiny magnets, with the direction in which they point determined by the property known as "spin". As such, they can behave as qubits. The qubits are manipulated, and the results of the calculations read, using NMR (nuclear magnetic resonance) spectroscopy. The spins do decohere when subjected to pulses of radio waves, but the presence of multiple quantum devices means that a sufficient number survive long enough to perform several dozen computational steps.

Using the carbon atoms in a molecule of alanine as qubits, the team have built a computer which can add one and one, and output the result. By the end of the year, it is hoped to build a ten-qubit device, using more complex molecules. (Extracted from *The Economist*, 22-28 February 1997)

### **OP-amp with potential of 0.8 V**

Engineers in Italy have developed a rail-to-rail output, precision input, bipolar op-amp which operates with a supply of only 0.8 V.

Designing the circuit with bipolar transistors brings with it the problem that the  $V_{BE}$  of a bipolar transistor is around 0.7 V. This leaves only 100 mV for other circuit elements, predominantly resistors and current sources, to operate within.

Final measured characteristics, in a sample fabricated by SGS-Thomson Microelectronics, show an input offset of 0.4 mV, current consumption of 0.75 mA and an output swing on 90 per cent of  $V_{CC}$ . The input common mode range, governed by the PNP input transistors, is -0.3 V to  $V_{CC}$ -0.7 V.

The output stage employs a complementary common emitter pair, rather than the usual emitter follower design. This type of output is difficult to drive effectively and doing so requires a lot of transistors. The design uses at least double the usual number. (Source: *Electronics Weekly*, 15 January 1997)

### **Germans see the white light at the end of the tunnel**

The Fraunhofer Institute in Freiburg, Germany, has developed a white LED which does not use three different coloured LED chips in the same package.

Instead, it uses a single chip and fluorescent material. The material absorbs some light at the wavelength emitted by

the chip, and re-radiates the energy at other wavelengths, filling out the optical spectrum and appearing white.

Fluorescent materials emit at longer wavelengths than they absorb at, so the chip has to emit the highest wavelength (blue) needed.

Applications will be as indicators initially. The LEDs use GaN on either a sapphire or SiC substrate (Bulk, monocrystalline GaN does not exist). The device, under the name LUCOLED, will be marketed by Siemens. (Source: *Electronics Weekly*, 15 January 1997)

### **GSM phones get GPS alternative**

A Cambridge University researcher has designed a system which allows a GSM handset's position to be calculated without requiring the use of Global Positioning System (GPS).

Dr. Peter Duffett-Smith, instigated by his radio-astronomy ideas, has designed a basestation which calculates the handset's position to an accuracy of 50 m. The technology is based on interferometry, where the positioning of an object is determined through a multiplicity of readings taken from various points.

The ability to locate handsets will enable numerous additional GSM services to be added. For example, it would enable emergency services to locate broken down cars or accidents, allow personal navigation, and even the locating of a stolen phone or car.

Duffett-Smith believes the technology, dubbed Cursor, could be adopted as early as this year and is currently in discussion with major handset and basestation manufacturers.

The main approach to combine location/navigation technology with GSM is GPS. But GPS has four disadvantages when compared with Cursor: it is expensive to fit into handsets, with a current accuracy of 100 m it is not accurate enough for urban environments, it is power-hungry and it takes a while to position itself as it consults geostationary satellites. With Cursor, the only modification needed in the handset is a software one.

In addition to Cursor, several other similar technologies are currently under development. (Source: *Electronics Weekly*, 15 January 1997)

### **Engineers see way ahead for false eye**

Engineers in North Carolina have made a prototype silicon artificial retina, designed to fit inside the eyeball, which attaches directly to the damaged existing retina.

Elliot McGucken of the University of North Carolina is one of the design team which draws members from several other institutions in the region. He said: "Some blinding illnesses, like retinal pigmentosa, only destroy the eye's photoreceptors, leaving the underlying ganglia and optic nerve cells unaffected".

The artificial retina is a single chip, currently 2 x 2 mm, with a 25 x 25 array of circuits that face the back wall of the eye and can couple signals through the damaged photosensor layer and directly into the ganglia. Each of the circuits has a phototransistor which receives light through the chip from the outside world. McGucken said: "The chip is ground until it is less than 20  $\mu$ m thick to make it transparent".

The problem of getting power to the chip has been overcome in a novel way. McGucken said: "We have put an area of photovoltaic cell on the chip which can be illuminated from outside the eye by a laser".

Currently the chip is undergoing tissue compatibility tests before human trials. If all goes well, the next develop-

# TECHNOLOGY AND INVESTMENT OPPORTUNITIES

## SELECTED INVESTMENT/TECHNOLOGY REQUESTS

### NETWORK AND ELECTRONIC INFORMATION SERVICES

The sponsors have proposed a new project that focuses on the development of a high speed data communication network based on ATM technology for multimedia applications. In addition, the network will provide international high speed links for information transfers to be used for the Internet. The project will be based in all the major cities of Pakistan. The product services will include CAN to CAN (Communications and Networking) connectivity, tele-teaching, image transfer, video-conferencing, etc. The sponsors are experienced in the area of computer hardware, software, communication and networking and have been dealers in WAN products/services since 1990. The company has know-how of current technology.

**Preferred mode of cooperation:** Joint venture, transfer of technology.

*(For further information, please contact: Mr. Javed A. Naushahi, CEO, United Computer Services, 2nd floor, Nabika Square, Shaheed-e-Millat Road, Karachi, Pakistan. Tel.: (92-21) 4539701, 4535794; Fax: (92-21) 452 4976; E-mail: javedn@biruni.erum.com.pk)*

### DEVELOPMENT OF SOFTWARE KIT FOR E-MAIL ON TV

The sponsors propose a new project based on the existing facilities of the company. The project proposes to introduce e-mail facilities on television, and the proposed product will be software kits for this purpose, along with related hardware for interfacing with TVs. The project is export oriented and the sponsors plan to sell only 20 per cent of their output to the local market. The project will be the first of its kind in Pakistan.

**Preferred mode of cooperation:** Joint venture, marketing expertise.

*(For further information, please contact: Mr. Ahmad Faraz, General Manager, Wavetech (Pvt.) Ltd., C-98, KDA Scheme No.3, Karachi, Pakistan. Tel.: (92-21) 4539400, 4539500, 4539600; Fax: (92-21) 4545465)*

### PRODUCTION OF ELECTRONIC BIOMEDICAL INSTRUMENTS

The proposed project is to manufacture electrocardiographs (single and multi channel) and computerized patient monitoring units (ECG, heart rate and temperature monitoring for up to six patients at a time). The company, through its R&D efforts, has developed these products at a cost that is far lower than that of imported articles. The project aims to improve the products further.

**Preferred mode of cooperation:** Joint venture, market access, sub-contracting, technology transfer, buy-back arrangement, joint R&D.

*(For further information, please contact: Mr. Nauman Saeed, Chief Executive, Microtech Labs, No.11, 2nd floor, Saleem Chambers, 114 McLeod Road, Lahore, Pakistan. Tel.: (92-42) 7226328; Fax: (92-42) 7226328)*

### MANUFACTURE OF PHOTOVOLTAIC SOLAR CELL MODULES

This R&D organization is specialized in the development of photovoltaic technology. At present the production is restricted to the production of modules on a non-commercial basis since the facilities are not able to cater for large-scale production. Assistance is required to upgrade the existing facilities for commercial production.

**Preferred mode of cooperation:** Joint venture, buy-back arrangement, equipment purchase.

*(For further information, please contact: Dr. Parvaiz Akhtar, Director General, National Institute of Silicon Technology, Plot 25, H-9, Islamabad 44790, Pakistan. Tel.: 051-448470-1; Fax: 051-448469)*

### SOFTWARE DEVELOPMENT AND TRAINING HOUSE

The proposed project aims at establishing a computer software development and training facility. The major products of the software development component would be customized packages for various types of business, such as banking, hotel management, etc. As the products will be custom made, a production capacity definition would be irrelevant. The training facility will provide the software section with quality programmes and systems engineers, and will also provide software development and analysis training to individuals from outside the company. The company hopes to focus the major part of its business on foreign markets. The firm has the expertise required to provide solutions for the upcoming "Millenium Bug" problem.

**Preferred mode of cooperation:** Know-how, licensing, equipment supply.

*(For further information, please contact: Mr. Khurshid A. Abbasi, Executive Director (Finance), Saigol Computers (Pvt.) Ltd., Units B & C, Block 1, Diplomatic Enclave, G-5, Islamabad, Pakistan. Tel.: 92-51-828347/8/9; Fax: 92-51-824125; e-mail: sclisb@isb.compol.com; Web site: www.cyber.netpk/sgl)*

### SOFTWARE DEVELOPMENT

The project aims to establish a software technology park near Lahore. A site has been purchased for the

project and the sponsors would like to obtain high-end computer equipment which they would combine with their expertise and manpower to increase the already established clientele. The services to be provided would include contract software development, IT services (work/job processing, etc.) and multimedia content design and development. The expected annual turnover from each of these is between \$10 and \$15 million.

**Preferred mode of cooperation:** Joint venture, market access, sub-contracting, buy-back arrangement, loan.

*(For further information, please contact: Mr. Mubashir A. Mian, Chief Executive Officer, Nextbridge (Pvt.) Ltd., 3-A/3 Gulberg III, Lahore, Pakistan. Tel.: 0092-42-575-0797; Fax: 0092-42-5758114; e-mail: Mmian@nextwerk.com; Web site: www.Nextbridge.com)*

### **SOFTWARE DEVELOPMENT AND INFORMATION TECHNOLOGY SERVICES**

The company is seeking to develop export-oriented software in the fields of application development and conversion, digitization and drawing management, CAD/CAM/CASE, Internet application, graphics and multimedia. The intention is to expand and modernize existing software and hardware capabilities and facilities. The company is confident it has the potential for the project to succeed in view of the availability of highly skilled English speaking experts at low cost. Being a subsidiary of a large Pakistani business group, the sponsors have strong links with local and international information technology markets.

**Preferred mode of cooperation:** Joint venture, sub-contracting.

*(For further information, please contact: Mr. Iqtidar Zaidi, President, Pakistan Technologies (Pvt.) Ltd., House number 3, Street 57, F 7/4, Islamabad, Pakistan. Tel.: 92-51-821559, 812853; Fax: 92-51-274749; e-mail: suntech@paknet1.ptc.pk)*

### **SOFTWARE DEVELOPMENT**

The company aims to expand its current facilities of software production in the field of information technology consulting services, Internet-based services and data entry services. The purpose is to expand by increasing market share through assured business and through joint venture collaboration to introduce the latest information technology to Pakistan. The target market of the proposed project is hospitals, software houses and companies that require legal transcriptions in Europe and the USA.

**Preferred mode of cooperation:** Joint venture, market access, sub-contracting, technology transfer.

*(For further information, please contact: Mr. Shabbir A. Usmani, Executive Director, System Research (Pvt.) Ltd., Gulrez Plaza, Gulrez Colony, Chaklala Scheme, Rawalpindi, Pakistan. Tel.: 051-508282, 508270-6; Fax: 051-508284; e-mail: usmanisi@transcripts.com; Web site: http://204.192.4.60/index.html)*

### **ESTABLISHMENT OF ELECTRONIC MESSAGING SERVICE**

The aim is to set up an e-mail network for the entire country. The EMS network would consist of a set of central e-mail servers that are the repositories of incoming and outgoing mail. In order to achieve wide coverage, there will be several hundred or even thousands of smaller message centre clients that can communicate with the central e-mail servers.

**Preferred mode of cooperation:** Joint venture, management expertise.

*(For further information, please contact: Mr. Shahid Jaffrey, TCS (Pvt.) Ltd., 22-A, Amber Tower, Block 6, P.E.C.H.S., Shahrah-e-Faisal, Karachi, Pakistan. Tel.: 9221-4534316; Fax: 9221-4548428; e-mail: shahid@tcsit.khi.erum.com.pk)*

### **INTERNET MARKETING SERVICES**

The Coral group of companies is proposing to set up a new project involving the establishment of an interactive Internet marketing service. The basic idea of electronic shopping is to take information from a mail-order catalogue and create a very large computer database which can be regularly upgraded and improved to display new products. This database can then be accessed by a series of smaller outlets at any strategic location such as airports, malls, neighbourhood stores and entertainment venues. The service will be provided to the general public of Karachi. The company has the necessary technical and managerial expertise.

**Preferred mode of cooperation:** Joint venture, technology transfer.

*(For further information, please contact: Mr. Muhammad Yousuf, Director, Coral Group of Companies, Al-Sayed Arcade, R.No.5, 3rd Floor 1/c, FI-1, Block 5, Gulshan-e-Iqbal, Karachi, Pakistan. Tel.: 9221 461407, 4993220; Fax: 9221 4993220; e-mail: mfi@khi.compol.com; Web site: www.acropolis-corp.com)*

### **PRODUCTION OF ELECTRONIC SECURITY SYSTEMS**

The proposed project aims at expanding the production of various types of electronic security systems for domestic and foreign markets. The security systems being produced at present are: security systems for private residences, commercial buildings and markets, security networks for public housing schemes and automobile security systems. The aim is to further upgrade the current level of R&D along with an expansion of production facilities.

**Preferred mode of cooperation:** Joint venture, market access, sub-contracting, technology transfer, buy-back arrangement, joint R&D.

*(For further information, please contact: Mr. Nauman Saeed, Chief Executive, Microtech Labs, No.11, 2nd floor, Saleem Chambers, 114 McLeod Road, Lahore, Pakistan. Tel.: (92-42) 7226328; Fax: (92-42) 7226328)*



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# **BRAZIL TECHMART '97**

**Belo Horizonte (Minas Gerais) Brazil  
1 – 3 December 1997**

## **INTERNATIONAL BUSINESS FORUM**

Organized jointly by UNIDO (United Nations Industrial Development Organization) and the Federation of Industries of the State of Minas Gerais (FIEMG), BRAZIL TECHMART '97 aims to promote and support the formation of technological and joint venture partnerships between and among enterprises from Brazil, particularly the state of Minas Gerais, and from other parts of the world, particularly Austria, Italy, Slovenia and the Republic of Korea. By putting into focus the technological needs as well as the strengths of enterprises in the Brazilian metal-mechanic, agro-processing and biotechnology sectors, the event aims at forging strategic business partnerships that will promote the competitiveness and growth of these three sectors.

Over 70 Brazilian enterprises seeking technological solutions for company growth and competitiveness will be present at BRAZIL TECHMART '97, as well as trade associations, chambers of commerce, manufacturers associations, research institutes, government organizations, technology transfer agents, development banks and venture capitalists

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ment is to be a 250 x 250 grid to increase resolution. (Source: *Electronics Weekly*, 29 January 1997)

### **Humans run out of brain**

A group at British Telecom Laboratories has estimated the year when machines will out-think *homo sapiens*. The date has come out of a study of the human brain, aimed at plundering it for concepts useful for machines, which concludes that humans cannot get any cleverer.

Team member Professor Peter Cochrane said: "For reasons, including cooling and nerve length, the human brain has come about as far as it can, whereas, machine intelligence is increasing in a fairly predictable way. We think the cross-over will occur around 2030".

Cochrane's group has already pulled a saleable concept from nature. A study of ant behaviour led to a 1,000 line network control program that replaced 1.6 m lines of more conventional code. (Source: *Electronics Weekly*, 29 January 1997)

### **World's first micro steam engine**

Sandia National Laboratories, renowned for its micromachines, has produced the world's first micro steam engine. Alongside making "conventional" micromachines like accelerometers, Sandia has produced several "proof of concept" gear wheel and rack mechanisms driven by its electrostatic comb motor, which converts reciprocating movement into rotation using cranks. Now the laboratory has sorted out its Web site and offers a gallery of stills and movies of its projects in motion. Further details at: <http://www.mdl.sandia.gov/micromachine>. (Source: *Electronics Weekly*, 5 February 1997)

### **Leeds leads with transistor model**

A team at the University of Leeds has developed a mathematical model of transistors with gate widths down to 10 nm, and has built terahertz (THz) devices to prove it.

The model is accurate enough for Hewlett-Packard to include in its modelling package due to be released at the end of this year, or early 1998.

Team leader Professor Chris Snowdon said: "The maximum speed of an electron in a normal GaAs transistor is about 200 km/s. As the transistor gets smaller this increases to 700 km/s. This effect, called non-equilibrium transport, is not covered by classical physics and is not exactly a quantum effect".

The model takes this increase in velocity into account and predicts the performance of GaAs and GaInAs to better than 5 per cent.

The University can fabricate devices down to 40 nm. The smallest, and therefore the fastest, transistor designed at Leeds (but manufactured elsewhere) is 25 nm, operating at 0.2 THz. The record at present is 0.3 THz for a US-made transistor. (Source: *Electronics Weekly*, 5 February 1997)

### **Matsushita claims DVD pickup first**

Matsushita has announced what it claims is the world's first integrated optical pickup for digital versatile disks (DVDs) and CDs.

It is a dual focus optical pickup that can read CD-ROM, DVD-ROM and other phase-change disks. It is created by combining a laser diode as well as the conventional photodiode.

The optical pickup is suitable for several disk drive types, including new DVD players offering compatibility with music, computer and photo CDs.

It can also be used for CD-recordable with the addition of several components.

A main difference between CDs and DVDs is in the lasers used for reading and writing. For CDs the diode used has a wavelength of 780 nm, while for DVDs it is a 650 nm red-diode laser, which later will be replaced with a blue or even a green diode to enable increased storage densities.

Matsushita's current offering can handle more than 20 times CD-ROM playback and over two times higher DVD playback. The company is still mulling over the timescales for commercializing the new product and its pricing. (Source: *Electronics Weekly*, 12 February 1997)

### **Accelerometer senses on 3 axes**

The University of California, Berkeley and Sandia National Laboratories have described their 3-axis micro machined accelerometer that includes on-chip servo and signal conditioning circuitry.

Both Analog Devices and Motorola already produce single-axis devices and Analog's has on-chip circuitry, so what is remarkable about this design?

X and Y axes are sensed using two comb finger arrays similar to Analog's and Z-axis (out of the plane of the chip) measurements are made using a moving flat plate mass above a fixed plate. In this sense it is less sophisticated than Motorola's which has fixed plates above and below the moving mass, but simplifying the structure has allowed the use of a single polysilicon layer process. A capacitor with two fixed plates provides compensation.

Acceleration is measured by determining how much force is required to keep the moving masses in a fixed position relative to the substrate. The same capacitive electrodes are used both to sense the mass position and provide a restraining force. To separate the functions, the tasks are performed sequentially, the inertia of the plate integrating the force pulses. The control loops use noise shaping.

Sandia built the device using its buried micromachine technology where the micro-accelerometer is built in a trench on the wafer and covered with SiO<sub>2</sub> while the CMOS circuitry is fabricated.

Annealing the machine first, then burying it, leaves a flat surface for CMOS fabrication and the SiO<sub>2</sub> is etched away at the end to uncover the machine and free its working parts. (Extracted from *Electronics Weekly*, 12 February 1997)

### **University research pack them in**

Researchers at the University of Minnesota say they have created a tiny transistor based on a single electron. Called the Room Temperature Single Electron MOS Memory transistor, it is just 7 nm<sup>2</sup>, which means millions of such transistors could be packed into a fraction of the die size occupied by current microprocessors. Researchers at the university say that their breakthrough has attracted interest from several major US chip firms. For more information check: <http://www.tc.umn.edu/nlhome/m017/nanolab/research/SEM/SEM.html>. (Source: *Electronics Weekly*, 12 February 1997)

### **Synthesis success for buckytubes**

Researchers at the Technical University of Braunschweig in Germany are close to developing a simple synthesis of so-called "buckytubes".

This rod-like form of carbon is produced by vaporizing carbon at temperatures as high as 10,000° C.

The new "picotubes" are smaller versions of the buckytube, which are made by exposing the compound

tetrahydrodithracene to ultraviolet light for ten hours. Buckytubes are normally 200 nm long, picotubes are less than 1 nm in length.

The research brings chemists closer to making buckytubes by conventional chemical synthesis. (Source: *European Chemical News*, 20-26 January 1997)

### **New accuracy clock**

The National Physical Laboratory, in Teddington, UK, is developing a clock based on a single ion of ytterbium (Yb<sup>+</sup>) cooled to within 0.5 mK of absolute zero.

The clock's potential accuracy is one part in 10<sup>18</sup>, which is 1,000 times better than current caesium clocks.

The ion is supercooled and charged to allow it to be held in a constraining electric field. Ytterbium has been chosen because it has an energy state which is ultra-stable. Hitting it with a photon at just the right frequency (energy) can push it into this state. The laser providing such suitable photons is the output oscillator of the clock. To determine what state the ion is in, a second laser, tuned to an unstable state, also illuminates the ion. Entering, then leaving, the unstable state emits photons which can be seen using a conventional photo detector. When the output laser is at exactly the correct frequency, the photon emissions due to the second laser, stop.

The second laser also cools the ion, as photons leaving the ion have more energy than the exciting photons causing a net energy loss.

In its cool state, the ion's physical position can be fixed to within ±30 nm, reducing Doppler distortions in the output spectrum. (Source: *Electronics Weekly*, 26 February 1997)

### **Technique eases high density circuitry layout**

Plasma & Materials Technologies says it has developed a way of laying down silicon dioxide insulation that dramatically reduces interference between transistors on a chip. The technique promises to ease the development of higher density circuitry. Using a liquid-based process called Flowfill, instead of gases, the company says it is possible to create insulation with a dielectric constant below 2.0 compared with industry standard of 3.5. Plasma & Materials says that several of its customers have begun testing the system and that it should be commercially available later this year. (Source: *Electronics Weekly*, 26 February 1997)

### **Self-repairing chip improves LSI reliability**

NEC researchers have produced a transparently self-repairing chip architecture. Called an Autonomous Reconfigurable Cell Array (ARCA), it is designed to improve the reliability of LSI circuits with over 10 million gates. The ARCA is a programmable logic array, of identical fine-grained logic blocks, but each block continually self-checks and its function is re-mapped automatically onto another block if a fault is found. (Source: *Electronics Weekly*, 26 February 1997)

### **US project develops new capacitor material**

A new material for making capacitors, developed under a US DAPRA project, offers a better chance for ferro-electric memory to be incorporated into mainstream DRAM technology as well as simplifying Gbit DRAM structures. The material, called barium strontium titanate (BST) was developed in a four-year project in which the partners were device manufacturers IBM, Micron Technology, and Texas Instruments, with semiconductor equipment manufacturer Varian Associates and two universities: Aachen University of Technology and North Carolina State University. (Source: *Electronics Weekly* 26 February 1997)

### **Capacitance sensor is a foot above the rest**

Sensatech has developed the world's first capacitance sensor that measures to an accuracy of 0.1 mm. The Brighton (UK) based firm has designed sensor arrays which can measure the three-dimensional profile of objects with an accuracy of 0.1 femto farads, 150,000 times more sensitive than current off-the-shelf devices.

The sensor technology has already been adopted by a shoe retailer which, in conjunction with Sensatech, has developed a foot gauge. It uses up to 1,800 sensors to determine the size and shape of the foot.

A foot gauge prototype already exists and the product is expected to hit the high-street shops later this year. The foot gauges will initially be manufactured by Sensatech.

Sensatech's sensor uses capacitance to measure the electric field around an object. Each sensor in a matrix senses its surroundings in all directions. Once charged and discharged, and depending on whether there is an object present or not, the measured voltage differences are used to determine the distance to that object.

For a regular-shaped object such as a block, the pattern of the sensors' capacitance will be regular. An irregular shaped object, such as a foot, will result in an irregular capacitance pattern. Applying statistical methods to these patterns determines the dimensions of the foot.

Other envisaged uses for the sensor array technology include medical, automotive and industrial applications. (Source: *Electronics Weekly*, 26 February 1997)

### **See through technology**

Researchers at Lucent Technologies' Bell Labs have used a single laser to generate 206 channels of data communication using wavelength-division multiplexing (WDM) techniques. The development promises to increase the capacity of optical fibre networks. Using a single femtosecond laser and light pulses each lasting just 100 millionths of a billionth of a second, the researchers managed to send data over 206 channels—the largest number of communications channels ever generated. The technique takes advantage of the fact that different wavelengths of light travel through the optical fibre at different speeds. This dispersion effect is usually a problem, but is essential for this approach if use of all the communications channels is to be made. Lucent claims the technique is still far from commercial deployment but could play an important part in future WDM communications systems. (Source: *Electronics Weekly*, 26 February 1997)

### **Nanoscale test tubes**

Researchers at Georgia Institute of Technology (Atlanta) say they have carried out a chemical reaction in the world's smallest test tubes—carbon nanotubes with inside diameters of less than 10 nanometers—and that the work could eventually pay off in microelectronic applications. Georgia Institute of Technology scientists, working with researchers at the Ecole Polytechnique Fédérale de Lausanne in Switzerland and the Laboratorio Nacional de Luz Sincrotron in Brazil, filled carbon nanotubes with molten silver nitrate; they then decomposed the silver nitrate into metallic silver by heating the tubes with a beam from an electron microscope. (Source: *Chemical Week*, 1/8 January 1997)

### **Researchers build optics into silicon**

A team of engineers has married electronics and optics by integrating a porous silicon light-emitting diode into conventional microelectronics circuitry. The all-silicon system can process light as well as electricity. The work is the

first use of silicon for both electronic and optical components on a single chip.

Currently, engineers must turn to other materials, such as gallium arsenide, to provide optical capabilities. However, these materials pose problems. They are either much more costly than silicon, or extremely fragile. Integrating them with silicon circuits demands large and costly changes in fabrication lines where chips are manufactured.

The substrate used in this work is a specially prepared type of silicon, known as porous silicon because it is permeated with pores and emits light. However, porous silicon is fragile. The team strengthen the material by chemically modifying it. They removed hydrogen atoms from the outer layer of tiny silicon nano-particles less than 100 angstroms wide. They replaced the hydrogen with a double layers of silicon oxide to create a modified form of porous silicon known as silicon-rich silicon oxide. These steps enable the material to withstand a temperature of  $900 \pm ^\circ \text{C}$ , as well as other processing steps such as deposition and etching.

The team from the University of Rochester and the Rochester Institute of Technology was led by Professor Philippe Fauchet. (Reprinted with permission from *Semiconductor International Magazine*, January 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### **First 0.25 $\mu\text{m}$ wafers processed at Crolles**

France Telecom-CNET and SGS-Thomson Microelectronics have successfully processed first wafers using a 0.25  $\mu\text{m}$  CMOS process, developed at SGS-Thomson's 8 in. plant in Crolles, near Grenoble, France. Having successfully produced several prototype integrated circuits, SGS-Thomson will supply full design tools to lead customers, mostly in the computer/peripheral and communication/multimedia market sectors at the end of the year. The first prototypes of customer designs will start production in the second quarter of 1997. (Reprinted with permission from *Semiconductor International Magazine*, January 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA.)

#### **Surgical laser**

Research on semiconductor lasers suggests that these small, relatively inexpensive devices might replace more powerful, costly and bulky gas lasers in some surgical applications. In computer simulations, the new approach appears to be able to solve the tendency of superconductor lasers to fragment into a number of parallel, but weaker beams, say graduate student John Marciantie and professor of optics Govind Agrawal at the University of Rochester. They say it will be possible to build a laser with a unified beam no wider than a grain of sand with the power efficiently packaged in the centre. Also possible are power ratings of 6 to 12 watts, two to four times that of current devices. (Source: *Industry Week*, 6 January 1997)

#### **Tflops barrier broken with parallel Pentium computer**

Intel has built the first parallel supercomputer to achieve more than one trillion floating point operations per second (Tflops), breaking the previous record of 368.2 Gflops.

Intel claims to now have the computing horsepower needed to address the grand challenges of science. These include applied fluid dynamics, environmental modelling, ecosystem simulations and biomedical imaging.

The computer achieved its 1.06 Tflop (Linpack) performance using only 7,264 of its planned 9,260 200 MHz Pentium Pros installed. The final system will have 575 Gbyte of system memory and 2.25 Tbyte of disk storage. Sustained operation at 1.4 Tflops is predicted, peaking at 1.8 Tflops.

The 7,264 processor configuration has 454 Gbyte of storage and resides in 57 equipment cabinets.

The computer is being built with help from Sandia National Laboratory and will be installed in stages at Sandia's New Mexico facility during the first half of this year.

The Linpack method is used to measure the sustained floating point performance of high-end computers operating on large linear systems, a category that includes many technical applications. (Source: *Electronics Weekly*, 8 January 1997)

#### **Hard disk storage record**

IBM's researchers are claiming a storage record by demonstrating product components working together to write and read data on a computer hard disk at a density of 5 Gbit per square inch, nearly three times the density of today's disk drives. Test data was read at 80 Mbit/s with an accuracy of one error in every billion bits, which, according to IBM, could be countered through the use of standard error-correction procedures. (Source: *Electronics Weekly*, 8 January 1997)

#### **Italians triumph with 0.8 V bipolar op-amp**

Engineers in Italy have developed a rail-to-rail output, precision input, bipolar op-amp operating with a supply of only 0.8 V.

Designing the circuit with bipolar transistors brings with it the problem that the  $V_{BE}$  of a bipolar transistor is around 0.7 V. This leaves only 100 mV for other circuit elements to operate within.

Final measured characteristics, in a sample fabricated by SGS-Thomson Microelectronics, show an input offset of 0.4 mV, current consumption of 0.75 mA and an output swing of 90 per cent of  $V_{cc}$ . The input common mode range, governed by the p-n-p input transistors, is -0.3 V to  $V_{cc}-0.7$  V.

Output stage employs a complementary common emitter pair, rather than the usual emitter follower design. This type of output is difficult to drive effectively and doing so requires a lot of transistors. The design uses at least double the usual number. (Source: *Electronics World*, February 1997)

#### **Full-colour miniature ferroelectric display**

A ferroelectric liquid crystal (FLC) system mounted over a custom silicon CMOS VLSI spatial light modulator (SLM) backplane technology has been used to produce low-power miniature colour displays. The backplanes are produced by a standard silicon wafer foundry process.

This work has been carried out in the Departments of Electrical Engineering and Physics and Astronomy, University of Edinburgh, in collaboration with the GEC-Marconi Research Centre (Great Baddow, Chelmsford, England).

A reflective SLM is actively illuminated by three high-intensity coloured LEDs. These emit light in red (670 nm, 3-cd), green (525 nm, 6 cd) and blue (450 nm, 1 cd). The SLM consists of a 176 x 176 array of single transistor DRAM style pixels of 30  $\mu\text{m}$  pitch. The display is produced by the GEC-Marconi Research Centre. It is operated in a binary amplitude mode and has an overall active area of 5.28 x 5.28 mm with an 81 per cent pixel flat factor.

A process is under development to produce wafers polished flat to <10 nm rms. Vias are defined by standard lithographic and etch techniques to connect the flat mirror/electrodes to the underlying circuitry.

The display technique involves cycling through a series of binary images with each frame being illuminated by a coloured 3 LED for a period of time that, when averaged by a human vision system, produces the required colour. An eight binary frame, 3 LED illumination system operating at an overall viewing frame rate of 50 Hz can generate 256 different colours, including black and white. Many more colours are possible with higher speed backplanes. The colour images produced by the SLM correlate very well with the same image viewed on a PC monitor screen. (Extracted with permission from *Semiconductor International Magazine*, February 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA.)

### **Researchers demonstrate GaAs MOSFET**

A group of researchers from Lucent Technologies has solved a problem that has puzzled researchers for 30 years—how to create GaAs metal oxide semiconductor field effect transistors (GaAs MOSFETs). The team, led by Ming-Hwei Hong and Fan Ren of Bell Laboratories, the research and development arm of Lucent Technologies, has disclosed that it succeeded in depositing a special formulation of gallium oxide as the gate dielectric on a GaAs semi-insulating substrate to fabricate both p-channel and n-channel GaAs MOSFETs.

“We have successfully demonstrated the first enhancement-mode GaAs MOSFET with an inversion channel”, Hong said, “by combining ion implantation and oxide deposition processes. This promises to make GaAs MOSFET devices very attractive for a variety of applications because we are using mainstream GaAs technology that is currently being used by the industry to make GaAs metal-semiconductor field-effect transistors (MESFETs). One obvious application of GaAs MOSFET devices could be for mobile wireless communications”.

Numerous attempts with anodic, thermal and plasma oxidation and deposition of various dielectric materials have been used to passivate the GaAs surface. However, until the Bell Labs team succeeded in its proof-of-concept demonstration—efforts to make viable devices eluded researchers due to, among other things, the poor quality of the interface between the gate oxide and the GaAs substrate.

In the silicon oxide-to-silicon (SiO<sub>2</sub>-to-Si) gate-to-substrate, the interfaced state density of the two materials is about 10<sup>10</sup> cm<sup>-2</sup> eV<sup>-1</sup>, making it ideal for the direct current (dc) and low-frequency operation of the Si devices. In contrast, researchers in the past found it very difficult to match the densities of Si devices when interfacing oxides to the GaAs substrate. This resulted in poorly operating devices.

“Oxidation of gallium arsenide does not make a good oxide”, Hong said, “but we have solved this problem by using ion implantation and MBE to deposit a special formulation, which is basically Ga<sub>2</sub>O<sub>3</sub>, onto the GaAs substrate. With this formulation, we have been able to create a Ga<sub>2</sub>O<sub>3</sub>-to-GaAs interface with a state density in the low 10<sup>10</sup> cm<sup>-2</sup> eV<sup>-1</sup>. We have solved the interface problem at last!” (Reprinted with permission from *Semiconductor International Magazine*, February 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA.)

### **MOSFET with bipolar characteristics**

Professor K. Yoh and his colleagues at the Research Center for Interface Quantum Electronics, Hokkaido

University, in collaboration with Hitachi Ltd., have developed a new MOSFET with increased current capability. The configuration is identical to that of conventional MOSFETs except that the gate electrode has a small contact window. The modified MOSFET thus operates in combined FET and bipolar modes.

A prototype of the new MOSFET had up to four times as much drain current and transconductance as predecessors with the same threshold voltage. With a 1.3 μm-long gate, the prototype had a performance comparable to a conventional MOS with a gate 0.1 μm long. The new design promises to enable smaller transistors without losses in operation characteristics, and may lead to a deep submicron generation of high-speed devices.

Further details from Research Center for Interface Quantum Electronics, Hokkaido University, Nishi 10-chome, Kita 11-jo, Kita-ku, Sapporo City, Hokkaido 060. Tel.: +81-11-716-2111; Fax: +81-11-757-1165. (Source: *JETRO*, February 1997)

### **Interferometric system profiles flip-chip bumps**

Wyko Corp. has developed a non-contact bump characterization system to analyse flip-chip devices with a stated bump height resolution of 10 nm, and accuracy of 0.2 μm. The automated Bump Measurement Profiling System (BMPS) is a three-dimensional, vertically scanning interferometric microscope designed to measure bumps with heights ranging from a few nanometres to 1 mm.

The system uses a white light interferometer, typically a Michelson interferometer, to obtain fringe patterns from the bumps. The contrast of the fringes is maximum when the optical path lengths of the two arms of the interferometer are the same, in other words, when the bumps are in best focus. The adjustment required to obtain the maximum contrast yields the height information. Since it is a white light interferometer, using a tungsten halogen lamp, no laser safety training is required for users of the equipment.

The system is designed to automatically measure not only height, but also width, volume and area of the bumps. Missing, bridged and extra bumps can also be detected, and statistics from the bump level to the lot level can be tracked. All of this is done non-contact, allowing the system to be used to perform pass-fail tests in production. Measurement times for the system are said to approach a tenth of a second per bump.

The company claims that the BMPS is the only tool that can repeatedly measure bump heights below 150 μm, as well as provide volume data on all bump sizes. Also, the repeatability of individual bump height measurements is said to be within 1 per cent across a wafer, and better than 0.35 per cent across a die. Since the measurements are non-contact, calibration can be done as often as necessary using NIST traceable step height standards. The company claims gauge-capable repeatability and reproducibility.

The speed of the white light interferometric technique makes it possible to collect all of the necessary data in real time. (Reprinted with permission from *Semiconductor International Magazine*, February 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA.)

### **Thumb-sized optical spectrometer**

Oak Ridge National Laboratory (ORNL) has developed an optical “microspectrometer”, designed for use in chemical detection. This “microspectrometer” has a volume of 6 cm<sup>3</sup>. The device is said to be low-cost, rugged and tuneable for visible and infrared applications. The fabrication technique

uses diamond turning equipment originally developed for the Ballistic Missile Defense Organization (BMDO).

Researchers at ORNL have identified a wide variety of applications for the device. Lockheed Martin Energy Research Corp., ORNL's operator, is offering non-exclusive licences in the infrared range of 0.7  $\mu\text{m}$  to 5.0  $\mu\text{m}$ .

For more detailed technical information, contact Slo Rajic of ORNL. Tel.: (423)-574-9416. (Reprinted with permission from *Semiconductor International Magazine*, February 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA.)

### **New superconductor discovered**

The Advanced Science Research Center of the Japan Atomic Energy Research Institute (JAERI) recently announced the formulation of uranium-platinum 3 ( $\text{Up}_3$ ), a new-type superconductor never known before.

Superconductivity is created by two sets of conductive electrons each making pairs. To date, there have been two known types of superconductivity, the s-wave-type in which the two electrons spin opposite each other, and the d-wave-type in which the direction of spin of the electron pair are the same but are distributed separately from each other. In this new superconductivity, which is called a p-wave-type, the electron waves become reversed left and right and the spins become parallel.

The s-wave-type is the traditional superconductivity discovered in 1911 in mercury. The d-wave-type is a superconductivity model seen in an oxide high-temperature superconductor, discovered in 1986. The present p-wave-type superconductor, which has parallel spin electron pairs, is known to resist breaking down in the presence of a magnetic field.

Although uranium-platinum 3 is not so remarkable at this early stage, if more excellent materials are developed in the future, properties of superconductive magnets could be strengthened extraordinarily.

For further information, contact the Advances Science Research Centre, JAERI. Tel.: 029-282-6735. (Source: *STA Today*, January 1997)

### **Method developed to grow high-quality LN single crystals**

The National Institute for Research in Inorganic Materials (NIRIM) of the Science and Technology Agency (STA) has developed a system capable of growing high-quality lithium niobate (LN) single crystals. As a result, an LN single crystal with a remarkably improved light-induced refraction has been obtained to varyate a refractive index inside a substance irradiated with light.

LN is a substance in which lithium, niobium and oxygen are compounded in the ratio of 1:1:3. A LN single crystal has traditionally been made by immersing the seed crystal into the molten liquid material and pulling up the seed slowly by rotating it (called the CZ method). But only crystals containing a large amount of excess niobium have been obtained by the CZ method.

Accordingly, under the same crystal-growth principle, NIRIM dualized the structure of the crucible into which the molten liquid is placed, fed the raw material with the same composition as the crystals to the molten liquid in the same amount as the produced crystals, and thus grew crystals of homogeneous composition. Furthermore, the crystal growth rate was monitored every second, and a system to feed a proper amount of raw materials was automatically developed.

The fact that the light-induced refractory effect can be utilized for high-speed and mass-storage hologram memory has been known for at least 20 years, but the development of materials which have such an effect has been greatly delayed. The successful development of this system could lead to further development of hologram memory and light-amplifier devices. For further information, contact the 13th Research Group, NIRIM, STA. Tel.: 0298-51-3351. (Source: *STA Today*, January 1997)

## D. MARKET TRENDS AND COMPANY NEWS

### Market trends

#### **Global billings report**

The Semiconductor Industry Association (SIA) is launching a new statistical programme that reports industry sales on a world-wide basis. This new programme, the Global Billings Report (GBR) replaces the monthly book-to-bill report that the SIA has published since 1978.

The book-to-bill programme covers the Americas market which represents 33 per cent of the world market. More than 50 per cent of all sales for US-based chip companies are now outside the Americas market.

Instead of focusing on book-to-bill ratios for just one major market, people will get to review sales numbers from all four major markets, (the Americas, Japan, Asia-Pacific (excluding Japan) and Europe). The data will include year by year and month by month comparisons for each market. Additional market information will be furnished to SIA subscribers. (Extracted with permission from *Semiconductor International Magazine*, January 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

#### **Microfiltration market to grow**

Due to a trend towards finer, purer, high performing filtration products, the US market for Microfiltration is poised for strong and steady growth, according to research by high technology market research publisher Frost&Sullivan.

Revenues in the market for Micro filtration products are predicted to grow from \$549 million in 1995 to \$956.2 million in 2002, a compound annual growth rate of 8.2 per cent forecasted in the report, US Microfiltration Markets.

The study provides an analysis of six sectors of the market: cellulose membrane microfilters, nylon membrane microfilters, polytetrafluorethylene membrane microfilters, polyvinylidene difluoride membrane microfilters, polysulfone membrane microfilters, and polypropylene microfilters. All of the specific segments are experiencing growth between 8 per cent and 12 per cent annually, with the exception of cellulose membrane products. (Reprinted with permission from *Semiconductor International Magazine*, January 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

#### **Imaging/document management trend**

The imaging/document management world is growing and maturing. It is coming into the mainstream of computer capabilities and uses; and despite different emphases and nuances, imaging and document capabilities are core technologies that will co-exist and integrate with departmental and enterprise systems and vital application solutions. The most significant trend for 1997 will be the idea of imaging and related technologies all overlapping even more than now. Workflow, document management, groupware and even text retrieval software will have more overlap.

Another major trend for 1997 will be the convergence of what have been separate products to handle document imaging and document management or COLD into a seamlessly integrated family of products. This is response to users wanting the ability to access documents of all types

from their desktop through a single mechanism. The Internet and Intranet will also have a huge influence on the complexion of imaging systems. The Internet is going to let users deploy new classes of applications that they did not previously envision from anywhere in the world.

The imaging and document management industries will continue to consolidate through mergers, acquisitions and strategic alliances that require integration of organizations. This will result in a downsizing of staff and a higher level of automation within the manufacturers and vendors. Laid-off professional staff will reorganize into new companies with new products. The total number of companies in the industry will not shrink and may even grow. Value-added resellers will continue to gain importance, especially those with vertical market expertise. (Source: *Inform (AIIM)*, January 1997)

#### **NCs to overtake PCs in five years**

Half the UK's large companies believe that network computers (NCs) will replace PCs as the choice for corporate desktop computing within the next five years, according to City market analysts, Durlacher Multimedia, with mounting enthusiasm for the NC.

The Durlacher Intranet Report 1997, which is based on interviews with 100 IT directors and managers from the top 1,000 UK companies, cites that corporate Intranets will help to drive the change to NCs. However, the savings in PC software and hardware upgrade costs will be the key driver.

The claim is backed by BT, which was the first European company to deploy Sun Microsystems' JavaStation NC. (Extracted from *Electronics Weekly*, 12 February 1997)

#### **A wave of change in IT**

Chemical manufacturer's spending on information technology (IT) is likely to remain steady or increase slightly in 1997 as companies begin to use the supply chain management-oriented system they have spent the past two or three years designing and installing. For some chemical companies, 1997 will mark the startup for enterprise resource planning (ERP) systems—large, often global information technology installations designed to link manufacturing, engineering and financial computer systems.

According to Gartner Group, large global chemical companies are currently budgeting 1.85 per cent of sales for information technology. In general, companies will upgrade desktop computers; many will implement company-wide standards to simplify maintenance and reduce operation costs on a global network. Large firms, including Dow, Eastman, and Amoco, announced plans to standardize desktop PCs globally in 1996, and others will follow their lead in 1997.

Some companies that have restructured business processes and IT simultaneously have experienced runups in cost and delays in starting up ERP systems. Performance expectations for IT have risen, however.

Several tools and adaptations to process industry ERP systems have been introduced during the past year and are likely to result in last-minute additions to ERP architectures in 1997. These include process modelling software and production planning tools. SAP (Waldorf, Germany)—the

world leader in financial ERP systems, with over half the market share in process industry—introduced its Process Planning-Production Industry (PPPI) system in late 1995, and the first installation went on-line at Monsanto in September. Monsanto is expected to implement it at three to five more chemicals sites in 1997. SAP expects PPPI startups at 30-50 new sites in 1997.

As chemical makers continue efforts to globalize, Internet and Intranet may grow into a key part of their IT strategy. The breadth of the Internet, its universal protocols, and a new generation of Internet software such as Netscape's Navigator 3.0 and Point-Cast Network, will allow chemical makers to share information seamlessly and independently of computer platforms. In turn, Internet computing is opening new doors in electronic commerce and supply chain management, tightening ties between suppliers and their customers. (Source: *Chemical Week*, January 1997)

**Overcrowded telephone networks**

Pacific Bell warned last autumn of the danger of collapse at 16 switching centres, because of the length of time people were spending hooked up to the Internet. The problem is the American phone companies' policy of not charging for local calls. With no incentive to logoff, Californian surfers are staying hooked for anything between 20 minutes and an hour, on a system originally designed for voice calls lasting about four minutes.

All the same, there is no longer any real rationale for charging for local calls. In a report published about a year ago, *The Internet in 1996: An Investment Perspective*, London stockbroker Durlacher pointed out the long term marginal costs associated with local calls were heading towards zero. It warned that technological developments could leave operators with "an obsolete system of no obvious value, other than the recycle value of the copper in the cable". Among the developments it was referring to was the Internet's potential to carry voice traffic.

However, if a recent Reuters' report is to be believed, one in four people admits to suffering from ill health as a result of the amount of information they are now having to absorb. Floods of faxes, e-mails and Internet data are causing managers mental anguish and physical side-effects, spoiling their leisure time and damaging personal relationships. Reuters have even coined a phrase to describe the condition: Information Fatigue Syndrome. Plagued with anxiety about missing something important, the temptation to read the unsolicited information coming in over the Internet will probably remain irresistible. (Source: *Information World Review*, 121, January 1997)

**Changing the business process boundaries**

Not too long ago the phrase "business automation" meant putting a computer on every worker's desk. The emphasis has switched and today the concentration is on automating the very process of work capturing and tracking a company's dynamic business processes to manage the flow of work throughout a department and enterprise. Consequently, Business Process Automation (BPA) is one area which is on the cards to be completely transformed by the Internet.

The value of the Internet can be summarized concisely: it is ubiquitous, providing users anywhere in the world with access to a common network. Access is inexpensive, installation and usage is easy. It is this foundation that has spurred the development of new Internet technologies and software applications, the capabilities of which encourage

greater use of this communication medium and huge information repository by an ever increasing number of users.

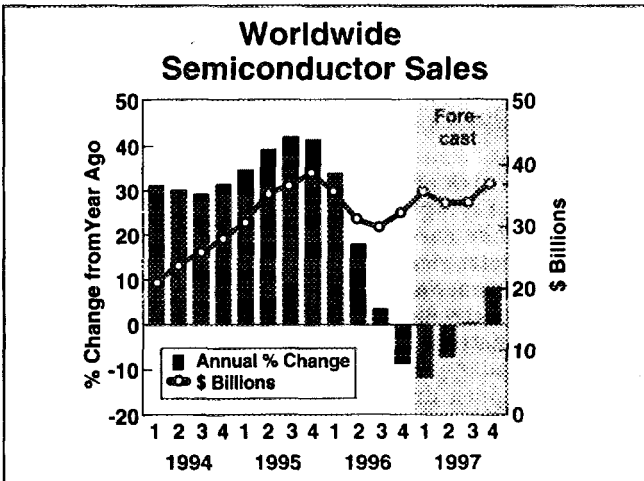
The Internet is a perfect medium for extending the reach of critical business processes. Its structure means that, physically at least, users are able to distribute work between BPA systems either across departments via intranets or between organizations via the Internet, originating and tracking work gleaned from Web pages. The Internet has provided the means by which organizations can, for the first time, cost-effectively automate processes for benefit by a breadth of diverse users, including remote and casual users, distributed organizations, vendors, partners and most importantly customers. BPA will receive a significant amount of benefit from Internet technologies not only in the kinds of applications that can now be BPA-enabled but more importantly, in the kinds of users that can become integral to the process. (Source: *Information Management and Technology*, 30(1), 1997)

**1997 at a glance**

The semiconductor industry has progressed faster than predicted, and could have 0.25 μm processes into production by the end of 1997, and 0.18 μm processes by 1999. The first 4 Gb DRAM will be unveiled in February, and a newly revised roadmap will be out by the end of the year. Fifty new fabs will be in various stages of construction and tooling in 1997, with many more planned over the next few years. If that is not enough, the industry is gearing up for what could be the most expensive re-tooling in history as it transitions to 300 mm processing. (Extracted with permission from *Semiconductor International Magazine*, January 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

**Strong market growth for microprocessors**

World-wide sales of microprocessors have begun to firm up in recent months, signaling a bottoming out in the semiconductor market. The rapid decline in sales in the world-wide semiconductor device market extended in to the microprocessor market over the last year. Now, total sales, average selling prices and unit shipments have stabilized and are on the up-swing. This is favourable news despite the continued slowness in other chip segments, principally in the memory product sector. The book-to-bill ratio has remained strong in the last two months. Monthly sales billed have increased over the past four months.



Source: World Semiconductor Trade Statistics Forecast: Cahners Economics



Worldwide semiconductor markets										
	US\$ Billions					% Change from a year ago				
	Total 1995	Q2 1996	Q3 1996	1996	1997	Total 1995	Q2 1996	Q3 1996	1996	1997
World	144.40	31.89	30.73	132.17	143.45	41.7	18.2	3.7	-8.5	8.6
- Americas	47.00	10.11	9.70	43.06	46.10	40.0	21.7	6.0	-8.4	7.1
- Japan	39.66	8.38	8.30	34.03	37.47	35.0	8.9	-3.5	-14.2	10.1
- Europe	28.20	6.64	6.20	27.76	30.04	43.0	21.9	8.1	-1.6	8.2
- Asia/Pacific +	29.54	6.76	6.53	27.31	29.84	54.1	22.4	5.5	-7.6	9.3
ICs	126.10	27.54	26.54	113.10	120.52	43.0	19.4	4.3	-10.3	6.6
Discretes	18.35	4.34	4.19	18.41	19.72	33.7	10.7	-0.4	-1.5	8.1
Historical data: WSTS						Forecast: Cahners Economics				

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### 300 mm equipment evaluation under way

The evaluation of 300 mm alpha and beta production equipment recently got under way in the United States and Japan, as device makers gear up for the first 300 mm pilot lines scheduled to begin operation in 1998. The transition from 200 mm to 300 mm wafers is said to be the most expensive industry re-tooling in history, with an overall cost estimated at about \$13 billion. Yet chip-makers believe it is well worth it, since they can obtain more than 2.5 times as many chips from a 300 mm wafer than a 200 mm one.

Equipment evaluation is under way in the United States at I300I (International 300 mm Initiative) in Austin, Texas and in Japan at a group called Selete (Semiconductor Leading Edge Technologies) in a Hitachi facility in Yokohama.

Work on 300 mm standards is also well under way; although not quite finalized, it appears as if the industry has settled on 13 and 25 wafer cassette sizes, and side-opening cassette pods. Handling will likely be done with a combination of open cassette and mini-environment SMIF-type enclosures.

Mechanical grade 300 mm wafers are presently available in large quantities, suitable for equipment handling evaluation; prime wafers should be available by late 1997 or early 1998. (Extracted with permission from *Semiconductor International Magazine*, January 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

### Researching microvias

Three microvia technologies—photo imaging, plasma etching, and laser—are on the research agenda of a North American cooperative programme of the National Electronics Manufacturing Initiative Inc. and the Interconnection Technology Research Institute. Miniaturization driven by the exploding demand for mobile and portable electronics devices, is creating the need for smaller electronic pathways, or microvias, on printed wiring boards. The strategy is to conduct a round-robin build and test project. The intention is to support a component pad density of 400 per inch in 1998 and 600 by the year 2000. By proceeding on a cooperative basis, the two organizations expect to halve the development and implementation time by the domestic industry. (Source: *Industry Week*, 6 January 1997)

### Europe in Asian rise

Despite a slow market for semiconductors in 1996, European chip companies made a strong showing in the Asian/Pacific market, according to US market research firm Dataquest. Company revenues were up by 12.5 per cent, capturing 10.7 per cent of a \$30.1 billion market.

US chip makers also increased their share of the Asian market, with a 38.8 per cent share compared with 33.4 per cent in 1995. The big losers were Japanese and other Asian/Pacific chip makers, whose reliance on memory chips led to declining revenues.

Japanese chip companies showed a decline in market share from 35.3 per cent to 31.1 per cent. (Source: *Electronics Weekly*, 5 February 1997)

### Revenues to double for networking switches

World-wide revenues from semiconductors in LAN switches will be up 98.3 per cent, reaching \$160.2 million by year end 1996, according to International Data Corporation (IDC). Increasing switch sales, which are expected to triple, are a key driver in spite of the forecasted 34.3 per cent decline in average semiconductor content per switch.

These numbers are part of a new report, "Worldwide LAN Equipment Semiconductor Market Review and Forecast", which predicts that semiconductors in LAN equipment overall will reach \$1.36 billion, up 13.3 per cent for the year. Although LAN equipment is a relatively small market for semiconductors, its growth is substantial when compared to IDC's forecasted 6 per cent drop in revenues for the semiconductor industry as a whole. (Extracted with permission from *Semiconductor International Magazine*, January 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

### Company news

#### Microsoft's controls coup

Fisher-Rosemount Systems (Austin) says it has introduced software incorporating Microsoft's Web browser technology that allows users to monitor Fisher-Rosemount control systems on an intranet.



The Fisher-Rosemount Intranet Server uses Microsoft's Internet Explorer technology, which is widely used for database Web browsing, to establish desktop computer monitoring of process graphics and event logs. It will also allow users to query the database of control systems at any one of a company's plants from any computer with access to that company's Intranet. (Source: *Chemical Week*, 18 February 1997)

### **Display link up**

Predicting a large market for desktop flat panel displays, leading PC maker Compaq Computer has teamed up with Mitsubishi subsidiary Advanced Display to create a line of colour, high resolution desktop displays.

Compaq will design and set the specifications for the flat panels displays and Advanced Display will manufacture them. Compaq says that there is a large potential market for such displays to replace bulky monitors in industries such as healthcare and financial services.

For example, stockbrokers often have several CRT monitors on their desks.

Over the long term, there are potential markets in home office applications where desk space is also at a premium. (Source: *Electronics Weekly*, 5 February 1997)

### **Hidden costs of the hummer PC**

With PC support costs running at nearly four times the original purchase price, not only are users complaining loudly but suppliers are taking positive action too. The humble PC shoulders a good proportion of the blame for rising IT costs. It is a conclusion that will surprise some: PCs, after all, are cheap. But peer a little closer at the supposedly inexpensive PC, and some frightening costs emerge.

Every time a new version of a piece of software is released, for instance, a user or a technician has to install it on every single PC which uses that software: and some companies own tens of thousands of PCs. Some large organizations, complaining that they have little control over either the timing or the benefits of such upgrades, are beginning to describe the process as "vendor push". Many large firms now find it quicker and more efficient to employ their own technicians to provide this service rather than rely on software vendors. And if the technicians cannot solve the problem remotely, they will have to make a personal visit, obviously adding further to the costs.

Oracle is now proposing an alternative. The chief reason that PCs are complicated to build, maintain and support is because they were originally intended to be standalone devices. Today, usually a network exists into which desktop computers can be plugged and automatically configured, and from which software can be downloaded. When software needs to be upgraded, the Oracle's Network Computer logic is to upgrade it once, on the central server Smart cards, like credit cards, that store users' configuration preferences. (Source: *Management Today*, January 1997)

### **Defence on the offence**

The Republic of Korea's Daewoo Group may not eventually end up with the Thomson Multimedia consumer-electronics unit of France's state-owned Thomson SA. But with the privatization of Thomson still going forward, the USA is still likely to confront a powerful new defence rival in world markets. The French Government intends for missile-maker Matra, part of Lagardere SA, to acquire

Thomson-CSF, state-owned Thomson's defence business. (Source: *Industry Week*, 6 January 1997)

### **SGS-Thomson enters top ten for first time**

SGS-Thomson Microelectronics has made it into the ranks of the world top ten semiconductor manufacturers and, for the first time, has displaced Philips as Europe's largest semiconductor company.

In a world market which declined 7 per cent SGS-Thomson grew 24 per cent—a growth rate which was exceeded, among the major companies, only by Intel (29 per cent). SGS-Thomson leapt four points in the world semiconductor league from 14 to hit the top ten for the first time.

The main sufferers were, as expected, the DRAM makers whose market fell nearly 40 per cent with price declines of three fourths during 1996. Samsung's revenues declined 26 per cent worldwide and over 30 per cent in Europe. An exception was Hitachi which benefited from product diversification and gained one point in the European rankings from tenth to ninth.

As a result of the DRAM price collapse, America overtook Japan as the top regional supplier. (Extracted from *Electronics Weekly*, 8 January 1997)

### **Push technology**

The on-line industry seems to be moving towards a future that looks like the past: television.

Suddenly, companies are scrambling to embrace the television business model. America Online Inc. executives constantly compare their big on-line service to cable television.

The industry is excited by something known as push technology, which delivers customized data from the Internet directly to personal computers, because it "broadcasts" information, presumably giving advertisers a television style captive audience, and the offerings of on-line services are labeled "channels."

Mining Co., a start-up concern based in New York, is seeking to recruit as many as 4,000 producers on the World Wide Web, each operating a special-interest site on the company's service.

Industry analysts who have seen Mining Co.'s prototype service describe it as a hybrid that blends features of an Internet search engine such as Yahoo! with those of an on-line service such as America Online Inc.

Mining Co.'s network, which is free to consumers, has a home page—[www.miningco.com](http://www.miningco.com)—from which users can tap into subject sites. It hopes to make money from advertising. (Extracted from *International Herald Tribune*, 11 February 1997)

### **TI to build 300 mm fab in Italy**

Texas Instruments (TI, Dallas, Texas) has signed a \$1.2 billion contract with the Italian Government to build its second wafer fab in Avezzano, Italy. The new fab, called AMOS 3, will manufacture 0.28  $\mu\text{m}$ , 300 mm (12 in.) wafers for Flash and other memory chips. TI expects the first production of wafers by early 1999. The fab is expected to reach full capacity in the year 2000, producing 6600 wafers per month. The manufacturing process will enable TI to scale down to 0.18  $\mu\text{m}$  technology and below. (Reprinted with permission from *Semiconductor International Magazine*, February 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA)

## E. APPLICATIONS

### **Motion estimation**

The MPEG-2 video and audio encoder market, confined to professional broadcast and video authoring applications, looks set to take off this year.

MPEG-2 encoding is significantly more computationally demanding than the decoding. This is primarily due to motion estimation (ME), which involves identifying blocks of 16x16 picture elements within search windows of future and past reference video frames. ME generates concise motion vectors, to introduce compression.

NEC's MPEG-2 encoder IC implements the main level at main profile standard. An MPEG-2 system based on NEC's encoder also includes an audio encoder, two 16 Mbit synchronous DRAMs, and a microprocessor for handling the audio stream, video rate and search range for the motion estimation.

The ME hardware comprises a first and second search unit and an embedded cache. (Extracted from *Electronics Weekly*, 12 February 1997)

### **Slimline battery charge**

Paper-thin batteries inside the plastic casing of products, inside smartcards, incorporated in clothing and embedded in the body could all be seen during 1997, according to Malcolm Howes, manager of the stationary battery division at Yuasa.

Yuasa's lithium polymer batteries can be made as thin as 0.2 mm—twice as thick as the average sheet of paper—but within the thickness of high quality writing paper and much thinner than the cover of a paperback book.

That has been made possible by the development of polymer-lithium batteries. As a new technology, the production cost is still high—about five times the cost of producing conventional lithium button cells—but Howes expects dramatic cost reductions as production volumes increase.

The batteries enable one of the products of the next decade: wearable computers powered by batteries in the form of belts, shoe soles, or clothing. (Source: *Electronics Weekly*, 15 January 1997)

### **High-speed wireless LAN PCMCIA card for advanced mobile computing**

NEC Corp. has developed the world's first high-speed wireless LAN (local area network) PCMCIA (Personal Computer Memory Card Interface Association). The card allows notebook computers with a PC card slot to achieve wireless transmission speeds of up to 25 Mbps—12.5 times faster than current wireless networks. This offers easy mobile access to office networks and the Internet.

The new NEC PCMCIA features exceptional signal reception clarity and speed, achieved through a high-speed modem chip and technology that allows the card to extract higher signal quality from its antennas.

NEC's high-performance V800 RISC (reduced instruction set computing) micro-processor can run software-based signal processing, achieving extremely high speeds. The new card is also programmable—a world first in an extremely compact PC card package. The best speeds achieved by wireless LAN products to date is 2 Mbps; PCs on fixed networks still attain an average of 10 Mbps on Ethernet,

which is the corporate standard for LANs, or 0.4 times the speed of the new development.

Future applications of the card span mobile shopping and access to various information services. This will be a step towards liberalization of users from location, and ultimately to the realization of deskless offices. NEC is investigating further miniaturization of this technology and promotion of supporting infrastructure. Further details from NEC Corporation, Public Relations, 5-7-1, Shiba, Minato-ku, Tokyo 108-01. Tel.: +81-3-3798-6511. Fax: +81-3-3457-7249. (Source: *JETRO*, February 1997)

### **Data storage**

Document management, pre-press imaging, CAD and other tasks involving fast delivery of data can be handled efficiently with a compact drive using LIMDOW, light intensity modulation direct over write technology. The DW260 drive from Plasmon offers impressive performance for less than £1,500 and additional storage of data is limited only by the £75 cost of media. Dukebox storage allows users to increase capacity as required. Existing investment in magneto optic systems is protected, with full read and write compatibility to standard disks. The drive reads and writes to 2.6GB and 2.3GB rewritable, WORM and LIMDOW disks, as well as being read and write compatible with earlier 1.3GB, 1.2GB, 650MB and 600MB ISO media. The drives also allow data interchange between Macintosh, Windows and WIN 95 platforms.

The LIMDOW technology is an advance on methods which required two disk rotations to record data; one to erase and another to write. A multi-layered media, incorporating two laser modulated magnetic layers allows data to be written in one pass, "on the fly" halving the time required. According to Plasmon Data Ltd., LIMDOW is closing the performance gap between optical and hard drives, and a consortium from industry is working with standards organizations to ensure a secure future for LIMDOW technology. Further details from: Alan Russell or Stewart Vane-Tempest, Plasmon Data Limited. Tel.: +44-1763-262963. Fax: +44-1763-264444. E-mail: arussell@plasmon.co.uk / stewart@plasmon.co.uk. Source: *Technology Ireland*, February 1997)

### **Fractal antennas "in use within a year"**

A US company is predicting that fractal antennas will be used in a commercial product this year.

A fractal antenna is effectively a track pattern on a pcb which is used as an antenna. The form of the pattern is determined using fractal maths.

Fractal Antenna Systems makes some significant claims for its designs. Its Fractal Micropatch is said to "incorporate the benefits of conventional patch antennas, but at a fraction of the size". (Extracted from *Electronics World*, February 1997)

### **TI RAM cell design saves power in ICs**

Texas Instruments (TI) claims to have demonstrated a static RAM cell in a III-V semiconductor with 200 times less power consumption than previous designs.

Known as tunnelling-based static RAMs (TSRAMs), the quantum devices have been demonstrated in indium

phosphide and are said to be readily applicable to gallium arsenide. TI also suggests the basic technique could be transferred to silicon for power saving, of up to 100 times, on DRAM cells.

Each cell employs two resonant tunnelling diodes and a heterostructure FET (HFET). This type of transistor is the fastest known three terminal device.

Power consumption is currently 50 nW/cell, with 10 nW expected after scaling. TI says that the best previous memory cells on compound semiconductors have been around  $20\mu\text{W}$ .

The TSRAM cell is also said to be around 100 square micrometres, 10 times smaller than other memory cells on these materials allowing 1 Mbit on  $1\text{ cm}^2$ . (Source: *Electronics Weekly*, 8 January 1997)

### **Japanese led group pushes out PPRAM**

Risc processors and DRAM have been combined in a single device by a consortium led by a Japanese university and companies including Fujitsu, Mitsubishi, NEC, SGS-Thomson Microelectronics and Toshiba.

The devices are designed to tackle the memory bandwidth bottleneck, and remove the need for high speed memory signals to move off-chip.

Parallel processing RAM (PPRAM) is the result of work by Professor Kazuaki Murakami of Japan's Kyushu University.

A small number of Risc-like processors are integrated into a DRAM memory device. Each processor has its own block of local memory and a register file.

Memory and processors are connected by a fast data interface, removing the need for complex circuit board design.

The combination of a processor and memory block is called a processing element (PE). PEs, and those on other chips, are connected to enable parallel processing to be carried out.

The university is building a test chip that combines four processors with 256 Mbit of DRAM. Thus each processor has 8 Mbyte of local memory.

When constructed on a  $0.25\mu\text{m}$  process, the processor to memory interface will be capable of running at 1 Gbit/s serially or 1 Gbyte/s in a parallel path.

Target applications include multimedia and networking products. Graphics functions such as 3-D rendering could benefit enormously from such an architecture. (Source: *Electronics Weekly*, 8 January 1997)

### **New video camera**

Using a small parabolic mirror to obtain hemispheric views, a TV camera developed at Columbia University's School of Engineering & Applied Science has potential in surveillance, teleconferencing, entertainment, and computer vision. In the surveillance mode, two are mounted back-to-back, providing a view encompassing 360 degrees. For teleconferencing, the omniscam can simultaneously show every participant seated at a table—in either hemispheric or linear perspective. Omniview software developed by graduate student Venkat Peri generates the linear perspective and several views can be displayed simultaneously. (Source: *Industry Week*, 6 January 1997)

### **Laser removes paint, graffiti**

Removing paint without harming the underlying surface has always been a problem. One solution could be a neodymium-yttrium-aluminium-garnet (Nd:YAG) laser, say

researchers at Lawrence Livermore National Laboratory, Livermore, CA. Photons at 1,000 pulses per second travel through the paint layer, ricochet off the substrate, and collide with incoming sound waves, pulverizing the paint and reducing it to a powder. Systems capable of cleaning 3,000 sq ft per hour are envisioned. (Source: *Industry Week*, 6 January 1997)

### **Teaming batteries and energy storage for superconductors**

A new power backup system at Tinker Air Force Base, Oklahoma City, integrates two storage technologies as protection against voltage dips and power interruptions. Short-duration protection is provided by a superconducting storage system from Superconductivity Inc., Madison, WI. That system is teamed with a large battery system from Exide that can accommodate outages up to several minutes. The superconducting system uses niobium-titanium wire and is housed in a stainless-steel cryostat. Liquid helium keeps the superconducting magnet at  $-452\text{ F}$ . Superconductivity Inc. says its system can be quickly charged and discharged thousands of times without degradation. (Source: *Industry Week*, 6 January 1997)

### **Dipstick on a chip**

Work on the world's most powerful laser has spun-off a sensor that is now being sold as a "virtual" dipstick.

The 100-trillion-watt Nova laser at Lawrence Livermore Laboratory, California, was designed for nuclear fusion research. As part of the project, engineers had to develop a high-speed data-acquisition system to capture data generated by the sub-nanosecond events. They produced what is effectively a high-speed oscilloscope combined with a digital read-out. The instrument, called a transient digitizer, records many samples from single electrical events, each lasting five billionths of a second.

Tom McEwan at Lawrence Livermore decided that the sampling circuits developed for the device could form the basis of a sensitive receiver for an extremely small, low-power radar system. He focused his work on the concept and perfected the micropower impulse radar (MIR)—radar on a chip.

Its principal components are a transmitter with a pulse generator, a receiver with a pulse detector, timing circuitry, a signal processor and an antenna. The MIR transmitter emits rapid, wideband radar pulses at a nominal rate of two million per second. The rate is randomized to create a distinctive pattern at a single location so the chip does not pick up other radar signals by accident. The receiver uses a pulse detector circuit and only accepts echoes from objects within a pre-set distance—from a few centimetres to 50 metres.

The MIR antenna determines the device's operating characteristics. A single-wire monopole antenna only 4 cm long is used for motion sensor applications but longer antennae can give it a greater range, directionality and penetration of materials such as water, ice and mud.

The first application McEwan envisaged was a burglar alarm, out of the 15 licenses already sold by the government-owned laboratory, nine are for electronic dipsticks. The dipstick launches a signal along a single metal wire and measures the transit time of reflected electromagnetic pulses from the top of the dipstick down to a liquid surface. The air-liquid boundary is the discontinuity that reflects the pulse.

The dipstick is said to be accurate to within 0.1 per cent of the wire's maximum length and works at temperatures

from -55 to +85° C. The MIR chip is expected to cost just \$10 to manufacture. (Source: *Engineering*, February 1997)

### **Computer learns user habits**

Australian firm Formulab Neuronetics has launched a computer in the USA which it claims learns from its user and makes decisions.

The device, called the Richter Paradigm Computer, uses a parallel-processing architecture comprising 896 simple Risc processors, and costs \$3,000. The company says that the low cost of the system will help establish a large market for a "reasoning" computer.

In a demonstration, Formulab said that it can run neural network applications 180 times faster than an Intel Pentium 166 MHz system.

Formulab also revealed plans for a supercomputer based on its computer architecture, which has taken more than 14 years to develop. The supercomputer would combine as many as 6000 microprocessors and could be used for scientific applications. It would run a special operating system that could manage the difficult task of splitting a computational problem into separate tasks and assembling the results.

The company also said that it is working on an add-on card for PCs which could assist users by learning from their work habits. It also plans to shrink its technology so that it can be embedded into products such as cameras and consumer electronics devices. Formulab said it will license the technology to other companies.

Other applications include stock buying, with the system noticing differences in stock prices and trading patterns. (Source: *Electronics World*, February 1997)

### **Straightening out a pcb problem**

Printed circuit boards, or pcbs, remain vulnerable to a simple, heat-induced threat: warpage. Unfortunately, warped pcb may cause a device to stop working, while boards that warp during manufacturing after expensive components are added can mean costly losses.

A technique developed at the Georgia Institute of Technology and now licensed by Electronic Packaging Services (EPS) could provide a new weapon against warpage.

The experimental Thermoïré process provides real-time data about pcb warpage in a simple and fast manner, so that manufacturers can avoid design problems.

The heat that can warp pcb's is generated each time computers, camcorders or other pcb-run devices are turned on. Also, temperatures up to 230°C are an integral part of pcb processing. In addition, if the pcb is small, thin and densely populated with components, as is the current industry trend, that is an invitation for warpage-related reliability problems.

For the new process, a special oven with a glass grating top was developed through which the pcb placed inside is visible. A white light shines through the glass grating onto the pcb, and an inexpensive, compact, charge-coupled device camera captures warpage digitally as it occurs.

The flat glass grating is etched with equally spaced parallel lines. It is placed above and parallel to the pcb. A beam of white light is directed onto the glass at a specific angle, causing the etched lines to create a shadow on the surface of the pcb. When the surface of the pcb curves due to warpage, a moiré pattern is produced by the geometric interference between the etched lines on the glass and the shadow of those lines on the pcb's surface. The more the pcb warps, the greater number of moiré fringes that appear.

The number of fringes are counted and put into an equation. A computer determines how much warpage has

occurred. The warpage process is displayed in real time on a television screen and recorded on video and on computer.

The Thermoïré technique can be used to simulate the three major kinds of soldering processes—infrared reflow, convective reflow and wave—and the automated oven system can reproduce any given soldering temperature history used in producing a board. In this way, the system can pinpoint which processes or designs may cause the most warping. Further details from Charles Ume, Georgia Institute of Technology, Atlanta, Georgia 30332-0828, USA. email: (charles.ume@me.gatech.edu). (Source: *Electronics World*, February 1997)

### **Surf'n'phone**

Satisfy information-access and communication needs in one device with the TouchPhone Internet screen telephone from Navitel Communications Inc. (<http://www.navitel.com>). The system includes Microsoft's Windows CE (compact edition) operating system and Pocket Internet Explorer Web-browser technology, with e-mail, voice mail, and personal information management, in addition to being a full-featured telephone. Always on, TouchPhone automatically checks e-mail and downloads user-selected Internet content throughout the day. It requires no configuration or programming and is active as soon as it is plugged in. (Source: *Industry Week*, 3 February 1997)

### **Conveyor control**

With the sensor, valve, and logic in one compact unit, the new WTR photoelectric proximity sensor can eliminate the need for programmable logic controllers or complex wiring in roller conveyor applications, says SICK Optic-Electronic Inc., Eden Prairie, MN. If desired, a version is also available without the solenoid valve for use as a standard proximity sensor or as a custom conveyor sensor, using a programmable logic controller. In addition, the design allows daisy-chaining of an unlimited number of sensors, making it easy to tailor for specific application needs. (Source: *Industry Week*, 20 January 1997)

### **The electronic house call**

Could health care become as accessible as cable television? The potential has been demonstrated by a prototype system developed in a collaborative effort between two Georgia universities, the US Army, and a private cable company. It includes videoconferencing equipment, a touchscreen, and equipment to measure and transmit signals from blood pressure cuffs, stethoscopes, and other medical devices. The developers are targeting people whose chronic health problems require constant attention that can lead to frequent doctor visits and hospital stays.

The other goal is to make such a system commercially available for under \$10,000, says Michael F. Burrow, senior research engineer at the Biomedical Interactive Technology Center at the Georgia Institute of Technology, Atlanta. (Source: *Industry Week*, 20 January 1997)

### **Prosthetic devices**

Lower costs and faster production of joint and bone-segment replacements could result from collaborative research focusing on rapid-prototyping and 3-D X-ray imaging. The technology would permit surgeons to create a replacement bone segment for a patient's left foot, for example, by X-raying the right foot and entering the digitized information into a computer which would flip it to produce a mirror image for the left foot. Using the computerized data,

rapid-prototyping equipment could proceed to build a ceramic prosthesis. Researchers are now working to control the porosity of ceramic to imitate real bone, which has variable porosity and allows tissue to grow around it. The project is a three-year cooperative research and development agreement involving Zimmer Inc., Midwest Orthopedics, and the US Dept. of Energy's Argonne National Laboratory, Argonne, IL. (Source: *Industry Week*, 20 January 1997)

### **Intel's hot Klamath**

Intel has a Pentium Proclass processor with MMX extensions running at 451 MHz. The technological feat was achieved by force cooling the device.

The chip has no level-two cache on-chip and thus has much in common with the company's forthcoming Klamath processor.

The first Klamath devices, expected in May, will be clocked at 233 and 266 MHz. (Extracted from *Electronics Weekly*, 12 February 1997)

### **Samsung offers virtual DRAM alternative**

Researchers from Samsung Electronics in Korea have developed a 16 Mbit virtual DRAM.

This is a memory that behaves as, and interfaces to, conventional DRAM, but whose underlying technology is different. The memory uses NAND flash technology and is called non-volatile DRAM (NVDRAM).

In keeping with modern trends, the device runs at 3.3 V.

Flash has traditionally been used for data accumulation and embedded code storage, and more recently for PC Card storage.

Faster DRAM has often been used to shadow the flash, running program code more quickly. Increases in flash access speeds mean flash can be used as long-term storage and fast local memory, removing memory redundancy and lowering system cost.

Using flash technology for local memory applications offers significant advantages over conventional DRAM.

As flash is non-volatile, it does not lose its contents on power down and needs no refreshing. So when no memory accesses take place, little power is consumed.

Flash cells will eventually become smaller than DRAM cells. This is because DRAM has a theoretical lower size limit as the capacitor must hold a minimum amount of charge.

For NAND flash, groups of cells are connected in series, in this case eight cells. To read an individual bit, all the bits in the group must be clocked out. This meant that, when NAND flash was first developed, it suffered from slow initial read access times because of having to read eight or more cells in series. The Samsung designers have solved this by using a folded bit line architecture.

With the option of deep power down mode, not available in DRAMs, NVDRAMs could have applications in portable consumer equipment such as digital cameras, notepads and

mobile phones. (Extracted from *Electronics Weekly*, 12 February 1997)

### **Chipset aid for DECT cordless telephones**

A Siemens researcher has developed a 2.5 GHz bipolar chipset for the radio front-end section of DECT cordless digital telephones. It operates from a 2.7 V supply. In the interests of integration and cost reduction in what will be a price-sensitive market, the design has integrated the normally external and discrete receive buffer amplifier into the receiver IC.

This design approach has the added advantage of an increased level of isolation performance due to the chip architecture's fully differential setup.

The chipset is for handsets and basestations of FSK digital mobile radio and cordless phone systems operating from 1.6 to 2.5 GHz, which includes DECT, wireless LAN, wireless local loop and the 2.4 GHz ISM band frequency hopping system. It is claimed that the level of integration can achieve a fully functional DECT handset with no more than 120 components.

Whereas the receiver circuit has been optimized for sensitivity, the transmit portion of the design has been optimized for low power consumption using the 2.7 V supply.

The first receiver sensitivity measurements were reported to be at the -95dBm level, at an input intercept point of -17dBm referred to the antenna. (Source: *Electronic Weekly*, 12 February 1997)

### **Smart-pills repeat the dose three times daily**

The Micro-Electro Mechanical Systems (MEMS) Unit at Sheffield University is investigating the concept of "smart-pills". These allow the intelligent sensing and delivery of medicines. The Unit is working on a prototype device in collaboration with local hospitals in the Sheffield area.

The devices will either be swallowed or injected and then anchored inside or allowed to pass through the body.

Initially, observations of pressure, temperature, and pH, will be made and transmitted in real time back to a receiving station and PC. Depending on the sensor measurements, the pills can release drugs to areas locally in need of medication. Further details from MEMS Unit, Tel.: 0114 276 7525. (Source: *Electronics Weekly*, 5 February 1997)

### **Smart flash ICs**

Siemens is to launch a smartcard IC family in mid-1998 based entirely on flash.

Flash has E<sup>2</sup>PROM functionality but offers faster access times. Siemens is likely to use a 0.5  $\mu$ m process for the new family.

Another advanced memory technology primed for use in various industries is Ferro-electric RAM (FRAM). Siemens, however, questions its suitability for smartcards where reliability and security are paramount. (Source: *Electronics Weekly*, 5 February 1997)

## F. SOFTWARE

### **Virtual prototyping in product development**

In times of shortening product life cycles, increasing product complexity and tightening global competition, it is necessary to define, design and test all the features of a forthcoming product before the creation of physical prototypes. This is especially the case in the development of electronics and telecommunication products.

Virtual prototyping aims at providing a fully digital front-end for product development. The developer can design a new product in a virtual environment, and customers can test it, even though it exists only in computer memory.

Virtual prototyping is based on the applications of advanced modelling, simulation, user interface and virtual reality techniques. The aim is to simulate as realistically as possible all the features of the product, such as visual outlook, sound characteristics, user interface, functions, behaviour, as well as tactile and force feedbacks of the users' actions.

Virtual prototyping can shorten product development cycles, reduce development costs, and improve the accuracy and quality of product development. A virtual prototype makes a future product visible and demonstrates its capabilities and features.

High customer appeal and satisfaction can be achieved by collecting user opinions and requirements at an early phase of the development process. Simulated features of the product can be verified before expensive implementation.

Virtual prototypes eliminate, or at least significantly reduce, the need for physical prototypes, which are costly and time consuming to prepare and modify. Meanwhile virtual prototypes can also be used in combination with physical prototypes.

The combination of World Wide Web techniques with virtual prototyping provides new opportunities for distributed product development and marketing. Virtual prototypes implemented with VRML and Java techniques can be studied on the Internet and intranets by using existing Web browsers and plug-ins.

Potential customers could perform on-line trials of product candidates. The use of a cellular phone could be tested, or the timer of a video recorder set to see how easy it is. Virtual prototypes in the Web could be used also in on-line customer services such as product training and support.

Virtual prototypes in the Web are a natural extension for previous developments in the management of distributed organizations and design processes. Functional models may facilitate communication in the design process, making the validation of progress more apparent.

At the moment the Web-based virtual prototyping cannot offer as sophisticated interactions or simulations as special virtual prototyping environments. The selection of interaction devices for today's typical PC-workstations is still restricted. However, it is obvious that in the near future devices such as data gloves and head-mounted displays with stereoscopic views will be available for PC environments at an affordable price. (Source: *Industrial Horizons*, January 1997)

### **Software for planetary rover**

Satellite manufacturer Matra Marconi Space has used the ICAD software package from Condentra to develop what it claims to be the world's first ever "knowledge-based" planetary rover and "virtual" satellite. The software can

automatically generate product configurations from an existing database of conceptual information and design "rules" if it is fed with performance requirement data. Different versions of the Viper planetary rover, for instance, can be derived by inputting information on any planetary body's environment, such as terrain and gravity, and the rover's missionary tasks. Matra Marconi says it now intends to extend the use of the software to the generation of detailed component design information. The satellite application works in a similar fashion to generate design data when supplied with mission details such as required orbit, outline physical dimensions, mass and best-guess positions of instruments and equipment. (Source: *Engineering*, February 1997)

### **World in motion**

The influence of computers has become so pervasive that it is sometimes easy to overlook their shortcomings.

Their excellence in manipulating text and numbers contrasts sharply with the inability to handle audio and image data. Computers can store and transmit such data with ease, where they falter is in recognizing objects in an image and understanding motion in video sequences.

Professor Alex Pentland of the Media Laboratory at the Massachusetts Institute of Technology (MIT) uses surveillance as an application example which would benefit greatly from such machine-based capabilities.

Pentland and his group are working on techniques to understand motion in video sequences. They are also developing algorithms to enable the complex searching of image databases. Such technology is already being used in Massachusetts for the mundane task of checking driving licence applications.

This ability to search media contents such as images and video is becoming increasingly commonplace. Current digital authoring tools used for games and broadcasting involve blending various media types. Such tools need to be able to identify content from large media databases.

The Web is another example where content identification is becoming important. The increasing wealth of imagery, in the guise of synthetic environments and video, available on the Web is resulting in the advent of "media" search engines.

Lastly, MPEG-4, the latest standard from the Moving Picture Expert Group, promises a universal mechanism for the communication of audiovisual objects. This, too, will require sophisticated indexing and retrieval schemes if the full potential of manipulating coded-media content is to be exploited. The Expert Group has recognized this with the recent setting up of MPEG-7, a standard solely focused on the issue of content identification.

Further details: <http://www-white.media.mit.edu/vismod>  
(Extracted from *Electronics Weekly*, 26 February 1997)

### **Web-based digital notebook architecture allows group interoperation**

Oak Ridge National Laboratory (ORNL) in Tennessee, collaborating with researchers from the Lawrence Berkeley National Laboratory and Pacific Northwest National Laboratory, are designing a common digital notebook architecture which allow interoperation of the different groups' notebooks.

The electronic logbooks, in addition to recording day-to-day work, will allow the communication of results with remote collaborators, as well as direct connection with development rigs.

In developing the Web-based electronic notebook architecture, the ORNL researchers are focusing on ensuring the security of the notebook.

Electronic notebook entries can be digitally authenticated and signed, individually or collectively. They can be time stamped and notarized. While entries cannot be modified once signed, the pages can be annotated and forward referenced. Moreover, encryption is available for data transit and storage, performed transparently to the user.

The ORNL prototype uses Common Gateway Interface scripts to access notebook pages. The researchers are developing Java applets to enter objects in the notebook, such as a pen-based sketch pad. <http://www.epm.ornl.gov/~geist/java/applets/enote>. (Source: *Electronics Weekly*, 15 January 1997)

### **New guide to marine computer software includes CD-ROM**

Fairway Publications Ltd. (Coulsdon, Surrey, UK) recently announced the release of the 1997 edition of the *Marine Computing Guide*. In its ninth edition, the annual contains a comprehensive international classified directory of computer software, systems and services for the maritime industry. For the first time, the information in the Guide is formatted on CD-ROM as well as in printed form. The CD-ROM comes with the printed directory at no additional charge. The CD-ROM contains demonstrations of some of the products listed in the directory, allowing the user to examine the programs more closely.

The Guide gives complete details for each software package, including application areas, hardware requirements, operating systems, most recent version date, price and narrative description plus information on the software developers/vendors. The 1997 edition also provides Web site addresses with the company listing. An article included in the Guide, "Navigating the Internet", provides a brief summary of the Internet and a reference to maritime-industry Web sites.

This 1997 edition lists 320 companies and more than 1,050 software packages. This includes 82 new company listings and more than 280 new products. (Source: *Sea Technology*, January 1997)

### **Faster Web with new software**

The explosive growth of the World Wide Web in the past five years has created computer traffic jams as the number of users has outstripped the hardware and data-network resources on which the Internet is based. But now a group of researchers has demonstrated that not all of the congestion results from the sheer weight of the millions of new users trying to squeeze onto the Internet. They suggest that a significant part of the delay is the fault of the design of the software underlying the Web. A study published by the group, based at the World Wide Web Consortium in Cambridge, Massachusetts, an industry-sponsored group that sets standards, also shows that a redesign of that software would improve basic performance on the Web.

Using such redesigned software, the authors of the report were able to retrieve data twice to eight times as fast as they would have using current World Wide Web software.

Later this year, browsers that support the new protocol are to be available.

The World Wide Web software works in conjunction with the basic software of the Internet, known as TCP/IP. The Internet consists of a growing collection of software

protocols, and the Hypertext Transfer Protocol—the "http" at the beginning of many electronic addresses—has been the basis of the World Wide Web since 1990.

Companies like Netscape Communications Corp. and Microsoft Corp. are readying versions of their software that are based on the new version of the protocol H.T.P./1.1. One of the most common server programs used on the Internet, the Apache server, has recently added the capacity.

As more computer users convert to Web browsers that support the new protocol, they will see significant increases in speed as they retrieve information from servers that have the new software. (Source: *International Herald Tribune*, 18 February 1997)

### **Web sites are a hacker's heaven**

SATAN, otherwise known as the Security Administrator Tool for Analyzing Networks, is a program that automatically scans computer networks to see if they are secure from outside interference. It has just been used in a major survey of sites on the World Wide Web, including many used for commerce, and has revealed that disturbingly large numbers are open to malicious damage or fraud. The vulnerable sites include some that ask customers to submit their credit card details when ordering goods or services, which means that this information could be easily copied by a hacker with criminal intent.

SATAN was designed to allow computer system administrators to spot security flaws in their networks. But when the program was posted on the Internet in April 1995 for anyone to download and use, there was an outcry. Some system administrators feared that hackers would get hold of it and wreak havoc on Internet sites that SATAN revealed were vulnerable. SATAN's release was followed by a flurry of security checks on the world's computer networks, and the release of several programs designed to recognize when SATAN has been snooping around.

More than 60 per cent of the sites could be broken into, SATAN revealed. More than half of these had major security problems, so that any competent hacker could completely destroy or subvert the information on the host computers. Most worrying is the revelation that the sites being used by banks, government departments and companies selling services via the Internet were more vulnerable than the random sample of sites. (Source: *New Scientist*, 18 January 1997)

### **Creating new pricing models for electronic publishing**

From the advent of electronic information, information providers have been challenged with pricing issues. Usage pricing based on connect time solved some pricing issues: it provided a means to compensate information providers and vendors for using current information. It also created a new market for on-line training. Since pricing was based on connect time, it behoved the searcher to be an "expert", knowing all the right commands. Being an accurate and fast typist was also a key.

What the connect time metric did not solve were the issues of predictability and budgetability. It also necessitated an "intermediary" who knew all "the tricks" of the on-line system to keep costs to a minimum. Frequently this resulted in the actual end-user being a step removed from the information.

When standalone CD-ROMS entered the scene with their fixed (subscription) price metric, it solved some of the disadvantages of the on-line connect hour price metric. It provided unlimited searching for a fixed fee which encouraged high use. Search systems were designed for the



end-user, removing the need for an intermediary to do the search, and the length of time to perform a comprehensive search was no longer an issue. The downside was establishing the "right" subscription fee: high enough to compensate information providers and vendors and low enough to attract subscribers.

Intense interest generated by the Internet and the World Wide Web have brought pricing and related security issues to the fore. Transacting business on the Web, while simple and cheap in theory, turns out to be technologically challenging and much costlier than many companies have bargained for. On the other hand, the Internet's origin as a free communications medium for researchers has contributed to an expectation among consumers for free or very low-priced information. (Source: *Digital Publishing Strategies*, 1 (5) January 1997)

### **Java shakes IT up**

Java looks likely to be adopted on a massive scale and the IT industry is preparing for an earthquake. Robin Bloor (author of *The Enterprise by Other Means*), claims that Java, brainchild of Sun Microsystems, is at the epicentre of an earthquake which will rearrange the IT industry. Java, Bloor argues, has two major qualities, which fill a desperate need in the computer industry. First, unlike the current generation of office tools, Java applets are small and fast. Second, Java is portable. Instead of sitting directly on the operating system, Java lives in a browser; it is in a development layer all of its own.

Bloor's vision of the future is shared by major software manufacturers who are now positioning themselves in readiness for great industry change. Corel, for instance, is developing new Java versions of WordPerfect, Quattro Pro and CorelCHART. These are currently in beta form and are scheduled to be available in the first quarter of 1997. Oracle has also announced plans for a set of Java-based office applets (codenamed Hatrick) including a word processor, spreadsheet and presentation graphics tool. The move towards Java has been driven by an increasing dissatisfaction with bulky office software.

The core idea behind the new Java suite is to replicate the functionality of large suites like MS Office in a tiny fraction of the code, so that each component runs considerably faster. Instead of buying a massive monolithic word processing application and using 20 per cent of its capabilities, users will be able to buy only the parts they require and end up with an efficient and manageable package that more closely matches their needs. (Source: *Personal Computer World*, February 1997)

### **Automation gets easier with AutoMate**

JE Software recently released version 3.5 of AutoMate for Windows, a program that lets your computer work while you rest. With its Task-Set-up Wizard, you can create macros to take care of your repetitive tasks, allowing you to devote your time to more important things. You can have AutoMate automatically download your e-mail, check your hard drive for viruses, back up your files, and perform all of those routine daily tasks you should be doing.

AutoMate is flexible enough to let you determine how often you want it to perform those tasks, but it schedules and executes them automatically and routinely. Plus, you decide which programs you want to open and close.

AutoMate works on Windows and DOS programs. The Standard version of AutoMate 3.5 sells for \$35.95 and includes a 16-bit Windows 3.x version as well as a 32-bit

version for Windows95 and NT. A professional version is available for \$119.95 and requires Windows95 or NT. Network and site licences are available. (Source: *Datamation*, February 1997)

### **Software made simple**

Learning to use new software programs can be a significant drag on productivity for any business. But help is at hand in the form of a new computer-based training system from Kelly Services, the temporary-help firm. Based in Troy, MI, Kelly is offering PinPoint CD-ROM software, available to corporate users as well as Kelly employees. The software teaches such popular applications as Microsoft Office and Lotus SmartSuite. PinPoint, which offers basic, intermediate and advanced lessons in each application, enables employees to learn at their own pace, taking into account what they already know and focusing on the new skills they need to develop. PinPoint runs on Windows95 and Windows 3.1. (Source: *IW*, 20 January 1997)

### **Graphics help code design in toolset**

I-LOGIX, the US software design automation company, has released a tool that allows software engineers to design code in a graphical format.

Dubbed Rhapsody, the tool is aimed at embedded systems designers. It is described as an object oriented analysis and design tool.

When using Rhapsody, focus is shifted from low level source coding to a higher behavioural level. This is similar to the way IC designers are moving from gate level designing to hardware description languages.

Individual objects in the software design are represented by state diagrams. The state diagram determines how the object behaves when it receives messages from other objects.

When the high level design is complete, Rhapsody takes the state diagrams and message passing information and creates full production C++ source code.

The generated source code can be compiled to an executable file for embedded operating systems such as Wind River's VxWorks.

Applications that could benefit from this approach include cellular phone network basestations and consumer products such as PDAs. (Source: *Electronics Weekly*, 12 February 1997)

### **Virus fights laptop crime**

Laptop computers will soon be able to report their own theft.

UK company Catchsoft has developed software that, once installed, will use the laptop's modem to call Catchsoft's database at weekly intervals. If the laptop has been reported missing, then the database will make a note of the tele-phone number it is calling from so the police can take action.

"The software is essentially a virus", said Charles Jackson, Catchsoft's marketing director.

This virus cannot be detected by most virus checkers available, according to Jackson. He said that his company has had more than 22,000 individuals and companies expressing interest in its product. (Source: *Electronics Weekly*, 12 February 1997)

### **Search engine for ftp sites**

Finding what you need on the Internet is a frustrating experience, which is why there are so many search engines cataloguing content on Web sites. But a new search engine called Filez searches for information on ftp sites which are



essentially simple directories of files. Filez says its search engine has catalogued thousands of ftp sites and has a directory containing 75 million files. Users can search for software updates, graphics, sounds, games and other categories, including specifying software for different computer platforms. Another advantage to using Filez is that users can search for files on normally busy ftp sites without having to try and log on themselves. Try Filez at <http://www.filez.com>. (Source: *Electronics Weekly*, 5 February 1997)

#### **CAD data shared over the Internet**

Engineers working in multi-company product development projects with partners using different CAD systems can now share design information over any distances via the Internet with the aid of a new software program from Sherpa. The Explorer program allows CAD data from different sources to be assembled and displayed on a single screen as a "digital mock-up" to enable engineers to carry out basic form and fit testing early in the development cycle of components that may have been designed on different systems on different continents. Sherpa says it is only necessary for the Explorer software to be run at the location where the data is assembled. The various CAD systems involved need only have an extra module of "adaptor" software to enable them to communicate over the Net. (Source: *Engineering*, February 1997)

#### **When the PostMan rings on the Internet**

PostMan, the new message handling software from Rhode & Schwarz, for the first time integrates the radio medium into international communication networks. The associated radio driver is based on the TCP/IP standard protocol and is interoperable with a wide variety of computer platforms and operating systems.

For the first time, PostMan links remote areas or ships to the E-mail systems of international communication networks such as Internet or X.400 by the medium of radio, providing a cost-effective alternative to satellite communications, which have been the only possible solution to date. (*ITU News*, February 1997)

#### **Antipiracy technology for videos and DVDs**

Antipiracy technology that is meant to prevent the current generation of videos and the new digital video discs (DVDs) from being copied can easily be defeated, says one of the companies that helped to develop it. The company has filed patents for an alternative system which it claims is pirate-proof.

Macrovision was one of the key developers of the antipiracy technology that protects DVDs. However, in patents that it is filing around the world, the company warns that such systems are of "limited effectiveness". By connecting a relatively cheap "black box" between the player and the recorder, it says, pirates can strip out the signals that prevent copying. Macrovision now proposes a completely different approach. Instead of trying to stop people making copies of disks, the company suggests that players should be designed to reject pirate copies.

All CD and DVD players have a servo control system that compensates for irregularities in the spiral of data pits pressed into the disk surface. Laser optics track this spiral while a sensor generates an error signal if the tracking is not quite right. The error signal is used to put the laser back on track. Macrovision plans to exploit this mechanism by introducing a subtle wobble into the spiral, which it compares to a signature that proves the authenticity of the disk. (Source: *New Scientist*, 22 February 1997)

#### **A survey of recent advances in optical and multimedia information technologies**

One of the more remarkable events of 1996 was the beginning of widespread adoption of CD-R drives. CD-R prices fell below \$400 before the end of the year. While most of the less expensive models are of the 4x read/2x write variety, some reasonably-priced faster units have started to appear. Yamaha is offering the CDR400, priced at \$849, with 4x write and 6x read speeds. CD-ReWritable (CD-RW), by contrast, at present appears to be a solution looking for a problem.

Bandwidth restrictions on the Internet have inhibited its use for distributing multimedia data to date, but this may be about to change. Cable modems offer the possibility of transferring a 2 Mb file in less than two seconds, and are anticipated to be the preferred method of Internet access within five years. Another network option to look out for is satellite service. Hughes Network Systems is offering an Internet service called DirecPC. The package, priced at \$999, includes the satellite dish and interface software.

Personal digital assistants (PDAs) must become easier to use and communicate better if they are to achieve significant market penetration. Nonetheless, Hewlett Packard's Palmtop computers, the Apple Newton and Sharp's Zaurus may yet prove to have useful applications in libraries.

The appearance of digital video disc (DVD) also excited considerable interest last year, but it is the currently emerging DVD-ROM (essentially a very high capacity CD-ROM) which will have the greatest impact on libraries. DVD-ROM drives are expected to be backwards-compatible with current CD-ROMs, although there are concerns regarding their ability to read CD-R disks. (Source: *Computers in Libraries*, February 1997)

#### **How to design and write an unforgettable World Wide Web (WWW) page**

The first step in creating a set of World Wide Web pages is to decide what information you want to provide and write a list of everything that you can think of. Next, get some catalogue cards and write at the top of each some major headings and underneath that, a list of the things that are appropriate to that heading.

Next, you need to arrange them in some sort of order: spread them out onto a table and create what might be described as a directory structure or tree. Make a note on each card as to which other ones it should link to. Once you have finished this process, you should have a clear idea of exactly what the structure of your Web pages should be and you are ready to progress to the next stage which is actually getting something down on the screen.

There are lots of software packages available to help you create Web pages, some of these are free and you can pick them up from the Internet and simply download them onto your computer. Others are commercial products and you will need to purchase them. What all of them will do is create what is called "Mark-up" for you. Each Web page is made up of "tags" which tell a browser such as Netscape how to display the information on the screen.

In terms of design the author suggests some simple guidelines. Provide your audience with lots of guidance to enable them to get to the information they want quickly and simply. Do not overuse graphics and remember that each page should stand in its own right. Do not make a single page too long and also provide the audience with a reason to return to the page. (Source: *Records Management Bulletin*, No.78, February 1997)

## G. COUNTRY NEWS

### European Union

#### **World DAB Forum puts Eureka 147 on the map**

The world-wide endorsement of the Eureka 147 implementation of digital audio broadcasting (DAB) has been cemented with the formation of the World DAB Forum.

The forum is a successor to the European DAB Forum formed in October 1995, but with an increased portfolio of responsibilities as it envelopes the interests of more parties and countries.

The new forum's work is split into four modules, focusing on conditional access (CA) for DAB services that will require payments, regulatory and spectral issues, marketing and promotion, and the launch of a satellite service to complement the terrestrial one.

First DAB consumer units in the form of car radios will be shown at the International Consumer Electronics Fair (IFA) in Berlin this summer.

DAB pilot schemes have already started in many countries, including the UK. The USA is still seeking a counterpart for the Eureka 147 implementation among its own digital broadcast radio patents. (Source: *Electronics Weekly*, 29 January 1997)

#### **PCB makers get new Euro voice**

A European PCB trade federation has been launched to address the shortcomings of the current European Electronic Components Association's PCB division (EECA-PCB) organization.

Headed by Brian Haken, of the UK's Printed Circuit Interconnection Federation (PCIF), the new body, the European Federation of Interconnection and Packaging (EFIP), has been formed by the PCIF and its equivalent organization in Germany, VdL.

Haken said that a need existed for the federation because the EECA-PCB body, which has represented European printed circuit manufacturers for six years has "become significantly less effective in recent years, with the result that just three countries—the UK, Germany and France—remain within the body."

The EFIP operation will be independent of the PCIF, restricted to dealing solely with inter-European issues and to representing European PCB fabricators in forthcoming meetings with America's Institute for Interconnecting and Packaging Electronic Circuits and the Japanese Printed Circuits Association. (Source: *Electronics Weekly*, 29 January 1997)

#### **Europe starts search for lone electron**

The European Union has launched a new \$3.7 million research programme that will link eight high-powered research laboratories around Europe in an effort to remove one of the main constraints for building more powerful computers: packing more memory onto a single chip. Chip designers are now working on prototypes that can hold up to four gigabits of information, but they are rapidly coming up against a technological wall. Fabrication methods are reaching the physical limit of how small they can create circuits on a chip, and energy consumption of chips is

becoming excessive. The new program, dubbed Fabrication and Architecture of Single-Electron Memories (FASEM), aims to tackle this problem by creating a working chip in which each bit of information is stored with a single electron. Current memory chips store information as electrostatic charges—pools of large numbers of electrons.

The ultimate aim of the project, which is part of the EU's ESPRIT programme for information-technology research, is to produce a single-electron memory capable of storing  $10^{12}$  bits of information by 2015.

The key components of such a memory will be tiny conducting "islets", typically only a few nanometers, or millionths of a millimeter, across. To move data around, single electrons hop from one such islet to another one nearby through a process called single-electron tunnelling (SET). This hopping is controlled by changing the voltage of the islets.

The FASEM programme has brought together a diverse collection of laboratories—in the United Kingdom, France, Germany, Belgium and Greece—to tackle the problem. The first step the consortium hopes to achieve during the initial 3-year contract is a 4 x 4 array of single-electron devices on a substrate of silicon. (Extracted from *Science*, Vol. 275, 14 February 1997)

#### **European electronics firms lag behind USA**

The European electronics industry is falling behind that of the USA, but edging out in front of that of Japan, according to the latest of a series of annual surveys of the industry. The 1996 *Study of Inventory Performance in the Electronics Industry* from consulting firm Pittiglio Rabin Todd & McGrath (PRTM) found that significant revenue growth by an admittedly "leaner, fitter" European electronics industry was still insufficient to make it fully competitive with the US counterpart and it was becoming comparatively less profitable.

The study summarizes the performance of more than 300 high-technology companies over the past five years in six industry segments—telecommunications, aerospace and defence, computers, industrial equipment and "diversified". It found out that while US companies had enjoyed an average 55 per cent growth over that period, European companies had managed only 19 per cent. But Japanese electronics manufacturers had actually shrunk by 2 per cent.

In some specific performance areas European companies had, in fact, outstripped both their US and Japanese rivals. European companies, for instance, reduced their inventory "days of supply", whilst those in other regions increased. They also reduced their "cash-to-cash" cycle time by five days, whilst the figures for US and Japanese companies constant. But the European electronics industry remains smaller and more fragmented than either of the other two. As a result the profitability of the median US company remains 10 per cent above the figure for comparable European or Japanese companies.

But European companies across all industrial sectors will shortly get the chance to copy US logistical practices. A

European equivalent of a US cross-company supply-chain improvement initiative will be formally launched later this month.

The Supply-Chain Council (SCC), was formed in the USA in April 1996. Members include leaders from organizations such as Lockheed Martin, General Electric, Rhone-Poulenc, Motorola, Nortel and Xerox. In collaboration with PRTM and Advanced Manufacturing Research (AMR), the SCC then launched a "framework"—the Supply-Chain Operations Reference (SCOR) model—last November. But a European arm of the SCC is now also being set up with the aim of bringing SCOR back across the Atlantic.

SCOR is described as a means of defining the common supply-chain management processes and benchmarking them against acknowledged best practice and optimal software applications. Moreover, major supply chain software vendors, including Oracle and SAP, have agreed to adopt SCOR as the basis for future software development.

More information on SCOR from PRTM. Tel.: 01235 555500; Fax: 01235 554835. (Source: *Engineering*, February 1997)

## Germany

### **MuseumForum presents 5,000 years of information technology**

It all began in Mesopotamia with the invention of numbers and writing; today, life in our information society is characterized by e-mail and the mobile phone. The past and present of communications technology are now on display over 6,000 square metres at the Heinz Nixdorf Museum-Forum (HNF) in Paderborn. The HNF, which is named after a German computer pioneer, is both a technology museum and training centre. Many foreign museums participated in the realization of this 100 million-mark project. Visitors can study some 1,000 exhibits or travel virtual worlds. (Source: *Deutschland*, January 1997)

## Taiwan

### **Etron forms chip start-up umbrella**

Etron Technology, a fabless Taiwan specialist DRAM house, has set up a "corporate engineering team" to spawn new start-up companies under the Etron umbrella.

The team has founded two companies: one in America called Etron Integrated Circuits (EIC), and the other in Taiwan which makes modules. The next could be in Europe.

Dr. Nicky Lu, founder and president of Etron, is backed by the financial community because of his formidable reputation. As a DRAM process technologist at IBM, Lu invented the substrate-plate trench capacitor cell which cut DRAM access times by a third; as the head of Taiwan's Sub-Micron project he developed the country's 16 Mbit DRAM

technology; and as founder of Etron he has grown a \$55 million revenue fabless DRAM company.

Lu sees DRAMs as conforming to a Chinese traditional pattern of 12 year cycles. "The 1 k DRAM was introduced by Intel in 1971; the 1 Mbit was first shown at ISSCC in 1983; the 1 Gbit was first shown by Hitachi at the 1995 ISSCC", says Lu, pointing out that there has been 12 years between each thousand-fold improvement in density. So, according to Lu's Law, we will see the 1 Terabit DRAM announced in 2007. (Source: *Electronics Weekly*, 5 February 1997)

## USA

### **USA approves cheap rate spectrum allocation**

The US Federal Communications Commission (FCC) has approved the allocation of part of the radio spectrum to enable schools, hospitals and other organizations to use fast, wireless communications technologies without paying high prices for radio spectrum use.

The spectrum allocation falls into the 5.150 to 5.350 GHz and 5.725 to 5.825 GHz ranges and will allow non-profit and commercial organizations to exploit wireless communications and thereby avoid the potentially high cost of wire installation in buildings.

The wireless devices will have a range as wide as three miles but supporters of the plan, which included Apple Computer, Lucent Technologies, Motorola and Northern Telecom, were disappointed that the FCC did not approve wider wireless links capable of extending as far as 13 miles. This would have enabled entire communities to share high-speed wireless data links.

The FCC faced opposition to the plan from companies that had paid billions of dollars for radio spectrum licences for Personal Communications Services.

The FCC says that the new wireless technologies will be best suited for rural areas or campus-type environments rather than in built-up areas. This is because the radio channels are adversely affected by buildings at such frequencies. (Source: *Electronics Weekly*, 15 January 1997)

### **Project to advance speech recognition**

The US-based Microelectronics and Computer Technology Corporation (MCC) consortium says it has begun a three year project to develop advanced speech recognition technologies that will bring advanced computer user interfaces to a wide variety of applications.

Called the Information Systems project or I3S, it combines the research efforts of the MCC consortium with researchers at Carnegie Mellon University and the University of Rochester. The I3S project will involve researchers from Texas Instruments, Southwestern Bell Technology Resources, Nortel and the National Security Agency. (Extracted from *Electronics Weekly*, 15 January 1997)

## H. AUTOMATION

### **Robot has an office at its heart**

Hiroshi Mizoguchi and colleagues at the University of Tokyo have devised a robotic office room (ROR)—a robot that supports human activity within the office. For example, when a human worker points to an object and gestures to get it, the room understands the behaviour and takes the object to them, perhaps using a long reach manipulator centrally located on the ceiling. In effect the office workers, works inside the robot.

To collect information, the ROR monitors behaviour through a TV camera. When it detect pre-defined functions of the motion of an object—moved by human behaviour—the ROR starts to make a response. By choosing to monitor objects that are moved by human behaviour rather than humans themselves, computing power has been considerably reduced.

An experimental prototype consists of a telephone, a pen, a TV camera VCR, a workstation and an audio set. In this case, the telephone, the pen and the TV camera are the input devices of the ROR since the system can infer human behaviour by monitoring them.

The workstation corresponds to the ROR's processing device, while the VCR is the output device because human memory augmentation—through recorded images—is one of the supporting functions of the ROR. This is also the point of the audio device.

So far, the Japanese ROR has been able to recognize when the receiver in the office has been lifted up, and can start video recording the telephone call. The volume on the audio set is also reduced automatically when a telephone call is being made. Further details from Hiroshi Mizoguchi,

Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo, 153, Japan. email: hm@lssl.rcast.u-tokyo.ac.jp. (Source: *Electronics World*, February 1997)

### **Researchers eye up robotic sight**

Researchers in Zurich are set to mimic in silicon the process by which the human brain assimilates data sent to it from the eye, paving the way for robots that make sense of their surroundings.

Rodney Douglas, at the Institute für Neuroinformatik, said his team has already connected an artificial one-dimensional retina to an integrated circuit (IC)-based brain. This demonstrated the artificial brain could follow what the artificial retina was seeing, though only in one dimension. The institute has now developed a 2-D retina using the same communication protocol. An interface is being built to link the latest retina to the artificial brain. Douglas expects this to be ready shortly.

The fingernail-sized artificial retina behaves like the human retina by reporting the contrast between an image's pixels rather than luminous intensity levels, as used in traditional cameras.

The institute's brain is biologically-inspired, modelled on the routings between the brain's neurons. It reflects these paths by using analogue VLSI devices linked via a serial bus. Adjacent ICs have many connections between them, while those further away use fewer ones. However, it has vastly less connections than the human brain.

The system works at 10 MHz while the brain manages 1 KHz. (Source, *Electronics Weekly*, 5 March 1997)

## I. STANDARDIZATION AND LEGISLATION

### Standardization

#### **Opinions divided over peripheral bus future**

The debate on how to enhance the IEEE1394 high-speed serial bus standard has polarized the members of the 1394 Trade Association.

One group, including Texas Instruments and Sony, support a backwards-compatible progression from 1394-1995 (the IEEE ratified issue of the standard) called 1394a.

The other group, which includes Intel and Microsoft, supports 1394.2, which is not backward compatible.

The 1394a proposal started as a tidy-up of 1394-1995, but became seen by some industry members as a route to 1.6 Gbit/s 1394. Others think it should just handle the loose ends, with the higher speeds achieved through 1394.2. (Source: *Electronics Weekly*, 8 January 1997)

#### **SCSI interface idea offsets merger snags**

The ANSI X3T.11 committee has put forward a new serial SCSI interface concept to counteract the disadvantages of the proposed merger between FC-AL and SSA.

Through the merger of the two former opposing standards, the resulting standard promises much but also stands to inherit certain disadvantages, including not being plug&play compliant with previous equipment.

To counter this, X3T.11 has concocted Torn, a concept seen by some as an extension to FC-AL, but a deflection from SSA. Its main disadvantage is its half-duplex topology, which will cause problems in accurately detecting faults in the loop.

The FC-AL and SSA merger did not have a perfect start as its first chosen name of Fibre Channel—Enhanced Loop (FC-EL) was opposed, quickly being replaced by the X3T.11 committee with the new name Aaron.

At present, modelling work is being carried out on Torn. The committee's choice over the final standard is expected in October. (Source: *Electronics Weekly*, 29 January 1997)

#### **Credit and security system**

Mastercard, IBM, and the Danish Payment System bank have tested a security system, based on the Secure Electronic Transaction (SET) standard, that is designed to protect credit card purchases over the Internet. The system scrambles the credit card information before transmitting it over the Web. Transactions are then authorized by a bank, without the merchants actually seeing the credit card information. (Source: *Datamation*, February 1997)

#### **GSM standards to support 64 kbit/s**

High-speed wireless Internet access over the GSM digital cellular telephone network is set to become a reality following proposals for the GSM standard to support data rates up to 64 kbit/s.

The latest version of the GSM core specification, agreed in Paris earlier this month, makes a number of changes to the GSM standard, including the support of data rates higher than the 9.6 kbit/s currently available. The use of multiple time slots in the radio channel will be supported by the standard, allowing for the introduction of high-speed Internet access

using circuit-switched data transmission in data rate increments of 9.6 kbit/s up to a peak of 64 kbit/s.

There is also an additional proposal to use data compression techniques to support even higher data speeds.

According to European standards groups, ETSI, the new standard which is known as GSM release 96 phase 2+, should start to appear in networks sometime next year.

The GSM '96 standard will also extend services through the use of intelligent networking and a more sophisticated SIM smartcard in the handset. (Source: *Electronics Weekly*, 26 February 1997)

#### **Cleanrooms and associated controlled environment standard now available**

The US Institute of Environmental Sciences, Secretariat for ISO/TC 209, announced the availability of ISO/DIS 14644-1: Classification of Airborne Particulates. This document is the first Draft International Standard (DIS) produced by ISO Technical Committee 209, Cleanrooms and Associated Controlled Environments. Copies may be obtained through the Institute of Environmental Sciences. This first ISO cleanroom standard is one of about 12 documents which will make up this new family of global cleanroom standards. Other documents will follow until the full family is complete, possibly by the end of 1999. These other documents will cover subjects such as cleanroom testing for compliance, metrology and test methods, cleanroom design and construction, cleanroom operations, mini environments, and isolators, and terms, definition and units.

The international spirit of cooperation with which the participants are working has allowed ISO/TC 209 to produce global cleanroom standards in one half the time usually needed for such an endeavour. There are still opportunities to participate in the activities of ISO/TC 209. For more information, contact the Institute of Environmental Sciences. Tel.: 847-255-1561. (Reprinted with permission from *Semiconductor International Magazine*, February 1997. Copyright 1997 by Cahners Publishing Co., Des Plaines, IL, USA.)

### Legislation

#### **Patent searching on the Web**

Want to find out if that hot idea of yours is original? IBM is now offering a Web-based patent searching service on its IBM Patent Server site with details on more than two million US patents issued over the past 26 years. Users can search by title, inventor, assignee, abstract, claims, attorney/agent and patent references. In addition, there have been one million full images of US patents issued since 1987 with additional images added on a continual basis going back to 1974. IBM says that the service is part of a capability it developed for its own uses to search US patents and decided it would make a valuable public resource.

The good news is that the service is free to anyone with Internet access.

The patent site is at: <http://www.ibm.com/patents>. (Source: *Electronics Weekly*, 15 January 1997)

**Big copyright clampdown on the way? (response to WIPO's copyright proposals)**

Proposals being considered by the World Intellectual Property Organization (WIPO) have been dubbed the least balanced and most potentially anti-competitive intellectual property rights ever created. Article seven of the proposed protocol extends the right of reproduction to all temporary copies, including copies which exist only in a computer's random access memory (RAM). At its worst this could mean that sending a document by e-mail would involve securing permission for it to be held on the mail servers of both the sender and receiver.

The Joint Consultative Committee of Aslib, IIS, LA, Sconul, and the Society of Archivists, in its responses, recognized the need to update copyright law to give more protection to creators but expressed concern that the proposals as written are likely to obstruct rather than assist the flow of information. It went on to describe the digital agenda as "premature" and expresses the concern that the viewpoint of users had not been considered or discussed.

It is, the response argues, essential that the gap between the information haves and have nots is not widened further and that consequently it is vital that there are exceptions in all countries to allow use, especially by librarians, for certain purposes. (Source: *LA Record*, 99(1) January 1997)

**Look, it's not there (digital watermarking to stop illicit copying)**

The principles of inconspicuousness and randomness help conceal information in digital watermarks which protect intellectual property of multimedia documents. A digital watermark can only be detected by appropriate software. A digital watermark aims to identify the origin; owner; usage rights; and distributor, or authorized user of an image, audio or visual clip; even if the image or clip has been processed and distorted. A digital watermark has to be invisible, or

inaudible in the case of sound or music files. It must be able to withstand any processing and tampering and it must be present throughout the document in case of cutting or cropping. While digital watermarking is relatively new as a means of protecting intellectual property, the technology and theories have been around for a while—computer-based steganography (cryptography); spread-spectrum communications; and noise theory. Modern steganographic systems use spread-spectrum communications to transmit a narrow-band signal over a much larger bandwidth so that the spectral density of a signal looks like noise in the channel.

There are two different spread-spectrum techniques—direct sequence and frequency hopping. The process of watermarking encodes the hidden information as additional noise and incorporates it into the document. Most common watermarking methods for graphics and audio signals work in the spatial, time and frequency domains. The advantage of this is that the watermark is spread throughout the whole video or audio clip. There are two types of watermarking tools—one based on fingerprinted binary information which is exemplified by the UK company HighWater FBI. The second uses documents identified by hidden numbers (fingerprints) developed by NEC Research and the University Catholique de Louvain (Belgium). Direct-sequence and frequency-hopping spread-spectrum techniques are the major watermark embedding methods used in existing tools. A watermark must be extractable even if documents are degraded. Extraction has two main steps—selecting the locations where the watermark is inserted and retrieving the watermark from these locations. The technology for digital copyright watermarking is still in its early development, and the major technical challenge is to develop a foolproof protection system to keep watermarks hidden. However, like encryption, this technology is useful as long as it makes tampering with watermarks a costly and time consuming task. (Source: *Byte*, January 1997)

## J. RECENT PUBLICATIONS

### Publications

#### **Server setup made simple**

To the novice Web user, operating a Web server—the computer that is home to one or more Web sites—could be an intimidating challenge. According to a new book by Peter Palmer, Adam Schneider and Anne Chenette, however, it is not as difficult as it may seem. In *The Web Server Handbook* (1996, Prentice Hall PTR), the authors explain how a company can create its own Web server that can provide text, graphics and sound to anyone on the Internet. See the book's site at <http://www.pobox.com/~plp/order.html>.

#### **Web "sites of scientific interest"**

Interesting publications from the UN's FAO which are now on the Web include: *Commodity Market Review 1995-96* at: <http://www.fao.org/waicent/faoinfo/economic/esc/escp/cmrai.htm> and *Food Outlook and Food Crops & Shortages* at: <http://www.fao.org/waicent/faoinfo/economic/gIEWS/english/fo/fotoc.htm>.

More than 1,000 full-text publications from the USA's National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and National Research Council are now available at its on-line "reading room" <<http://www.nap.edu>>. The National Academy Press (NAP) plans to put 5,000 books on the Web by the end of 1997. Books were scanned in page by page; NAP recommends Netscape Navigator (version 2.0 or higher) or other frames-compatible browsers to access the site.

*Science* magazine is putting more issues on line; details from <<http://www.sciencemag.org/science/home/faq-text.shtml>>.

All you ever wanted to know about uranium, including its origins and geochemistry, together with the implications for the evolution of life! Brought to you by the Uranium Institute in London: <URL:<http://www.uilondon.org>>.

The Internet Pilot to Physics (TIPTOP) in collaboration with the European Physical Society (EPS) provides an electronic bulletin board for over 200 physics meetings, including interdisciplinary fields. The free service claims over 100,000 hits a month; join them at <http://www.tp.umu.se/TIPTOP/FORUM/CONF/>.

#### **D&B, Lycos create directory**

Dun & Bradstreet Corp., Murray Hill, NJ, and Lycos Inc., Marlboro, MA, recently unveiled an Internet directory focused on on-line businesses. The free service, CompaniesOnline, is available on the Web and features information on 60,000 public and private US companies, all of which have sites on the Web. D&B will provide the company-specific data, while Lycos will supply the search-engine technology. CompaniesOnline is located at <http://www.companiesonline.com>.

#### **Advice on Asia**

Nikkei BP Biztech Inc., Santa Clara, CA, a unit of the Japanese publishing giant Nikkei Inc., has created an on-line consulting company. Located at <http://www.JapanBizTech.com>.

com., the site includes articles from Nikkei's 30 businesses and technology publications and other material from Nikkei research.

#### **Thomas expands Internet database**

Thomas Register on the Internet, which contains the entire database of the print and CD-ROM editions of the *Thomas Register of American Manufacturers*, has added 600 industrial product catalogues to its database. New York-based Thomas Publishing's site includes a search engine that enables users to perform real-time searches of its 155,000 company database. Thomas Register on the Internet is located at <http://www.thomasregister.com>.

### Reports

#### **Designing for Equipment Safety—a Practical Guide**

The introduction of the Single European Market on 1 January 1993 removed trade barriers between member States. Harmonization of the various electrical safety standards now in force played an important part in this process. The designers' guide covers domestic electronics/electrical equipment, information technology and industrial instrumentation and controls. It provides an understanding of the principles common to most of the standards and laws for safety and will facilitate compliance with them. It is also a useful introduction to the electrical equipment and safety standards and regulations and relevant product liability legislation. The report is divided into three sections. In Part 1 regulations and standards are discussed together with the implications for the Single European Market. Attention is paid to the CE marking and its effect on removing trade barriers, the uses and harmonization of standards, standards organizations, certification of product conformance, independent approvals, mutual recognition agreements and the treatment of equipment outside the scope of a single standard. Part 2 introduces the principles of designing for safety and outlines the scope and content of the electrical safety standards in the electrotechnical field, particularly energy, fire, heat, radiation and chemical hazards, and also electric shock. Part 3 gives more detailed design guidance in these and other areas including equipment classification, insulation, creepage distances and clearances, wiring, components, tests, measurements and markings and user instructions, concentrating on areas where difficulties are most often experienced. The guide ensures that no vital areas of concern in the field of electrical safety standards will be overlooked. Useful references to standards, regulations, warning signs and international symbols, and Directives are also included. This report was originally listed as 94-0241 "Designers' Guide to Electrical and Electronic Equipment Safety for the European Market", it updates and replaces 90-0220R "A Guide to the Design of Electrical Equipment for Safety and Approvals in the European Market—1992". (*ERA Report 95-0035*, Leatherhead, 1995. Non-Members; £150.00 Members £135.00.)



### **Designing for Electromagnetic Compatibility—A Practical Guide**

Electrical and electronic devices, equipment and systems must be able to function satisfactorily in their electromagnetic (EM) environment, without introducing intolerable EM disturbances to anything else in that environment. Even without the new and impending legislation, electromagnetic compatibility (EMC) should be an integral part of the production, design and development programme, thus avoiding the need for expensive, less effective retrospective action. This report provides guidance on the reasons for incompatibility, the design measures which can be taken to minimize and control interaction and noise generation and improve immunity, and on measuring techniques which can be employed to demonstrate the success of such measures. After a general introduction, Part 1 of the report studies EMC technology, including the EM environment, the basic EMC modes, intra- and inter-system EMC, and EMC diagnosis/ identification. Part 2 deals with achieving compliance by design and covers the methodology of control, shielding and filtering, and product design, including device selection, PCB layout, interconnections, grounding, enclosures and external cables. A section on systems design and installations discusses emissions and immunity standards, measurement techniques and certification options. Finally, the report deals with electrical shock hazards from filters, and RF safety, including hazardous atmospheres. Appendices provide a summary of standards, legal regulations, basic formulae and a glossary of terms. This report was originally listed as 94-0221, it updates and replaces 90-0106 "The Achievement of Electromagnetic Compatibility". (*ERA Report 95-0030*, Leatherhead, March 1995, 147 pp. Non-Members £90.00; Members £85.00.)

### **Programmable Logic and ASICs: Costs and Benefits**

Programmable logic covers a broad range of digital applications offering an alternative to discrete logic gate, microcontrollers or a software solution. The report gives an overview of the capabilities and costs of programmable logic and digital ASICs, to help in the identification of appropriate technology and design software. It examines the device architectures and relates them both to the design processes and typical applications. In many cases programmable logic or ASIC technologies are not just alternative implementations for existing applications, but open up new possibilities which would not otherwise be considered feasible. Design software is discussed in terms of the facilities and features appropriate to each category of devices. The various design routes are explained in relation to the complexity of the designs for which they are intended and the requirements of the target devices. The design entry methods examined are based on both schematic capture and hardware description languages and the two approaches are compared in the final section. Specific design examples are addressed in detail and the reasoning behind the choice of technologies and design routes is given. An analysis of the financial aspects of a standard cell ASIC design project is presented illustrating the manufacturing volume at which the design becomes economically viable. Some very useful conclusions are drawn. (*ERA Report 94-0552R*, Leatherhead, July 1994, 46 pp. Non-Members £125.00; Members £110.00.)

### **Research Report on the Visions of the Electronic Display Industry in the Year 2000**

This report together with the update that was published in 1996 provides a unique insight into the entire display

industry with special focus on flat panel technologies, both those that have been successful or those that have failed. It is based on the results of research carried out by Nomura Research Group for the Electronics Industrial Association of Japan. Major Japanese suppliers and users were surveyed, the questionnaires focusing mainly on product applications, the demand for such products, their cost and specifications, and the installation rate up to the year 2000. Follow-up interviews were conducted. The report covers all flat panel displays (FPDs), including Liquid Crystal Display (LCD), Cathode Ray Tubes (CRT), Vacuum Florescent Display (VFD), Electro-Luminescent (EL), Plasma Display Panels (PDP) and Light Emitting Diodes (LED). After a brief overview the report studies the outlook for application products and demand forecasts including: the trends in electronic display; demand, markets and end product forecasts; and the prospects and the manufacturing process of thin film transistors (TFTs). The current status and future prospects of each type of FPD is looked at individually, together with the technological trends and issues each technology faces. Some of the expected applications by the year 2000 are highlighted, including multi-information conferencing and store management systems; intelligent terminals; multi-media personal computers and the industry's shift to recreational purposes. Energy consumption is discussed briefly. One hundred and eighty charts and tables are provided. The supplier questionnaire survey results, user survey results, and the user survey questionnaire are included as appendices. (*ILI*, USA, July 1993, 195 pp. Price £395.00. 1996 UPDATE £150.00, 2 volumes £495.00.)

### **Survey on the Implications for Recycling Electronic and Electrical Equipment**

Recycling is now an important part of waste management in minimizing environmental damage, principally by reducing land-fill disposal and conserving natural resources. Legislation is gradually appearing which seeks to allocate responsibility for the constructive disposal of end-of-life products. This report presents an overview on recycling issues relating to electronic and electrical equipment. It identifies the implications for improving the recyclable features of products within the economic constraints of supply and demand. After providing a brief introduction to recycling the report studies current and likely future legislation and its effects. The reasons for the present low levels of equipment recycling are looked at, particularly the cost of reclamation and the market value of the recycled materials. A wide range of domestic and industrial products are suggested as possible items for recycling. Some of the issues that arise are discussed, including collection, refurbishing, dismantling and the segregation of materials. The possibilities of designing for manufacturing, dismantling and recycling are studied together with material selection and identification. Finally, the economic factors are reviewed, including the generation of recycled material, the value, the costs incurred and the limits to which recycling can go without subsidies. Useful conclusions are drawn on likely driving forces for recycling, product design for recycling, the economics, and the consequences of ignoring recycling issues. An extensive list of references and some contact addresses are provided. Appendices cover environmental auditing, technicalities of reclamation, quantities and volumes of equipment scrap, and the composition of equipment scrap. (*ERA Report 93-1003R*, Leatherhead, 1993, 104 pp. Non-Members £95.00; Members £85.00.)



### **Guide to Low Cost ATE**

This report has been compiled from information provided by suppliers and manufacturers of low cost automatic test equipment (ATE) for electronic systems, low cost being less than £50,000. The report will assist potential users with the selection of test equipment by highlighting the important features of the different types of ATE, and providing an understanding of the technical specifications. The types of ATE and techniques covered include component, continuity, in-circuit testing, manufacturing defect analysis, functional and power supply testing. The options available in the production environment for testing at the goods inward stage, the detection of manufacturing errors and the functional testing of systems prior to delivery are studied. The differing test requirements in the maintenance environment for an item which has failed in service are also examined. Ancillary items including test program preparation, adapter design and manufacture, maintenance and training are studied. Technical data in the same format is provided for over 50 types of ATE, allowing an initial assessment of the low cost market and the possibility of establishing a short list.

(*ERA Report 93-0608*, Leatherhead, October 1993, 248 pp. Non-Members £75.00; Members £65.00.)

### **Modern Digital Signal Processing: Evaluation of Techniques and Applications**

Classical Digital Signal processing (DSP) methods are still used for many current DSP applications despite their inherent limitations and the major advantages of modern DSP. The main reasons for this are a lack of familiarity with both the mathematical foundations and the methods of implementation of modern DSP, plus, until recently, the high computations cost of such techniques. This report provides a grounding in modern DSP. It is divided into two main sections, firstly spectral estimation, which is starting to be used in such applications as condition monitoring and speech processing, and secondly adaptive filtering. A wide range of modern spectral estimation techniques are described and compared and the advantages and disadvantages of the more important techniques are illustrated by computer simulation results. Implementation aspects of the adaptive filtering algorithm are considered and a number of current practical applications are detailed. The report concludes that modern DSP will be used for a far wider range of applications over the next few years, the most important being mobile and satellite communications, radar signal processing and advanced instrumentation systems. A useful list of over 40 references are also included in the report. (*ERA Report 90-0415R*, Leatherhead, June 1991, 68 pp. Non-Members £60.00; Members £50.00.)

### **The Specification and Selection of Power Supplies for Inclusion in Electronics Equipment and Apparatus**

This report provides guidance on the preparation and writing of specifications for power supply units (PSUs). As necessary background it gives information on the basic techniques and circuit configurations used in PSUs, an understanding of the special terminology or jargon of the PSU

specialist and includes a glossary of terms. It gives information on the basic power conversion circuit configurations from which most of the circuits in use today have been derived and upon which most developments in the near future will be based. In the area of standards for safety, supply distortion and EMC, information has been presented which reflects the changes likely to result from the creation of the Single European Market at the end of 1992. A list of UK PSU designers, manufacturers and vendors and a bibliography are also provided. (*ERA Report 90-0083R*, Leatherhead, April 1990, 61 pp. Non-Members £40.00; Members £35.00.)

### **Digital Signal Processing: Technology and Applications—Conference Proceedings, London, 19 October 1989**

The papers in the proceedings deal with system design, applications and future trends in the digital signal processing (DSP) field. The papers included: system requirements, technology choices, high performance digital filter architectures, system opportunities in designing, analogue digital conversion, loudspeaker and room correction, high-speed floating point FFT processors, the Pan-European digital cellular radio system, a high performance acoustic signal processor, an aeronautical satellite communication terminal, system level tools for future ASIC technologies, enhancing high-level DSP software portability and productivity with a real-time DSP operating system, heterogeneous parallel systems, the future of VSLI, TMS320C50—a 35 nanosecond fixed-point processor and an ASIC approach to DSP. A delegate list and details of the exhibitors are included. (*ERA Report 89-0461*, Leatherhead, December 1989, 186 pp. Non-Members £35.00; Members £30.000. A 30 per cent discount applies to two or more proceedings from this series, purchased together.)

### **Reconstruction of Sampled Signals**

When using sampled data systems it is often necessary to know the data values between sample points. An interpolation technique is developed which takes into account the band-limited nature of the sampled data. A computer program is given as an example which uses the technique. (*ECRC/M2263*, Capenhurst, May 1988, 10 pp. Price £40.00. NOT available with a membership voucher.)

### **Software Engineering Methods and Safe Programmable Logic Controllers**

These reports result from a collaborative research project jointly funded by the Department of Trade and Industry and the Engineering and Physical Sciences Research Council. Led by the Software and systems integrity Department of ERA Technology, the project has investigated the use of advanced software engineering methods and safety analysis techniques for the development of Programmable Logic Controller (PLC) application software for safety-critical and safety-related applications. For further information please contact Publication Sales. Tel.: 01372 367014. (Set of 11 Reports—SEM 0100-5009.)

ERA Technology Limited, Cleeve Road, Leatherhead, Surrey, KT22 7SA, England. Tel.: +44(0) 1372 367014; Fax: +44(0) 1372 377927; E-mail: pub.sales@era.co.uk.)



# INTECHMART PAKISTAN'97

**Karachi, Pakistan  
7 – 10 December 1997**

## INTERNATIONAL BUSINESS FORUM

Organized jointly by UNIDO (United Nations Industrial Development Organization), UNDP (the United Nations Industrial Development Programme) and the Federation of Pakistan Chambers of Commerce and Industry (FPCCI), the Board of Investment, Government of Pakistan (BOI) and the Export Promotion Bureau, the Government of Pakistan (EPB), the INTECHMART PAKISTAN '97 is the first programme to facilitate investment and technology transfer to be held in Pakistan. This programme aims at supporting development of small and medium sized industries by identifying opportunities for selected projects for investment, transfer of technology from abroad, and the transfer of indigenously produced technology overseas. Priority industrial sectors for INTECHMART PAKISTAN '97 are:

- Agro-based industry
- Leather and leather products
- Mineral processing and petrochemicals
- Textiles and garments
- Light engineering and information technologies
- Infrastructure
- Tourism, including hotels and amusement parks

The event will also include a number of workshops and seminars on issues such as technology transfer, project negotiation, use of the Internet to attract investment, intellectual property rights, etc. A conference will also be held on the subject of Investment Policy and Climate in the Country.

### **For further information, please contact:**

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