

Report 1993/94

***Cover:** The system developed in the MARC project, based on work in VASARI, can capture digital images of fragile paintings while still in their frames.*

Raphael's "The Madonna and Child with the Infant Baptist", shown here, has been electronically scanned and a selected portion of the image enlarged to examine the brushwork and monitor the craquelure, the network of fine cracks caused by the deterioration of pigment or varnish. The MARC system can acquire, store and manipulate such images for printing high-quality catalogues and art books.

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**IT R&D
Programme –**
Esprit –
Report 1993/94

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 I.T. PROGRAMME • ESPRIT

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 I.T. PROGRAMME • ESPRIT

Foreword

by **Riccardo Perissich, Director-General, DGIII**

Increasing the international competitiveness of European firms is the primary objective of the European Union's industrial policy. To be effective, this requires a coherent approach to all other policies affecting industrial activity. The move in 1993 of the information technologies R&D programme, Esprit, to DG III, the directorate-general for industry, is a clear application of this idea. Further emphasising the role of R&D for the promotion of industrial competitiveness will lead to greater consistency between, on the one hand, the scope and means of implementing future phases of the programme, and on the other, the horizontal aims of the Union's industrial policy.

The new information technologies programme under the Fourth Framework Programme is Esprit's successor. The ideas behind it have been elaborated on the basis of the experience gained during Esprit's ten-year existence, and shaped by the Commission's understanding of the Union's current industrial situation. To make a significant contribution to competitiveness, the new programme is designed to help build the services and technologies that underpin the new information society and that form, when joined to information content and people, the information infrastructure.

This information infrastructure will make it easier for companies to communicate with suppliers, collaborators and customers, give them quicker access to information, provide the basis for building cooperative networks, and should lighten administrative overheads by introducing electronic methods of transferring payments and data. It will be especially beneficial for SMEs, enabling them to make product information available to a vast and potentially global customer base, introduce more flexible working arrangements through

the use of group working and teleworking techniques, and access training materials remotely.

As the new programme aims to enhance industrial competitiveness in general, industry's views have been sought to help ensure its relevance. Over 90 representatives of IT users in six advisory panels, each representing a group of industry or service sectors with related business and IT needs, met in 1994 to discuss the draft programme. Their reports have been complemented by the deliberations of a further 1,500 experts gathered into working groups representing the technical domains that the new programme covers.

The results of a parallel exercise to streamline and simplify management procedures in the light of the new programme's industrial goals will include more frequent and focused calls for proposals, simplified contracts (lessening the administrative burden for SMEs, in particular), and, as appropriate, two-stage proposals and projects.

The new technologies, processes and techniques to be developed, described in the Introduction to this report, have not only been chosen to provide some of the key technological building blocks for the information infrastructure. They are also areas for which effort at a European level is appropriate, for three reasons: so as to provide the critical mass needed for effective R&D; to ensure proper coordination across Europe and help minimise the duplication of work; and to create the best conditions for technology transfer. They will ease the transition to new business processes and new modes of industrial operation - a transition that European enterprises must master to remain globally competitive.


 I.T. PROGRAMME • ESPRIT

Introduction

by George Metakides, Director,
IT R&D Programme

The information infrastructure

As envisioned in the Commission's White Paper on growth, competitiveness and employment, we are at the beginning of the transition to a new information society, a transition that is one of the key elements for the future of competitiveness and employment in Europe. This point marks the onset of a qualitative transformation in the impact of information technologies after forty years of quantitative growth.

The "engine" of the information society is the information infrastructure - the set of services and technologies providing easy access to usable information to any citizen or enterprise, at any time, in any place. For the citizen it is the long-anticipated "global village", and for the enterprise the "global workbench".

The infrastructure brings together information processing, information storage and retrieval, information transmission and the information content itself. It includes networks carrying data, voice and image, computers and personal communicators, databases, services and applications, information, and of course the people who actually use the services that the infrastructure makes available.

The transition to the information society and the information infrastructure, as with previous technological and industrial transitions, is not an easy one. Industry is undergoing drastic restructuring as it moves towards the knowledge-based or information-based economy of the information society. Boundaries are becoming blurred between products and services, suppliers and users, between the

professional and consumer markets, and between the IT industries and other industrial sectors. The information technologies, telecommunications, consumer electronics and media industries are converging, and a new "digital" industry is growing up. The changes now in train will dramatically transform production and consumption.

It is in this context that research and development is seen as a key Community initiative contributing to the growth of the information infrastructure and easing the necessary, if at times painful, process of industrial restructuring. As the pace of technological development accelerates and competitive pressures increase along with the complexity and cost of R&D, enterprises and institutions need to look more widely to find the expertise and critical mass they need. While much of the R&D required will be carried out by industry and within the national programmes of member states, the Community's R&D programmes in information technologies and communications technologies have a catalytic role to play.

Esprit and the new IT programme

Since 1984 the Community's IT R&D programme has been laying the groundwork for these developments. Esprit has established a range of results for exploitation by European industry. It has brought researchers and engineers together and created a truly pan-European research and development community. Activities in a number of areas have brought major improvements in

technology training and have taken knowledge and opportunities for collaboration to the more outlying regions of the Community.

The objective of Esprit was primarily to reinforce cooperation between European industrial enterprises and to strengthen the technological base of the Community. This has, in the common view, been broadly achieved. However, analyses of the results of Esprit have concluded that new orientations are needed in general approach, in procedures, and in methods of working. In the Fourth Framework Programme, the new focus will be the emerging information infrastructure, and the programme will in consequence be led, to a greater extent, by the needs of users and the market, and act so as to improve the competitiveness of all industry in the European Union. The new IT R&D programme will emphasise ease of access to information, services and technologies for companies, administrations and individual citizens. Activities will stress the **use and usability** of technologies, and **best practice**. The RTD areas proposed are those vital to the development of the information infrastructure, taking into account the need for selectivity and concentration of effort.

Implementation

Turning first to implementation, the new IT programme will introduce a number of "**focused clusters**", based on the experience of the Open Microprocessor Systems Initiative (OMI) under Esprit, make use of **supplier-user collaborations**, and put greater emphasis on **networks of excellence**.

A focused cluster will embrace a number of projects, joint enterprises, technologies and disciplines in an effort focused on the achievement of a well-defined goal. This may be a mobilising activity addressing a major social or industrial requirement, or it may be directed towards breakthroughs in a strategic technological area determined by user needs and the market. Networks of excellence, supplier-user associations, cooperation with Eureka, coordination with national initiatives, international cooperation, the dissemination of results and training initiatives can all be included.

Major events of 1993/94

- Following the April 1993 call, the last in the Esprit phase of the IT programme, a total of 202 projects were selected for funding from the 1,277 proposals received.
- The Commission's White Paper on growth, competitiveness and employment was strongly endorsed by the European Council at the Brussels Summit in December 1993, and led to the formation of a High-Level Group on the Information Society, chaired by Mr Bangemann, charged with producing a report for the Corfu Summit in June 1994.
- The entry into force of the European Economic Area Agreement (EEAA) on 1 January 1994 led to the stepping up of efforts to prepare EEA organisations for full integration into the new IT programme.
- Agreement was reached on the Fourth Framework Programme on 21 March 1994 after the successful conclusion of the conciliation procedure between the European Parliament and the Council (the first time that this had been used). The global budget for the Framework Programme was set at 12.3 Becu, with a further 0.7 Becu reserve to be decided in mid-1996. The allocation for the ICT line (telematics, advanced telecommunications technologies and information technologies) is 3.405 Becu, made up of 0.843 Becu for telematics, 0.630 Becu for telecommunications technologies, and 1.932 for information technologies.
- The European Parliament gave a positive opinion on the new IT specific programme proposal on 5 May 1994.

Supplier-user collaborations will supplement joint research projects, with supplier enterprises and users forming consortia to pursue new R&D, with the users having a particular interest in taking up and exploiting the results of the collaboration.

Nine **networks of excellence** have already been launched under Esprit, involving around 500 research teams, and four more are being established. Bringing together industry, users, universities and research centres with a common research objective, a network combines the critical mass of centres of excellence with the benefits for training

and technology transfer that derive from a wide geographical spread.

Participation in the programme will be further facilitated by the further **streamlining of management procedures**. The aims are to reduce the cost of preparing proposals and to simplify and shorten the call and evaluation process. There will be more frequent calls for proposals, with each call focusing on particular topics within the programme. Each year there will be a call on one or more of four fixed dates - 15 March, 15 June, 15 September or 15 December. Specific procedures to help SMEs are being established, and ways of simplifying proposals and contracts are being examined.

Content

The technical content of the new programme equally reflects the new emphasis on infrastructure, access, use and usability, and best practice. Part of the programme addresses the more basic or underpinning technologies: **software, components and subsystems, and multimedia**. At the same time, four focused clusters will be established, in part intersecting with the underpinning technology areas, as well as including activities with more of an application focus: **technologies for business processes, integration in manufacturing, high-performance computing and networking, and the open microprocessor systems initiative**. **Long-term research** will also be supported.

Two of these domains are quite new in their orientation: **multimedia technologies** (work on tools and standards for basic multimedia processing) and the enterprise-focused cluster **technologies for business processes** (the integration of enterprises into the information infrastructure, and the effective use of IT in business).

The other "enterprise" domain, **integration in manufacturing**, is the successor to Esprit CIME: as the technologies developed at an earlier stage are taken up in industrial applications, this domain will move on to newer leading-edge topics.

In **software technologies**, the major new emphases will be on the dissemination of best practice to user industries, on reliability, dependability and usability in software, on open distribu-

ted systems, on the *application* of novel software techniques, and on support for access to very large amounts of distributed information.

The work on semiconductors under **technologies for components and subsystems** will continue to support R&D on CMOS technologies, with an emphasis on integrated circuits for specific applications and on techniques for flexible and economic semiconductor manufacturing. Microsystems is a new and emerging area, in which much basic work has to be done. In the area of LCDs there is a degree of continuity, but with accelerated development for a European industry ready for take-up.

The **open microprocessor systems initiative**, which started as recently as 1991, aims to develop technologies for microprocessor-based systems. There will be a strong element of continuity in the new programme, though with a shift in emphasis towards tools and standardisation, and with accompanying measures such as conformance testing aimed at SMEs.

The **high-performance computing and networking** cluster will put great emphasis on areas which are only now nearing wide applicability, such as the use of parallel systems for the substitution of simulation for experimentation and testing, and for large-scale data and image manipulation.

Long-term research will continue to support basic research activities while taking new approaches to implementation. The distinction will be drawn between, on the one hand, projects whose risk is not yet assessable, where short, intense efforts are needed to assess the feasibility of new technologies; and on the other hand, advanced projects of high but known risk that require a more sustained effort.

In summary, the objectives of the new IT programme are to help improve the competitiveness of all European industry and the quality of life. It aims to achieve this through the contribution it will make to building the global information infrastructure of the future. It focuses on access to information and technologies, on usability, and on best practice. In this way it is not only part of the Community's research effort under the Fourth Framework Programme, but also one of the keys to the implementation of the objectives of the White Paper.

Key results of 1993/94

- ESSI, the European Systems and Software "best practice" initiative, launched over 100 pilot application experiments and dissemination actions, chosen from over 980 proposals.
- The European Software Institute (ESI), supported in its start-up phase by Esprit, was established with 14 leading European software companies as founding members.
- The European IT Conference, EITC '94, was held in June 1994 as the successor to the Esprit Conference Week. The accompanying IT Exhibition was based around three key themes for Europe's IT industry: the home, the workplace and mobility.
- An Information Technology European Awards scheme, the ITEA, was announced under the auspices of Euro-CASE, the European Council of Applied Sciences and Engineering, with Esprit funding for the first-year pilot phase.
- The Intelligent Manufacturing Systems (IMS) feasibility study, involving the EU and EFTA countries, Japan, US, Australia and Canada, was completed.
- ICL launched the GOLDRUSH parallel processing system based on work in the EDS project.
- SGS-Thomson launched a power-line modem based on work in the EHSA-IDC project.
- Meiko won the tendering exercise to supply the US Lawrence Livermore National Laboratory with a highly parallel computer system, the CS-2, whose memory technology is based on the results of HPCN project work.
- Siemens launched SYNAPSE, a "neurocomputer" performing 8000 times as fast as conventional workstations for certain applications, based on work in the GALA-TEA project
- Following the successful adoption of the PCTE (Portable Common Tool Environment) standard by ECMA as the first public standard in this area, the recent ISO ballot on its acceptance as an ISO standard was carried, and PCTE is on course for formal adoption in 1994.
- ElipSys, a tool for building decision systems stemming from the APPLAUSE project, has been used by Systems & Management, an Italian systems house, in developing an environmental management system for evaluating and ameliorating pollution in the Venice Lagoon. ElipSys is also being used by the International Cancer Research Fund in London to study protein structure.
- Olivetti's PCC (Personal Computer Communications), combining multimedia and video communications, is now on the market, resulting from cooperation between Olivetti and British Telecom in the M-CUBE project.
- Europe's electronics industry got a significant boost with the release by the JESSI Joint Logic consortium of a common set of target design rules for the 0.5 micron basic CMOS logic process.
- Multidoc, a multimedia product stemming from the project of the same name, was installed at the Western European Union for tests.
- The MARS real-time dependable computer system, developed in the Basic Research project PDCS, was adopted by European car manufacturers for vehicle control applications.
- East Coast Scientific, a company spun off from Cambridge University, commercialised Threshold Current AFM, an ultra-high spatial resolution method developed in the ASSIST project for measuring electrical properties.
- CIME projects made major contributions to the ISO STEP standard in the areas of mechanical design and ship construction.



Basic Research

by Simon Bensasson, Head of Unit

Objectives

The main objectives of Esprit Basic Research are to replenish the reservoir of new knowledge and expertise from which industrial research can draw to ensure tomorrow's innovation, and to secure the environment for training tomorrow's researchers through research itself. From the perspective of Esprit as a whole, Basic Research is an "upstream" activity, whose results feed into several of the more industrially oriented (downstream) sectors of the programme. Basic Research is contributing to the construction of a solid research infrastructure throughout Europe, which in turn underpins the EU's strategy of helping European industries maintain and increase their competitiveness in global markets.

Three distinct types of activity are sponsored by Basic Research: projects, working groups and networks of excellence. These activities have different but complementary roles in fostering the growth of a research community in Europe. Projects bring together teams to collaborate in carrying out research and achieving results for a specific research topic. Working groups aim to improve the systematic exchange of information between teams working in a common field through exchange visits, workshops and conferences. Networks of excellence are groupings of research teams sharing common long-term technological goals that closely coordinate their research and training activities.

Continuing evolution

In 1993 an important stage in the evolution of Esprit was reached with the third and final call for proposals of the Third Framework

Programme. The Basic Research call focused on a small number of priority themes, either reinforcing areas already established after previous calls or addressing newly identified ones such as multimedia, virtual reality and ultimate miniaturisation. The priority themes selected were designed to meet the future challenges of industrial research and were decided through consultation with experts from academia and industry. Some 250 proposals were received from the call, and of these 27 projects, 15 working groups and 4 networks of excellence were accepted for funding after evaluation. A noteworthy fact is the increasing participation of industry, which now participates in 50% of projects, compared to 36% in the 1991 call and 25% in the first Basic Research call in 1988. This steady growth reflects the relevance of the topics included within the focus of the call, and testifies to a successful track record in attracting industry to this part of the Esprit programme.

Under the Fourth Framework Programme it is envisaged that basic research will be commissioned either as long-term research projects, characterised by their potential to produce breakthroughs in the longer term but with clear industrial implications, or as advanced research projects involving a high but assessable technological risk whose success would have a direct impact on industrial competitiveness. Accompanying measures will include an expansion of the networks of excellence as a major contribution to available research infrastructure. The new approaches and orientations are designed to meet the priorities foreseen for the 1990s whilst building on and consolidating past achievements.

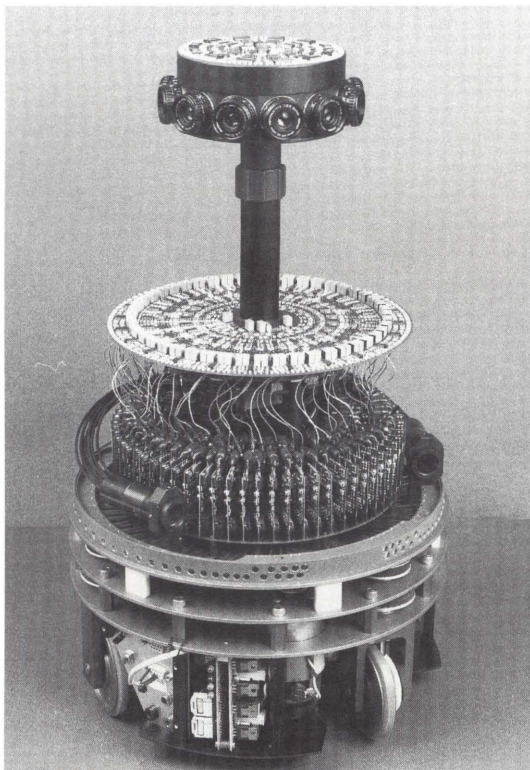
Results highlights

The results of Basic Research span a wide range of activities from robotics to virtual reality and through to microelectronics. Of the 95 projects, 45 working groups and 13 networks of excellence currently running under Basic Research, it is possible only to give a small sample of the kinds of results that have been achieved within these activities. Rather than giving an exhaustive list, the examples presented are intended to give a flavour of the innovations of Basic Research, demonstrating the many ways in which Basic Research contributes to the complex chain of innovation, development and production in IT.

IT learns from nature

Natural biological systems have found solutions to problems of processing information through the age-long process of evolution.

Biologically inspired mobile robot based on work in SSS (project 6691). Its main visual system consists of a compound eye with 118 facets built along the same principles as that of the fly.



Gaining insight from these natural systems and applying them to information technology has been the theme of a number of projects. For example, SSS (6691, Smart Sensory Systems) aims to find quantitative descriptions of information processing occurring in early stages of vision, olfaction and hearing, and to make comparisons between artificial and natural sensors in order to see which

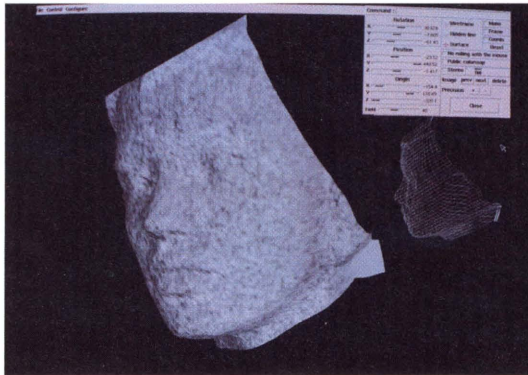
features of biological sensory processing can be useful in designing new sensors or robots. Already some relevant results have been obtained in the understanding of natural and artificial sensors: for example, the model of early stages of phototransduction, originally developed for amphibian photoreceptors, has been successfully extended to human photoreceptors; and techniques inspired by the visual system of the fly have been successfully used for controlling the navigation of a mobile robot. In the fly, a mechanism actively moves the two retinas of the eye in synchronisation, so achieving the stabilisation of moving objects in the front part of the field of view. The discovery of this technique in the fly has led, in turn, to an implementation of an equivalent component in the robot and greatly improved its ability to avoid obstacles while in cruise mode.

A related project, INSIGHT II (6019), aims to improve our understanding of natural vision at the computational level. The project draws on the disciplines of psychophysics, neurophysiology and computer vision to study key areas including the measurement of optic flow, cue integration, task-dependent use of optic flow, and surface and object representations. A number of results have been achieved including, for example, the discovery of the site of convergence of luminance, motion and texture cues specifying shape in the primate brain, and insights into the integration of visual and eye movement signals. On the computational side, a new theory has been developed on the recovery of surfaces from the structure of the disparity field, and new biologically inspired stereo algorithms have been developed for surface reconstruction. A number of standard 3D busts were used as reference objects that were then digitised and then reconstructed using this biologically inspired method.

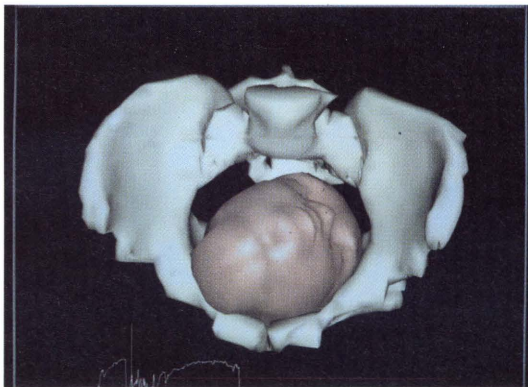
Motion planning

Today's range of robotics applications has grown to include space exploration, under-sea work and intervention in hazardous environments. However, existing industrial robot programming systems still have limited motion planning capabilities. How a robot can decide what motions to carry out in order to achieve its tasks in the physical world is the theme of the PROMOTION (6546) project. The objective has been to create a

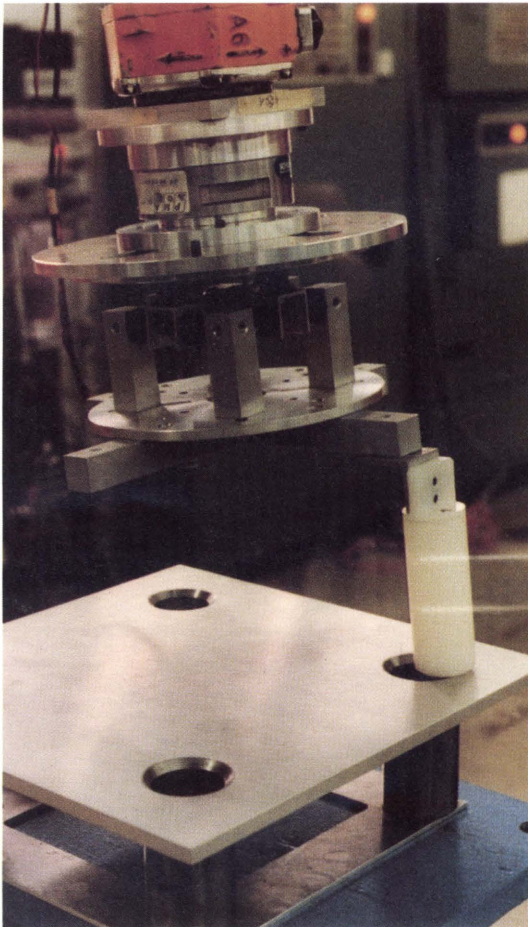
Stereo algorithms derived from neuro-physiological research in INSIGHT II (project 6019) were used to reconstruct this bust from its digitised counterpart.



Based on diagnostic scans, the twisting motion of a baby's head during birth can be simulated using the motion planning software developed in PROMOTION (project 6546), aiding obstetricians to assess the need for surgical intervention.



Robot programming-by-demonstration techniques, more flexible than methods based on expert systems, have been developed in B-LEARN II (project 7274) and used to generate a demonstration "fuzzy" controller for a typical peg-into-hole assembly operation.



synergy between the four disciplines involved in motion planning (robotics, algebraic geometry, computational geometry and control theory) in order to provide theoretically well-founded methods that correspond to the motion planning issues in advanced robotics and its challenging real-world applications. This research has resulted in two significant advances: one in the algorithm for planning the motions of the all-terrain mobile robot, and the other in simulating the motion of a baby's head along the birth canal during delivery. The first application tackles the difficult problem of dynamic path planning for undulating terrains, where a mobile robot has been used as a research testbed for navigation in natural environments. For this task, motion planning software has been developed and significant inroads made using a laser range-finder and camera on board the mobile robot. The second application enables the three-dimensional simulation of a delivery where the baby's head is too large for the mother's pelvis (cephalopelvic disproportion). Here diagnostic scans are used to produce simulations of baby and womb surfaces and the entire delivery process, including the twisting motion of the baby's head, which has been modelled in detail. The aim of this work is to aid obstetricians in assessing the need for surgical intervention.

In a similar vein, the B-LEARN II (7274) consortium is employing machine learning techniques for improving robot perception and control. A key aspect of the project is the extension of the "programming by demonstration" paradigm to robotics, especially with respect to allowing the easier development of controllers for sensor-guided robot motion. This is required for the performance of tasks such as contour tracking (eg for deburring) or the handling of complex structures (eg when dealing with mechanical locks or the assembly of complex work-pieces). To realise these tasks, controllers, fuzzy rules, decision trees and neural networks are being employed that are created off-line on the basis of examples provided by a human teacher. An experiment where learning techniques are applied to generate a fuzzy controller for a peg-into-hole assembly operation has been successfully concluded. This is a major achievement compared with standard expert system technology, which usually works on the

Three previously unknown features in molecules leading to carcinogenicity have been detected by applying an inductive logic programming system developed in ILP (project 6020) to descriptions of cancer-causing molecules.

The screenshot displays the ILP software interface. At the top left, a chemical structure of a substituted benzene ring is shown with labels: NH₂, N, H₂N, CH₂, CH₂OCH₃, OSO₂CH₃, and Q(CH₂)_xCH₃. Three arrows labeled Option 1, Option 2, and Option 3 point to different parts of the structure. Below the structure is a menu with options: Show options, Next, Previous, Select a file stem, Select a directory, Set activity value, Store as example, Read from files, Write and induce, Show results, Show examples, Show rules, and Restart examples. A slider for 'sigma' is visible, ranging from 0 to 10. On the right, a 'Display' window shows two columns: 'Positive Examples' and 'Negative Examples', each containing a list of 'great(drug1, drugX)' statements. Below that, an 'Options' window lists various chemical groups and their corresponding symbols, such as H, OH, Q(CH₂)_xCH₃, NO₂, F, Q(CH₂)_xCH₃, CH₂OH, OCH₂CH₂OCH₃, CL, CH₂Q(CH₂)_xCH₃, OCH₂CONH₂, OCF₃, CH₂OCH₃, N(CH₃)₂, CH₃, Q(CH₂)_xCH₃, NHCOCH₃, OCH₂C₂H₅, CF₃, I, OCH₃, BR, NH₂, and OSO₂CH₃.

basis of hard-coded rules and allows at best the online tuning of the weights given to each rule. The mobile robot PRIAMOS, developed at the University of Karlsruhe, equipped with both ultrasonic sensors and a video vision system, is being used in experiments on the application of learning techniques for navigation tasks. The system is adaptive not only with respect to its direct environment, but also includes a long-term memory that makes it able to handle periodic changes, such as variable traffic, or to adapt its behaviour to the general production strategy defined for a whole factory.

Diagnosis and safety

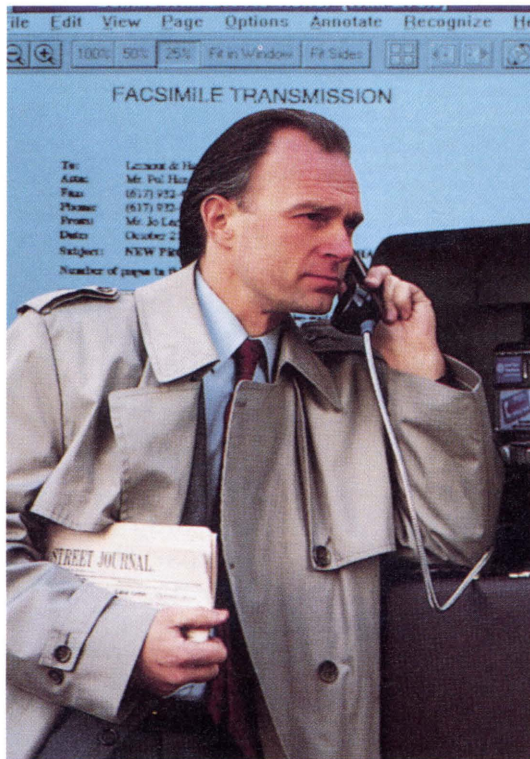
Inductive logic programming (ILP) is a research area formed by the intersection of machine learning and logic programming. ILP systems develop predicate descriptions from examples and background knowledge, in which the examples, background knowledge and final descriptions are all described as logic programs. Successful application areas for ILP systems include the learning of structure-activity rules for drug design, finite-element mesh analysis design rules, primary-secondary prediction of protein structure, and fault-diagnosis rules for satellites. In a recent application in the project ILP (6020), the molecular descriptions of around 200 carcinogenic molecules were given to the ILP Progol system. A small set of optimally compact rules were automatically discover-

ed which suggest three previously unknown features leading to carcinogenicity. The predictive accuracy of these rules was significantly higher than using rules derived by way of statistical techniques. On the basis of this and earlier work, the Oxford ILP group is presently working on a contract with Pfizer UK to develop novel ILP-based drug discovery techniques.

People and IT

There is a pressing need to enable people to communicate more easily with computers and, via computer-mediated systems, with each other. Speech recognition systems are key to advances in this area. Much progress has been made in recent years, especially in the development of speaker-independent, large vocabulary, continuous speech recognition systems. The WERNICKE project (6487) is contributing to this progress and paving the way for future advanced commercial systems. The project has the potential to further improve the speech recognition prototype systems by adding an artificial neural network (ANN) component to the existing hidden Markov model (HMM) technique. At the end of its first year, WERNICKE presented hybrid ANN/HMM approaches which proved to be competitive with state-of-the-art systems on international reference databases. There are three areas where the results of the project can be used: short-term developments of existing products for phone

The picture shows a user accessing a Lernout & Hauspie Speech Products application based on work in WERNICKE (project 6487) through a normal phone link; L&H has now successfully established itself in the US marketplace.



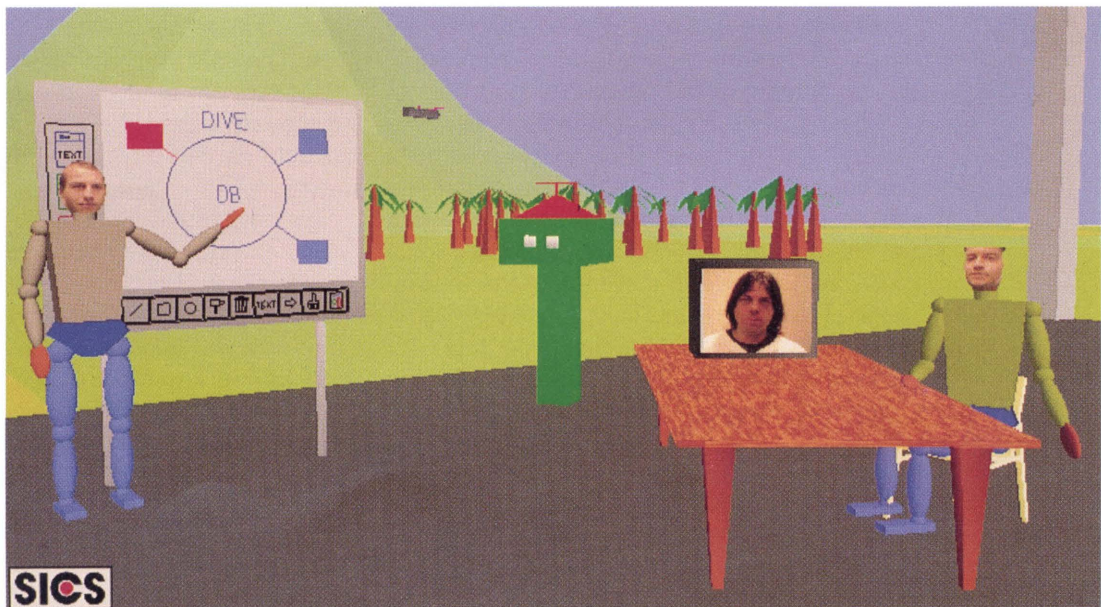
applications; medium-term development products (automated phone directory assistance, automated answering machines, and, more generally, voice-processing platforms connected to the public phone networks); and long-term developments of medium-to-large (200-10,000 words) vocabulary recognisers.

The increased accessibility of low-cost networking technology has highlighted the possible use of computers to support the work of

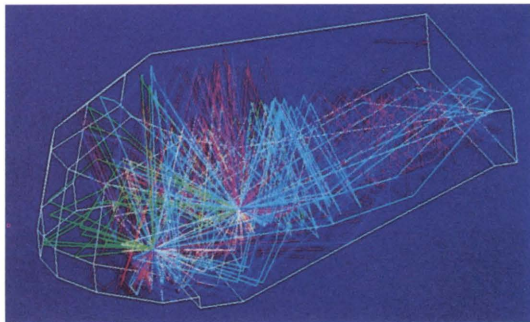
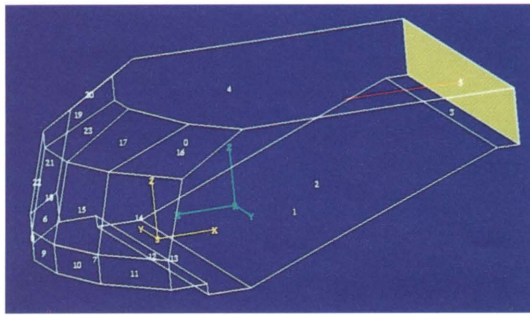
groups rather than just individuals, and such computer-supported cooperative working (CSCW) is attracting great interest. The COMIC (6225) project aims to develop the theories and techniques necessary to support the development of future CSCW systems. An interesting aspect of COMIC is the way it brings together researchers from fields as diverse as computer science and sociology. As part of its research, COMIC has examined the possibilities provided by the emergence of virtual reality (VR) techniques and high bandwidth communication systems. The combination of these technologies allows the creation of cooperative virtual environments that can be shared by a number of users across a network. The project seeks to gain an understanding of the social nature of these environments and the forms of cooperative work they could support. As part of this investigation, the development of techniques to support virtual meetings have been examined using a collaborative VR environment, DIVE, produced by one of the project partners.

Visualisation is just one component deployed when creating a convincing virtual environment. Sound is also very important. The SCATIS (6358) project aims to create an interactive virtual auditory-tactile environment in which a person is exposed to a virtual space with various invisible auditory-tactile objects distributed in it. These virtual objects can be localised and identified by sound cues (using headphones) and then reached for and grasped.

Social conventions for shared virtual realities are being explored in COMIC (project 6225). Shown is a virtual meeting combining animation and video-conferencing techniques.



Modelling sound environments is being undertaken in SCATIS (project 6358), a key step in creating a virtual audio-tactile environment. The first image shows a computer simulation of a lecture room with receiver (green) and source (yellow) coordinate systems. The second shows sound rays that start from the source and hit the receiver within the first 200 milliseconds after emission. Each colour shows a different travel time.



Smaller and more reliable devices

Despite recent advances in semiconductor technologies, the manufacturing process does not produce defect-free microchips. Depending on the type of circuit produced, only a fraction of the fabricated devices are fully functional. Faulty devices must be identified before a chip can become part of a working system. The provision of efficient and reliable IC testing techniques has been sought for some time, and has recently taken on a new urgency due to the enormous complexity of the current generation of ICs coupled with the increasingly complex fault behaviour displayed by the advanced technologies employed. Manufacturing deficiencies will often result in slower devices that may cause intermittent fault effects rather than well-defined functional faults. The available commercial tools are not able to handle such problems adequately. The ATSEC (6575) project is developing methods and prototype CAD tools that will allow the safe testing of complex ICs. The promising results already obtained and published have positioned European institutes at the leading edge of research in this field. The ATSEC consortium is now offering prototype tools for automatic test-pattern generation and for the validation of the test patterns themselves.

Mastering the fabrication of semiconductor structures with lateral dimensions below 100 nm, the limits of current conventional technology, opens the way for exploiting quantum effects for the production of novel devices,

such as narrow bandwidth semiconductor lasers, nanometre-scale field effect transistors (FETs), photodetectors, and modulators for very high data-transmission rates. Features as small as 5 nm were patterned for the first time in LATMIC II (6536) using e-beam lithography on organic resists. Such small dimensions will allow efficient device operation at higher temperatures. The project will use these techniques in novel switching devices and memories, such as single-electron devices.

Threshold current AFM (TCAFM) is an ultra-high spatial resolution method for the non-destructive measurement of local electrical properties that has been developed in the ASSIST (6108) project. This type of diagnostic method is used in clean-room semiconductor processing to improve yield and quality. For example, using this method on an oxidised silicon substrate, correlations with nanometre precision can be obtained between the surface topography and local electronic properties, such as changes in capacitance and conductivity. East Coast Scientific Ltd, a University of Cambridge spin-off, has successfully commercialised TCAFM equipment.

In the SOLDES (7260) project, a unique method of producing quantum wires by a self-organising process has been discovered. The technique involves growing epitaxial layers of GaAs containing erbium: this produces precipitates of ErAs in the form either of dots, wires or multiply bifurcated wires called "quantum trees". The size of the uniform dots can be controlled in the range 1 to 3 nm. The wires are typically 3 nm in diameter and 100 nm long. The significance of this discovery lies in the ease with which such structures can be made (compared to conventional nano-lithography), the low cost and high yield of the technique, and the stability and reproducibility of electronic characteristics compared with other quantum wire structures. If such structures are to find their way into devices, a fabrication route such as this will be the key to their use. Applications in optical devices, communications and fast signal processing can be foreseen.

The picture shows erbium arsenide quantum wire "trees", with each wire about 100 nm long, produced by a self-organising process discovered in SOLDES (project 7260). Their ease of fabrication augurs well for applications in nanometre-scale electronic devices.



VLSI design training

The purpose of EUROCHIP (6573) is to provide academic institutions with access to industrial training facilities so as to increase the number of trained VLSI engineers. The second phase of EUROCHIP is now well underway, and involvement has been extended to include universities and polytechnics from EFTA and central and eastern European countries. By the end of the 1992/93 academic year more than 10,000 students had been trained in VLSI skills under the scheme. At present there is an initiative to try to merge EUROCHIP and other related activities (ROC, MEDCHIP and CHIPSHOP) into an integrated action.

Networks of excellence

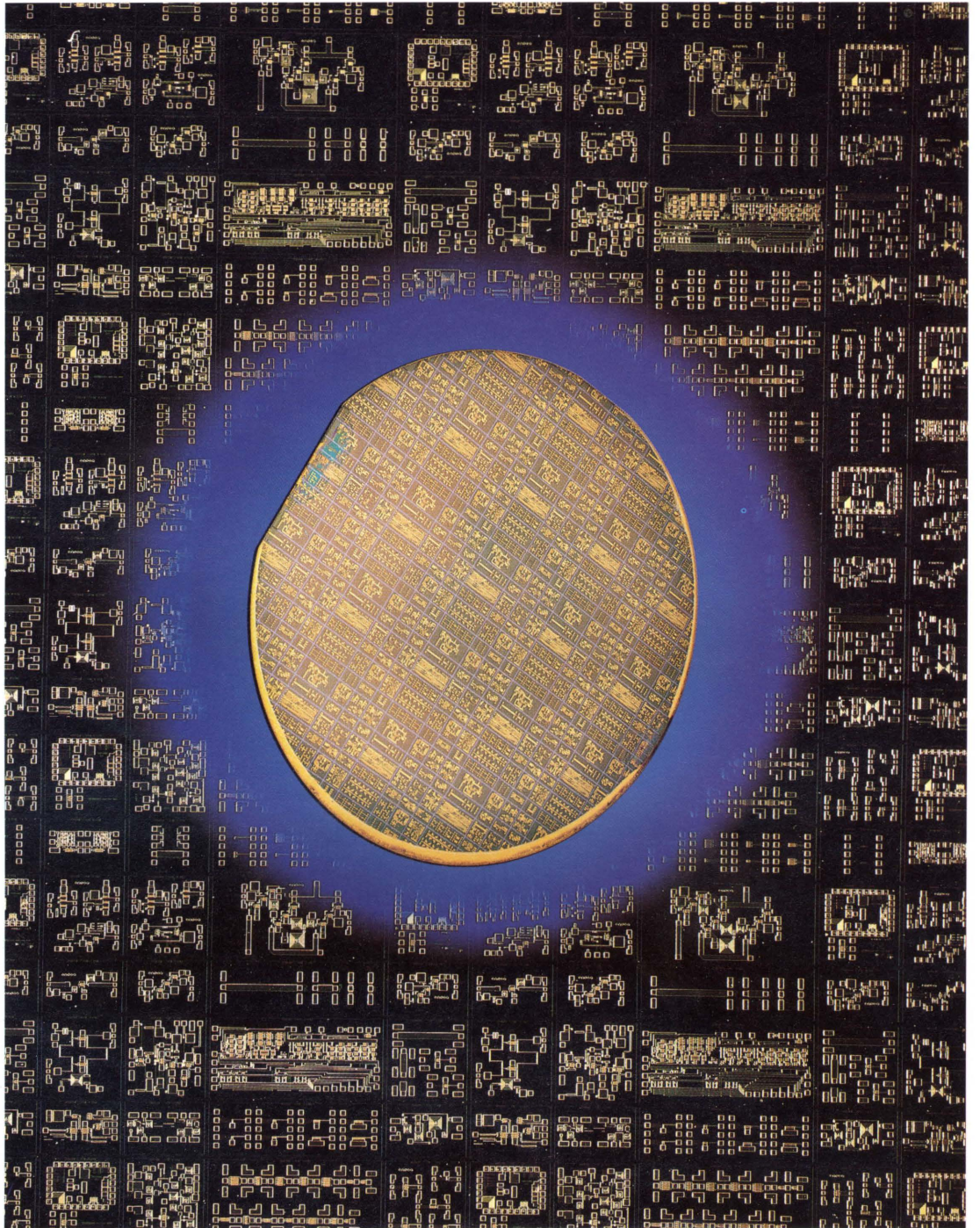
A network of excellence comprises industries, university laboratories and research centres active in a key technological area and sharing common long-term goals. Networks aim to coordinate R&D activity at

the European level and to assemble and mobilise the critical mass of resources and expertise required for technological breakthroughs. Turning these breakthroughs into market successes is achieved through guidance from industry and by making sure that the networks are sensitive to industry's needs.

Three pilot networks of excellence were set up in 1991: speech and natural language (ELSNET), computational logic (COMPULOG-NET), and distributed network architectures (CABERNET). The success of these three led to the establishment in 1992 of a further six networks covering multimedia and database systems (IDOMENEUS), organic materials for electronics (NEOME), multifunctional microsystems (NEXUS), high-temperature electronics (HITEN), machine learning (MLNET), and mesoscopic systems (PHANTOMS). A total of about 500 nodes have been established within the nine existing networks. The four additional networks launched in 1993 cover the intelligent control and integration of manufacturing systems (ICIMS), high-performance computing (HPCNET), computer vision (CVNET), and neural networks (NEURONET).

Now that the basic infrastructure is in place, most networks increasingly focus on their more strategic function of coordinating R&D activities on the basis of consensus strategies, including the systematic assessment of their industrial impact and value and of the prospects for eventually exploiting the research undertaken. NEXUS, for example, has been very successful in bringing together all the significant players in the area of microsystems technology. Participating industries are currently jointly defining a common R&D strategy and providing guidance on all network activities, which include training, education, publications, "who's who" almanacs, technology transfer to SMEs, and the screening of R&D proposals. The ELSNET network has been instrumental in bringing the speech and natural language processing communities together and in formulating a common R&D strategy. The area of speech and natural language is rapidly maturing, and ELSNET is helping to ensure that Europe will maintain a good competitive position in this market.

This gallium arsenide wafer for MMIC applications contains the chips resulting from 14 EUROCHIP projects.





Microelectronics

by Horst Forster, Head of Unit

Introduction

Mastery of microelectronics technologies, and in particular ASICs (application-specific integrated circuits) and sub-systems, is the key to continuing electronic systems innovation. The added value and competitive edge created through the effective integration of systems in silicon drives users to demand ever more complex and high-performing components. The results of Esprit microelectronics projects are found embedded in a very diverse range of applications affecting all aspects of modern commerce and everyday life.

The timely availability of advanced and low-cost integrated circuits is, therefore, a vital factor enabling European industry to be competitive in global markets. Two of the most vigorously growing markets which have experienced these benefits are mobile communications and the automobile industry, where electronic sub-systems will soon account for 25-30% of the total vehicle cost.

Microelectronics activities in the Third Framework Programme focused on four lines of action: consolidating a sound technological and manufacturing base in order to meet cost and performance demands; encouraging application-driven projects where goals were set by close collaboration between users and suppliers; introducing highly integrated systems (microsystems); and providing easier access to advanced technologies for SMEs through pilot technology transfer actions.

Technologies enabling advanced applications

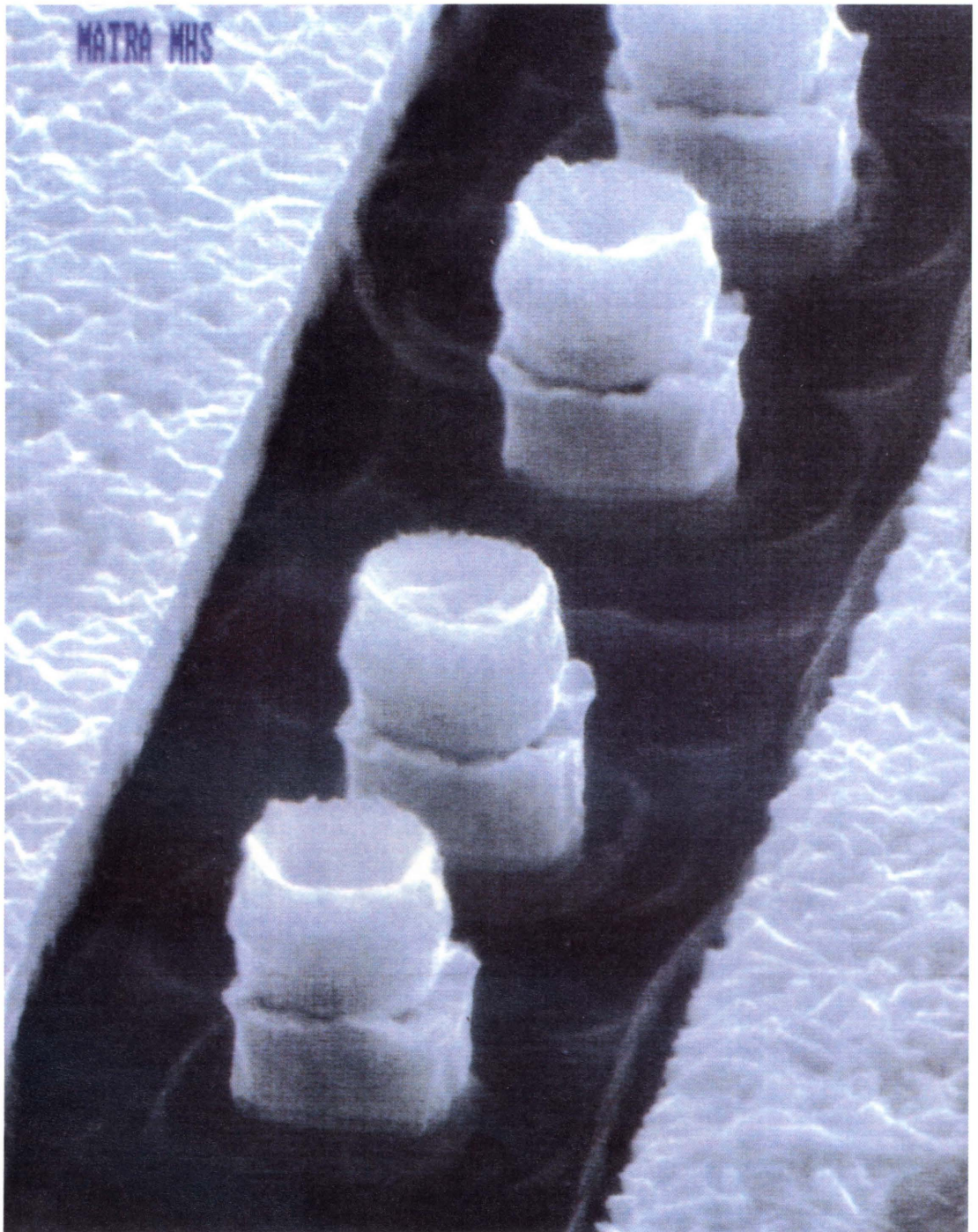
In order to provide competitive solutions to a broad spectrum of applications requiring higher system performance and lower costs per function, considerable R&D investment is needed to develop advanced technologies, increased efficiency in manufacturing and quick and effective design methods. Very few companies can afford to allocate sufficient resources to undertake these tasks alone. The technology developments in Esprit have been particularly successful in harnessing the combined expertise and resources of Europe's IC industry, research institutes and academia in a coherent and mutually supportive framework of projects spanning several generations of CMOS technology.

The next generation of CMOS

A key focus of these activities is the Esprit-supported JESSI Joint Logic Project (JLP) (5080, 7363), which is establishing a platform for the industrial assessment of new CMOS technologies, pursuing the development and installation of new processes, and providing the basis for enhancing the manufacturing excellence of semiconductor equipment and materials suppliers.

The technical targets for the work have been set following extensive research into high-profile application requirements. These include chipsets for communications (ISDN, digital audio broadcasting, cellular phones), consumer products (CD players and digital compact cassettes) and automotive applica-

Highly optimised interconnect structures using 0.5 micron CMOS technology developed in the JOINT LOGIC project (7363).



tions (novel safety and navigation features). In 1993 the consortium announced the availability of a common set of design rules for a state-of-the-art, triple-level-metal, 0.5 micron digital CMOS technology which is being simultaneously installed and qualified at seven European IC manufacturers' sites. This announcement represents a considerable boost for European industry, which can now access technology capable of manufacturing products which are 80% more complex and 30% faster than those

designed in the current 0.7 micron generation. The mainstream JLP project also defines the industrial process requirements for the work being carried out in institutes and academia on future technology generations (down to 0.18 micron) within a comprehensive set of projects: ADEQUAT (7236), COIN (9021), PROMPT (8150) and NOVA (9159). This strategy has led to the early demonstration of 0.35 micron technology at the 8" fabrication facility at Crolles (Grenoble).

The Joint European Submicron Silicon (JESSI) Eureka project started in 1990 with support from national governments and the Community. Esprit provides approximately 25% of the public funds, which support a combined effort of 2,500 researchers working in more than 150 organisations in 14 countries. CMOS and BiCMOS technology, manufacturing science, and CAD framework projects supported by Esprit are at the industrial core of JESSI. Results from this work are having a very positive impact on the competitiveness of the participating companies, and the gap with US and Japanese rivals is closing. For example, Europe's electronics industry was given a significant boost in 1993 when the Esprit-funded Joint Logic project released a common set of target design rules for a 0.5 micron CMOS process. Seven European chip makers can now provide a common technology platform to give Europe's electronic systems companies early access to multi-sourced, leading-edge semiconductor technology. The process performance has been defined to meet the collective needs of JESSI user-partners, who are today using it to develop application-specific chips for a very broad range of markets including the telecommunications, automotive, computer and consumer electronics sectors.

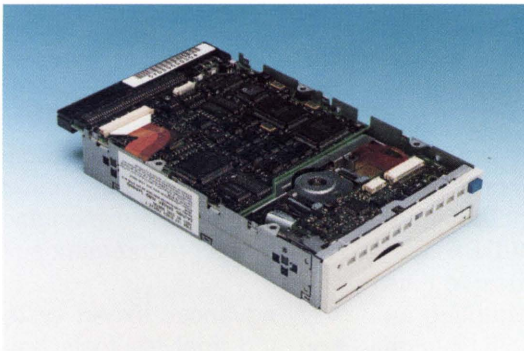
Bipolar technology

In addition to the important results registered in the CMOS domain, Esprit projects have also made significant progress in a range of important higher-frequency technologies. For example, in the MIDAS project (6135), world-class transistor performance with cut-off frequencies between 40 and 70 GHz and gate delays of 18 ps has been demonstrated, indicating an extension of bipolar technology.

Peripherals

Based on the MAGNOPT (7801) project, a high-performance, low-power magneto-optic hard disk drive with 128 Mbyte capacity has been launched on the market. Future high-capacity drives will benefit from the results of HIRED (6134), which has produced semiconductor lasers emitting 50 mW of visible light, enabling higher data density and faster writing speeds.

The magneto-optical disk-drive shown, developed in MAGNOPT (project 7801), has full read-write capability. The 128 Mbyte capacity version is already on the market, while the double-density version is expected to be available in the second quarter of 1994.



Compound semiconductors

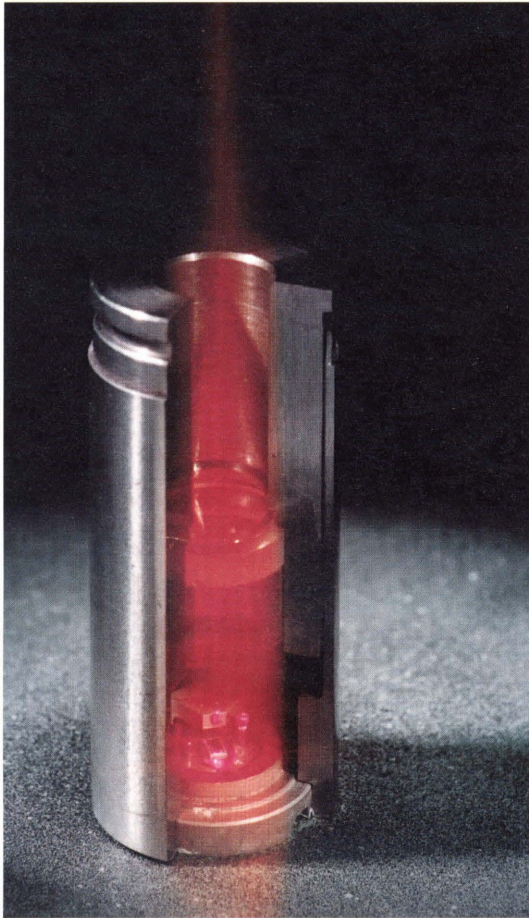
Work on compound semiconductors technologies using gallium-arsenide (III-V) material within the AIMS project (5032) has provided high frequency monolithic microwave building blocks for the 20-40 GHz frequency window. This technology has already been demonstrated in a system for airport ground traffic surveillance radar, and is now being used by telecommunications companies to extend existing line-of-sight earthbound wireless microwave links to the 38 GHz band. These versatile building blocks have also been proven in satellite-to-satellite and satellite-to-earth (VSAT) applications, and can be configured for use in 78 GHz car radar anti-collision systems.

Design methodologies and tools

In order to exploit to the full the potential of these powerful technologies, users need access to new design methodologies and tools that can cope with increasing complexity and higher performance. Today's systems are so complex that teams of designers need to work concurrently at the chip, board and systems levels. Such concurrent working requires managing the design process as well as design data. Through project 7364 on common frames, SNI has launched the commercial product SIFFRAME. This revolutionary product is the first commercially available, general-purpose open framework for integrating design tools from a wide spectrum of interacting applications. Racal-Redac Ltd, which is among the world leaders in tools for electronic system design, has announced that their design tools are now available integrated into the SIFFRAME product.

Complex electronic systems can be decomposed into a number of re-usable functional blocks such as micro-controllers, signal processors and memories. One building block of particular importance is the programmable digital signal processor (DSP), which has

Semiconductor lasers developed in HIRED (project 6134) are capable of emitting up to 50 mW of red visible light, delivering the high power levels required by erasable optical disk memory systems.



become a key functional part of consumer electronics, communication, multimedia and automotive systems. In this area, the partners of the SPRITE project (2260) have produced a highly automated environment for the development of DSP systems on silicon, providing impressive cuts in cost and time-to-market by enabling an order of magnitude reduction in design time. The tools have been verified by project partners in many industrial designs, including a critical time-to-market million-transistor video processor chip developed by Philips for the consumer market, and a DECT (digital European cordless telephone) chip developed by Siemens, where a reduction in board size and power consumption of more than 50% was achieved. The tools developed in these Esprit projects are now commercially available in the Mentor DSP station, which has been installed in more than 100 sites worldwide. The work of the RETIDES (6800) project is complementing the DSP design tools by developing real-time DSP emulation for fast prototyping. This technique allows fast verification and test of

DSP algorithms, in real time, before a design is committed to silicon. Within the first year of the project, a desktop hardware emulation machine, Paradigm RP, has been commercialised through InCA/ZYCAS (UK).

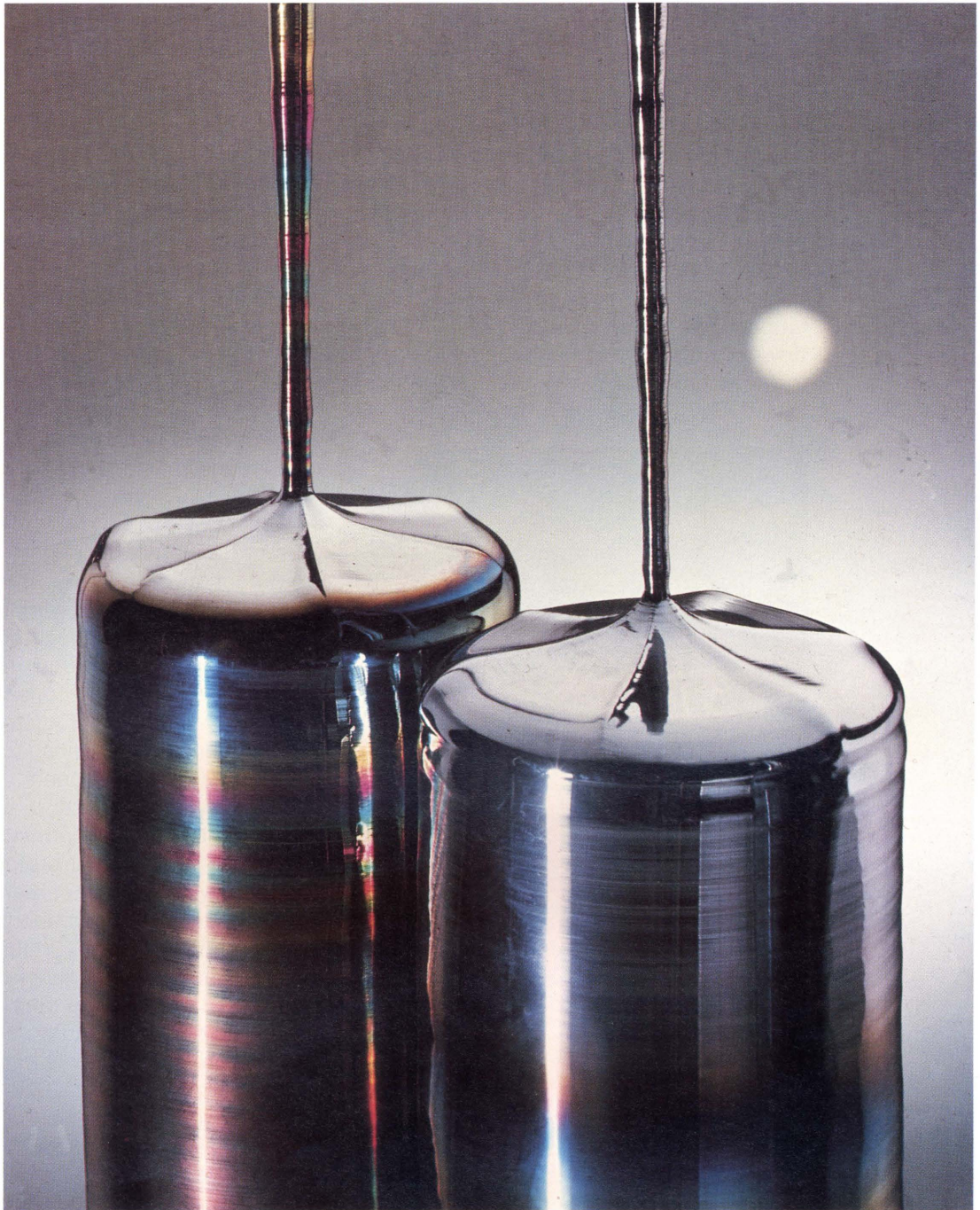
These Esprit projects have helped to catalyse an extremely fertile DSP design environment in Europe. Many small design companies have become established in the Leuven area of Belgium to the extent that they have created the so-called DSP Valley network, which unites over 300 DSP experts in a combined global marketing and design service. The network can offer a complete spectrum of DSP solutions ranging from consulting services through to total system development.

Manufacturing science and technology

The ability to bring new applications to market is dependent on the competitiveness of the IC manufacturers working in a field where fabrication methods are continually changing, with completely new techniques evolving every three to five years. In this area, the significant collaborative efforts by European IC manufacturers in the ambitious MST project (7365) reached a major milestone in December 1993, with the demonstration of their achievement of world-class competitive manufacturing at the 0.7 micron level. Other important results include contributions to international standards with models for flexible manufacturing cell controllers and procurement specifications.

Very advanced expert systems data collection and analysis tools have now resulted from the IMPROD project (6200), where SMEs and institutes worked with SGS-Thomson and Bosch to evolve automated process measurement and yield enhancement tools. Due to the importance of this work, the major European IC manufacturers have taken the same academic partners into the new MST project phase (8003), which aims to decrease the cost of 0.5 micron CMOS production. Fast cycle times and flexibility of production are now essential in the race to bring high-complexity ASICs to market in time. The study phase of FAB 2000 (8413) is addressing this issue by modelling a fabrication line with the objective of cutting the total IC production cycle time from about 150 days down to a target of about 12.

High-performance silicon ingots manufactured by MEMC SpA in DIASYSICON (project 7327).



High-purity silicon ingots used in making silicon wafers for microelectronics are manufactured by MEMC SpA, who have benefited from their work in DIASYSICON (7327) on contamination reduction and crystal structure control aimed at enhancing their commercial competitiveness.

Lithography

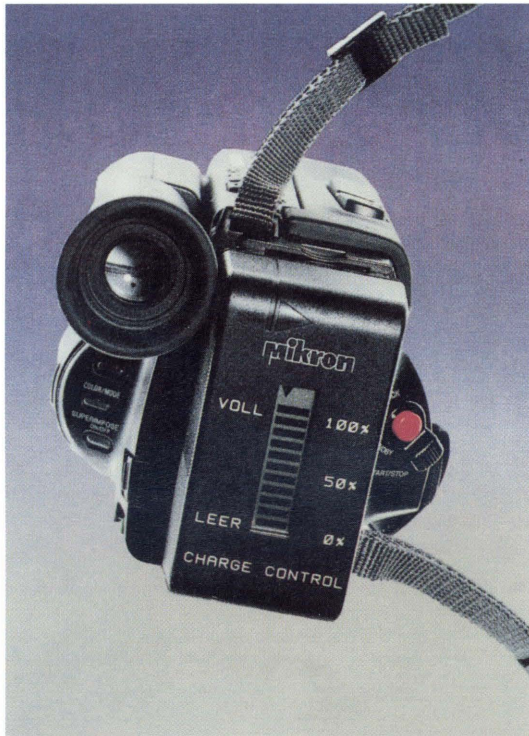
Support for optical lithography, especially in the i-line UV band, has now provided world-beating production tools for this most challenging process. ASM-L has reported strong

international interest in their PAS 5500/100 wide-field i-line wafer stepper, the subject of ASPRO (6793). The stepper's specified resolution is 0.35 microns, and it will be used for multiple generations of advanced DRAMs, ASICs and large-area microprocessors. Customer interest is strong, and orders for this stepper already make up over 40% of ASM-L's current order book. Complementing this success, the JEEPS project (6908) is developing several types of phase shifting masks to extend the production life of the installed base of optical steppers.

Increasing functionality in electronic systems

The projects in this area cover the most important aspects relevant to the integration of a system on a single chip by combining several core technologies with special-purpose variants at single- or multi-chip level. The requirements of modern applications, in particular in terms of high speed and circuit packing density, as well as the need for embedded memory, sensing elements and power stages, have directed the work towards the development and application of BiCMOS, CMOS non-volatile memory

A battery recharging pack incorporating a control and monitoring module that uses a CMOS EEPROM chip developed in APBB (project 7802).



(including flash memories), smart sensor and smart power technologies.

BiCMOS applications

In order to fulfil the requirements of growing market segments such as mobile and broadcast communications, a spectrum of BiCMOS and bipolar technologies are needed. The 0.7 micron, 12 GHz BiCMOS technology developed in CANDI (2268) by SGS-Thomson and TEMIC is now being offered on the market for different applications. The first components available include a line termination chip for B-ISDN and a GSM port for cellular radio. SGS-Thomson's process is now being transferred into production at their new 8" facility in Crolles.

As a result of projects 2039 and 7802 (APBB), technologies incorporating EPROM and EEPROM have already been transferred to production by SGS-Thomson and GEC-Plessey for major applications in automotive, consumer and telecommunications products. From amongst the demonstrator chips developed by SMEs participating in the project, a battery fuel gauge chip (designed by Mikron and prototyped by GEC-Plessey) is of particular commercial interest. Discussions with a number of battery manufacturers have resulted in a new design offering more flexibility and functionality for many applications including power tools, hand-held computers, video cameras and medical equipment.

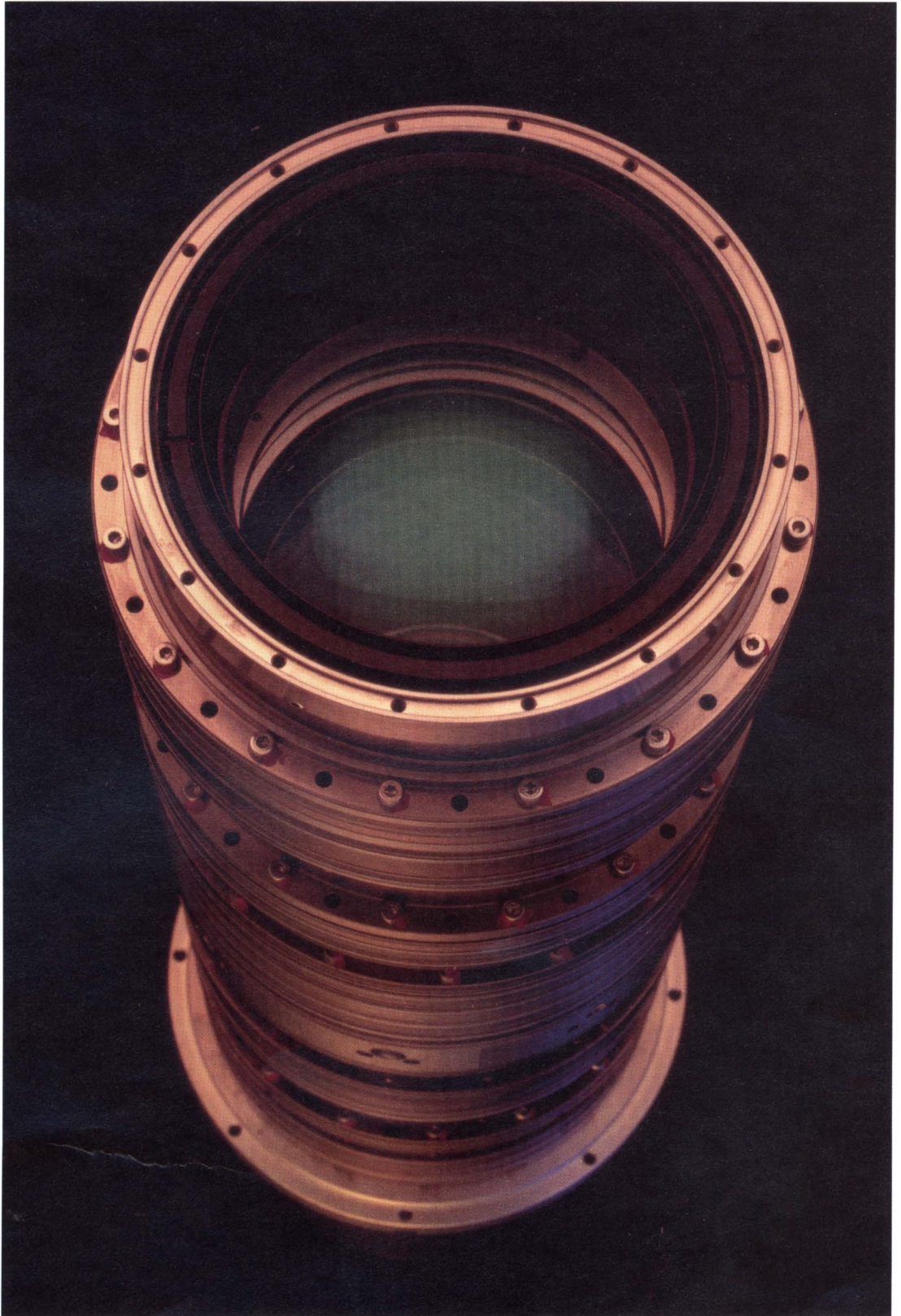
Packaging

Progress in the area of packaging and interconnection has been demonstrated by higher integration at component and sub-system levels, enabling the production of smaller, lighter and more reliable systems for a large variety of applications. In IBCAR (6285), a technology for integrating passive components (such as capacitors) in a ceramic substrate has been developed. The improved reliability and cost reductions offered by this technology have been exploited in industrial prototypes, with two automotive sub-system manufacturers producing an electronic module for throttle valve control which is mounted directly on the engine, and a module for the signal processing of data from a petrol engine. Highly innovative packaging consisting of stacked semiconductor dies in three-dimensional structures produced in TRIMOD (6490) has been used to produce 256 Mbit memory modules with the world record memory density of 45 Gbit/litre. These components are now being used to produce a miniature video communications system.

Microsystems: developing integrated applications

Microsystems are microscopic assemblies combining electrical with mechanical, optical, chemical or biological functions. This allows the realisation of highly complex sensor/actuator and signal-processing functions in a small space. Significant work is now underway, particularly in the automotive, medical, environmental and communication

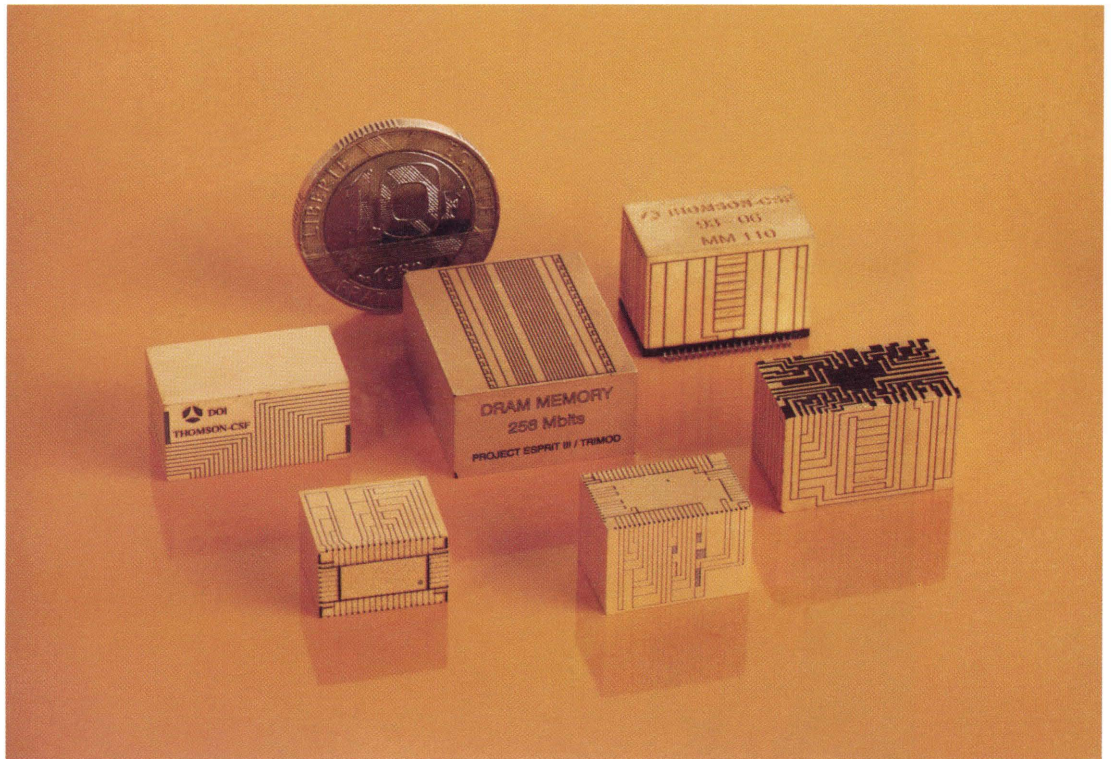
*A lens made by Zeiss
for use in ASM-L's
i-line wafer-stepper
developed in ASPRO
(project 6793).*



sectors. One project, MAXIMA (6416), has developed a monolithic accelerometer for the automotive market, where large numbers of lower cost sensors in airbags, safety restraint, active suspension and anti-lock

braking systems are required. Production of these has now been successfully integrated into a modified BiCMOS process. In AMIS (6505), a hybridised flip-chip approach is being used to integrate intelligent sensors.

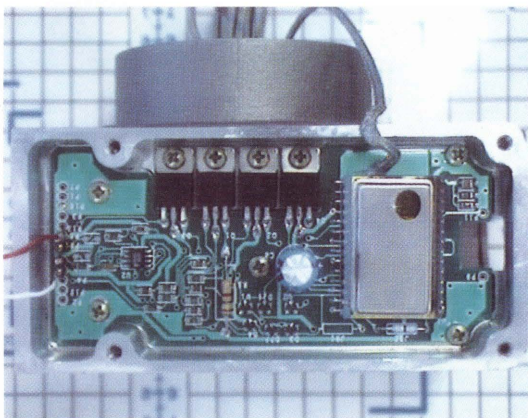
Three-dimensional memory blocks, developed in TRIMOD (project 6490), formed by stacking semiconductor chips.



The project demonstrators include an accelerometer for crash detection in airbag applications, a medical catheter sensor for blood pressure, temperature and flow measurement, and a hydraulic pressure sensor for industrial and aerospace applications.

In the project MMM-GAS (6374), the partners have succeeded in developing a process for fabricating 200 semiconductor catalytic gas sensors of the SnO, ZrO type on a wafer, and are examining this for low-cost aircraft cabin air-control applications. Complementary approaches for more demanding applications include optical methods for ensuring high selectivity in the presence of other gases, using signal processing methods for smart calibration.

Shown is an electronic throttle-valve control for automotive applications. The low-temperature cofired ceramic (LTCC) substrate, which incorporates electronic components, was developed in IBCAR (project 6285). This ruggedised module controls the air flow into the engine, on which it is directly mounted.



Several microsystems projects deal with medical applications. The IMICS (8736) project is concerned with the development of a catheter system for cardiac intervention and plaque removal. The system uses a micro-miniature ultrasonic head sensor and corresponding on-board signal processing electronics to determine the location and texture of intravascular plaque deposits, and includes a microturbine to remove them.

Finally, in the area of industrial and environmental applications, project 7101, MINOSS, is working on the design and fabrication of micro-integrated optical sensor systems. Applications now being commercialised include instruments for the measurement of dissolved oxygen in bio-reactors and bore holes. Future uses foreseen include spectral analysis, as a component of a smart camera, and as part of a fog measurement system.

Promoting the exploitation of microelectronics

Surveys show that some 25,000 SMEs in the European Union are interested in incorporating microelectronics components into their products. However, access to these technologies requires considerable effort in terms of acquiring skills and needs a sub-

The microsystem under development in IMICS (project 8736), pictured here with a matchstick for scale, uses a miniature ultrasonic head sensor and on-board signal-processing electronics to determine the location and texture of arterial plaque deposits. The subsystem shown contains micro-valves for controlling the placement and positioning of the device.



stantial financial commitment. These obstacles are often difficult for SMEs to overcome without expert assistance. To help them to understand and apply new technological developments, and at the same time improve the take-up of technology stemming from Esprit, a number of initiatives involving ASIC demonstrations have been implemented.

As a result, several hundred SMEs have now familiarised themselves with ASIC technology. For example, in I-SMILE (5085), Esaote has developed, in co-operation with the University of Genova and MIDA, a circuit to be used in a new-generation echotomograph. This circuit prototype received an award for the best industrial ASIC design at the EDAC-EUROASIC '93 Conference. Notable amongst the very good projects completed in GAME was the work of Contazara, which developed a configurable ASIC for use in a non-invasive water consumption and flow measurement system. This product is being exploited in flow and leak control systems for water distribution in several major urban areas. In the same project, Leventon developed pressure sensors for catheter applications which simplify and improve the interface between the patient and the monitoring system.

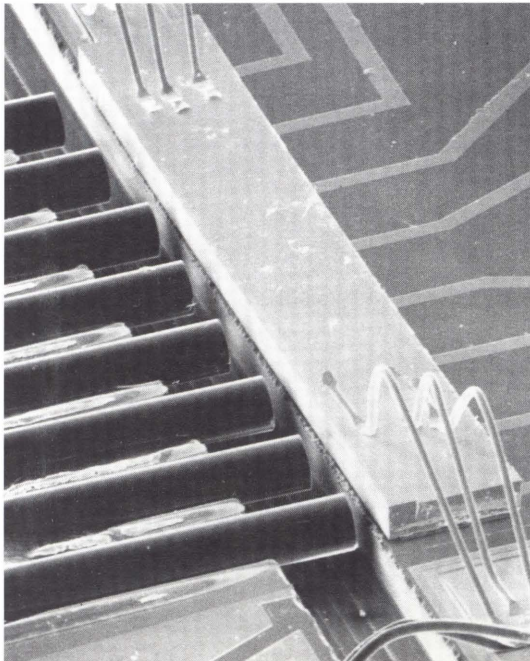
To further promote the use of ASICs by SMEs, access to low-cost fast-turnaround prototyping services is essential. This has been precisely the target of QUICKCHIPS (6043), which has led to the construction of a new wafer fabrication facility at INESC in Portugal, complementing the design platforms and libraries developed by the consortium. The direct-write laser lithography tool developed by Heidelberg Instruments

A water analysis system based on a disposable sensor incorporating sensing and calibration electronics has been developed in B-ASICS (project 6240). The system can rapidly measure concentrations of heavy metals in a few drops of water, enabling real-time on-site pollution monitoring.



Scanning electron micrograph showing the interface between 125 micron optical fibres and a monolithic laser array in a six-channel, 1 Gbit/s per channel optical transmitter array module.

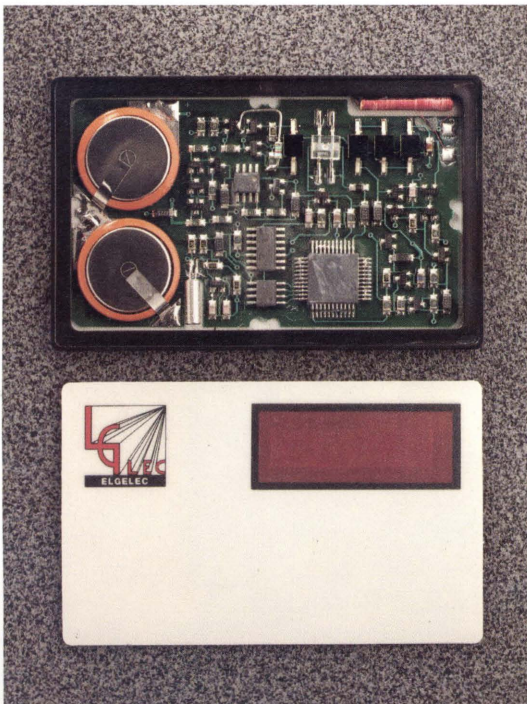
The module, developed in OLIVES (project 2289), is used for interconnecting telecommunications and computing devices.



avoids the use of expensive masks and is making a significant contribution to ensuring a low-cost, timely supply of ASICs.

A particularly notable result of the work undertaken in Esprit microelectronics projects is the establishment of a significant number of high-tech start-up companies, some of which have already been mentioned. During 1993 some of the original members of the Boundary Scan (2478) project consortium established a start-up company,

The smart card developed in MORECO (project 5051), here shown disassembled, is now being commercialised in areas such as access control and toll payment systems.



JTAG Technologies AB, which took over the exploitation of project results. Today JTAG offers a very comprehensive range of boundary-scan test equipment, ranging from entry-level systems through to full production testers. JTAG's products are particularly important for small and medium companies who, for a relatively low-cost investment, can improve their product quality by exploiting the full potential of the boundary scan technique. In the equally important area of device and process modelling tools, a new company, Integrated Systems Engineering (ISE) AG, has been founded to exploit the software which has been developed within the Esprit projects DESSIS (6075) and the newly launched PROMPT (8150).

Planning for the future

In readiness for the launch of the Fourth Framework programme, a major series of consultations with European microelectronics users and providers has been undertaken. These consultations, held on both a bilateral and workshop basis, are a precursor to the publication of a workplan document covering the first phase of the Fourth Framework Programme. Moreover, and with a somewhat broader perspective, a panel of senior industrial executives have been invited to analyse the current status of European microelectronics with respect to the rest of the world, assess the impact of public funding activities, past and present, including those of the Community, and then to come forward with suggestions for future orientations and policy for the European microelectronics industry's R&D activities for the years to come.


 I.T. PROGRAMME • ESPRIT

Software and Advanced Information Processing

by David Talbot, Head of Unit

The industrial context

Software is now the principal cost of a typical IT system and the main source of its added value. This is reflected in the position that software and software-related activities hold in the European IT market, where software and its associated services are now the dominant source of revenue.

However, software is not only a major issue for the players in the IT industry. All industrial and service sectors have an interest. In Europe some 70% of all software produced is developed by IT user industries. For these enterprises, software-intensive IT systems are essential for controlling costs, improving the quality of customer service, optimising industrial and business processes, and helping them get closer to both customers and suppliers. Moreover, a vast range of familiar products, from domestic equipment through to transport systems, have a rapidly growing software content. The quality and the facilities embodied in this content is an increasingly important component of the competitive advantage offered by the suppliers of these products.

The European position

In contrast to the hardware position, software represents an area of comparative European strength. European capabilities to engineer software are widely regarded as world class, and European players dominate the professional and processing service segments of their home market. However, the size of the market and the comparatively good margins available in Europe, together with declining hardware margins, are all stimulating the entry of new and powerful competitors.

The position in the packaged software market is less good. Aspects of the business are showing clear signs of globalisation and these (particularly in the area of standard software for PCs) are still largely dominated by US vendors. Nevertheless, in specific niches, such as those concerned with the supply of the larger and more complex packages and the new generation of software tools, European vendors are demonstrating an appetite and capability to be truly competitive worldwide.

Esprit: a framework for developing an international business strategy

As businesses move to take advantage of the development of the single market, enterprises across the full spectrum of industrial and service activities are increasingly seeking software-based solutions that involve not only the integration of a wide range of software-based technologies and many disciplines but also, from the vendors, a capacity to operate across Europe. Against this background Esprit offers opportunities for all segments of its diverse software community, and especially for the growing number of innovative software SMEs: it is noteworthy that SMEs are present in some 92% of all current SAIP projects.

Operating in multinational and usually multidisciplinary projects provides opportunities for all project partners, both large and small, to access complementary and often hard-to-find skills, and the possibility of identifying future partners and technology sources. Projects in SAIP have given rise to a growing number of joint ventures, business spin-offs, cross-licensing arrangements and friendly acquisitions, supporting the trend in the

domain for an increased concentration on core activities and the drive to gain critical size.

Complexity: the software challenge

Complexity is embodied in the know-how and knowledge that are the essential sources of attraction to the buyer of a software-driven system. Hiding the inherent internal complexity from the user is a fundamental requirement for ease of use, and managing the complexity is an essential capability for the producer. Establishing a world-class European capability to address these issues is a pre-requisite for the successful implementation of the European Information Space envisaged in the recent Commission's White Paper on growth, competitiveness and employment. Furthermore, a mastery of these issues is essential if Europe is to benefit from exploiting the subsequent opportunities offered by this new information environment.

To attack these concerns, the SAIP area pursues two complementary strands of activity. These address the dilemma faced by the professional software producer: on the one hand, current technologies cannot cope with the challenges posed by future application needs, while on the other, present practice fails to make adequate use of available technology. This leads to the so-called "software crisis", with demand continually exceeding supply. SAIP addresses the first issue by a programme of focused R&D driven by the constantly changing application-led challenges, and the second by a set of actions designed to encourage the widespread and accelerated take up of software best practice.

R&D activities

Sustaining and enhancing the European capability to build advanced systems

Activities centre on the need to ensure that European professional software developers in both vendor and user organisations have the world-class skills and support technology necessary to build the ever more complex and varied systems demanded by the marketplace. Two broad complementary approaches are taken. The first is concerned with the

need to improve both the effectiveness of the software process and the quality of the delivered product. The second addresses the need to provide an increasingly powerful set of supporting technologies and tools.

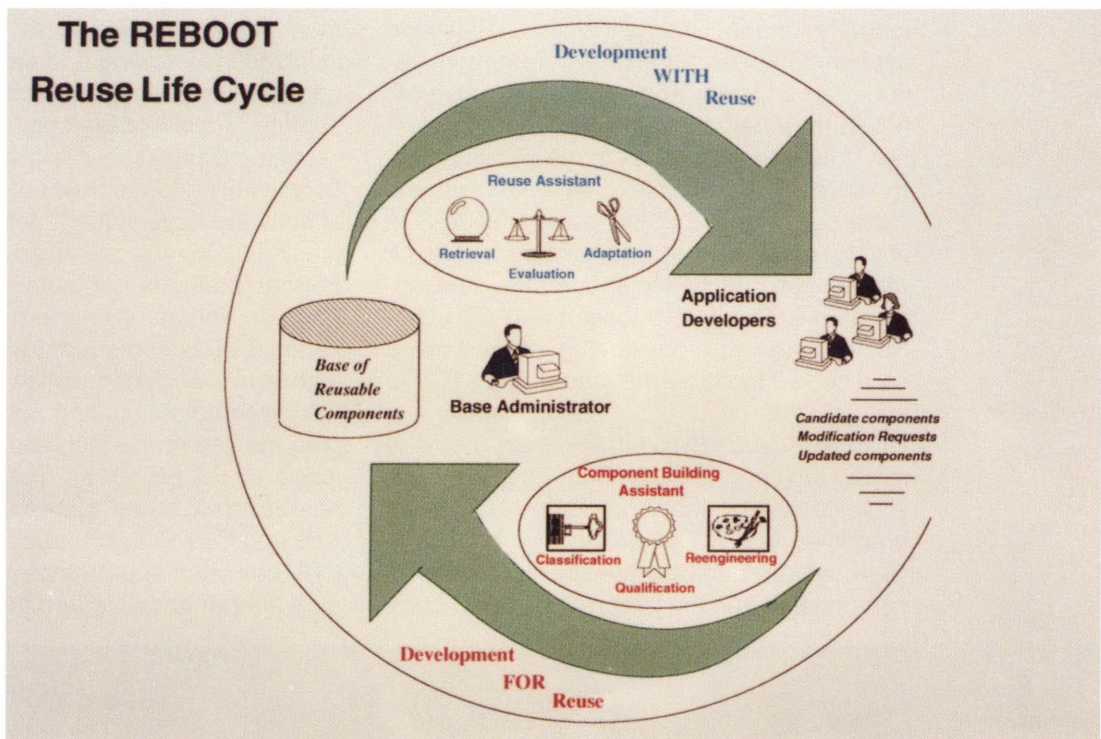
Improving the process: the framework of managerial and technical concepts and practices for software development is key both to improved efficiency and to increased quality in terms of the delivered product. Esprit projects identified in previous editions of this report have contributed to a range of insights into quality and efficiency mechanisms and their potential application in industrial environments. In this context and for the period covered by the report, the further activities of five projects are of particular interest. All of them are concerned with the fundamental but, for software, notoriously difficult subject of assessment and measurement.

The complementary and cooperating cluster of projects comprising AMI (5491), PYRAMID (5425) and METKIT (2384) have all been concerned with various aspects of measurement, the promotion of metrics, and the provision of practical guidance on the matter of installing systematic measurement programmes in industrial software producing organisations. The METKIT training material has already been used to instruct more than 5000 European software professionals. It is already in use in over 60 major organisations in both Europe and the USA, and more than 300 modules of the academic package designed to be incorporated into university courses have been purchased. As a result of the activities of the AMI project, the AMI User Group now numbers some 2000 organisations. The AMI method and model has already, in addition to its deployment by the project partners such as GEC Marconi, been adopted by clients such as Schlumberger, Bell Canada, TRT (Philips), Matra and Provident Mutual Life Assurance. It is now being considered as a potential major contribution to the process improvement guide being developed by the ISO-SPICE initiative. Materials from METKIT and AMI are now distributed by Brameur and Objectif Technologie respectively.

Complementing these measurement activities, BOOTSTRAP (5441), led by 2I Industrial Informatics GmbH, further developed methods of assessing the overall software development process. The maturity model developed by the US Software Engineering Institute (SEI) has been mapped onto the requirements of the ISO 9000 quality standard. BOOTSTRAP assessments are thus used to both assist organisations in examining their current software development capabilities on what is now an increasingly accepted international scale, and to link this, where appropriate, to the

embraces consideration of functionality, ease of use, maintainability, portability and reliability. The techniques developed by the project have been deployed on some 20 major case studies, and Verilog, which led the project, has now set up a specialist company, PSTI-Evaluation SA, to exploit these capabilities in the commercial arena. MUSIC has focused on usability aspects and has played a significant role in the development of ISO and CEN standards concerned with this matter (notably the ISO 9241 set), and produced a comprehensive package of tools and techniques designed for use by software

REBOOT (project 5327) has developed methods and tools that support the whole life-cycle of software re-usable components from re-engineering, through qualification and classification, to retrieval and adaptation.



attainment of the ISO quality standard. The method is now operated as a commercial service by Enoteam SpA and a rapidly developing European BOOTSTRAP network. To date more than 150 software producing organisations have used the method as the basis for improving their approach to software development.

developers purchasers and users. MUSIC tools and services have already been sold by the partners to an impressive list of world leading software developers and major users in both Europe and the USA.

SCOPE (2151) and MUSIC (5429) were aimed, in contrast to the above process-oriented projects, at assessing and measuring product quality and, as a result, supporting subsequent improvements in the development process itself. SCOPE has made a major contribution to the development of the ISO 9126 norm concerned with the evaluation of software products. The standard

Technologies and tools: Current actions in SAIP aim to support an overall systems engineering approach in which not only are hardware and software components to be considered but also the people engaged in the system and the organisation in which it is embedded. Activities must be directed at the particular challenges thrown up by the real-life requirements for systems to evolve, to increasingly employ a systems building approach that exploits existing components, and to address

applications in which dependability issues grow ever more prominent.

Support for evolution, building by components and reuse are features of IPTES (5570), REBOOT (5327) and BUSINESS (5311). IPTES addressed the subject of support for the concept of incremental prototyping as a way of coping with the constantly increasing complexity and risks associated with the industrial development of embedded computer systems. The prototype testing of the tools and techniques of the IPTES project carried out by VTT Electronics and Rautaruukki New Technology in the development of the Smartvis vision inspection system has been an impressive demonstration of their power and applicability. Overall, IPTES has demonstrated that formal definition added to existing methods allows industry to develop complex real-time systems more safely, and that the ability of IPTES to fit into a concurrent engineering approach offered opportunities to shorten the development time. The IPTES tools (the IFAD VDM-SL Toolbox) are now being offered on a commercial basis by the lead partner IFAD.

REBOOT and BUSINESS both have a strong object-oriented (O-O) focus with a view to using the component concepts embodied by O-O to provide for more efficient system building, the greater re-use of components and the integration of O-O com-

ponents into the infrastructure of existing systems. BUSINESS has developed a range of tools including an Analyst Workbench and a Design Workbench. These are now available from Télésystèmes. The Design Workbench will be included in the next version of the O-O language EIFFEL together with an accompanying method.

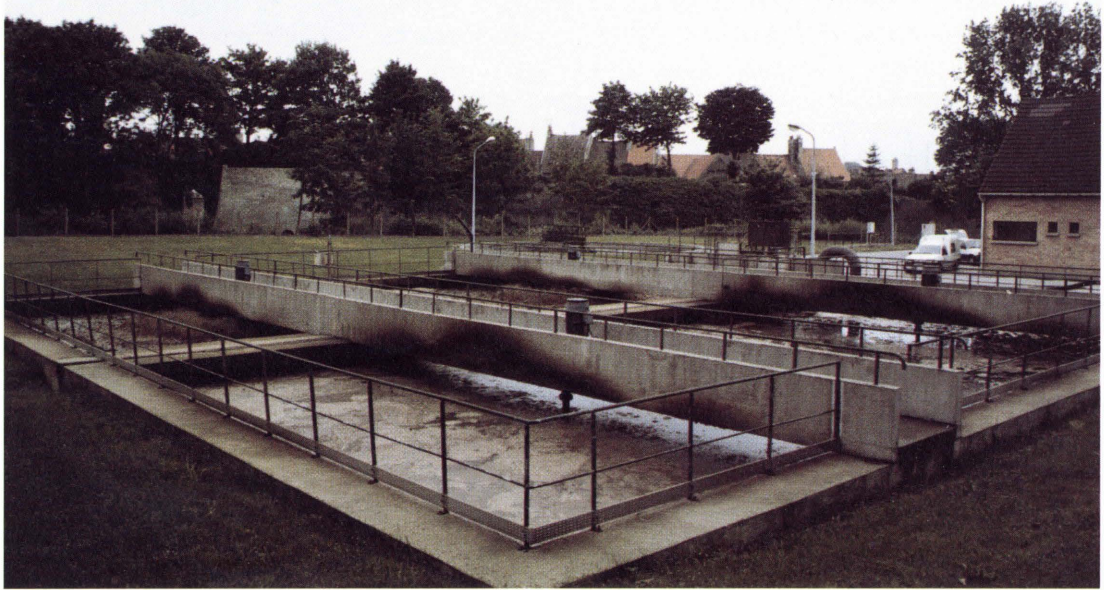
REBOOT has placed particular emphasis on developing and evaluating advanced methodologies and tools for, and with, reuse. It is cooperating with NSR, a Norwegian reuse consortium comprising Norwegian applications and tools developers in industry, government and the service sector. NSR is actively involved in reviewing and validating the tools and concepts offered by REBOOT. The consortium has also developed a comprehensive training package designed for organisations seeking to employ reuse in their internal software development activities.

Formal methods for software engineering have an important role to play in the development of systems required to exhibit very high levels of dependability. LACOS (5383) has been demonstrating and further developing the use of the technology initially developed in RAISE (315). The RAISE toolset has been extended to include translators to Ada and C++. The commercialisation, led by CRI, has seen applications in domains including aircraft handling and the on-board soft-

The SARAS oil refinery in Sardinia is installing the demonstrator developed in REAKT (project 7805) in the control room to provide improved alarm management, fault diagnosis, alarm filtering and alarm prevention facilities. The artificial intelligence and real-time functionality components of the REAKT tool-kit were used to develop the demonstrator.



The sewage plant of Bergues near Dunkerque uses the LED expert system developed in I-SEE (project 6013).



ware of the Orsted satellite. Bull is applying RAISE to the validation of SESAME, a security architecture for distributed systems. The cryptographic protocols have been formally specified and the security properties justified and formally proven.

Further progress for PCTE: Following the successful adoption of the PCTE (Portable Common Tool Environment) standard by ECMA as the first public standard in this area, the recent ISO ballot on its acceptance as an ISO standard was carried, and PCTE is now on course for formal adoption in 1994. ICL and EDS have now added their names to the already substantial list of PCTE-based product suppliers. ICL announced a distribution agreement covering the Emeraude technology in January 1994, while EDS announced its PORTOS (CTE compliant) range in Paris in March 1993.

Matching IT to critical business needs

The information asset is recognised as a key component in establishing competitive advantage. It is also an increasingly important aspect of both social and personal development and well-being as we move into the Information Age.

The current generation of information management systems face major problems of adaptation to a new and pressing range of user demands brought about by the need to

transform vast quantities of data into relevant and meaningful information, ensure consistent access to multiple data sources, enable the distribution of data whilst maintaining integrity and security, and accommodate information in an extensive number of modes. All these changes provide new opportunities for European IT players, including the currently limited number of core DBMS technology providers (some of whom are beginning to establish a global position in markets for the next generation of basic support technologies) and the much larger number of added value providers. Above all, it offers users a significantly expanded range of possibilities for the successful exploitation of their information assets. Activities in this relatively new SAIP domain have been concerned with new core technology opportunities, improved forms of access and experiments with novel features.

New core technology opportunities are pursued in IDEA (6333) and GOODSTEP (6115). IDEA, targeting the provision of a deductive capability, is establishing an industrial DBMS prototype that is now positioned to use its deductive properties to demonstrate clear added value over those offered by present state-of-the-art relational systems. Early exploitation announcements are expected. GOODSTEP seeks to build on object-oriented (O-O) technology using the O2 database management system as its baseline. This development is carried out in the context of providing a next-generation software engineering environment repository.

This demanding target environment drives important improvements in the capabilities of the core supporting technology, such as integrity constraints and triggers, support for change management, and versioning of objects together with improvements in the advanced graphical interface. In addition to enhancing the capability of the core O-O based data management system, the project targets the output of new tools and methods to manage an advanced new form of software development, suited to the flexible integration of software tools within a customised development process.

Geographic information requirements pose particularly demanding problems for database management systems, necessitating the mixing of a wide variety of graphical and non-graphical data such as digital maps, statistics, technical material and legal texts. The data are often located in separate proprietary databases and may be stored on different media and platforms. For these reasons, in addition to the fact that there is a rapidly growing and important market for systems of this type, database R&D conducted in the context of this demanding application is judged to offer important insights into the generic issues that have been identified in the earlier part of the report.

Dangerous levels of crowding in areas such as metro stations can be monitored with the aid of the multisensor surveillance system developed in DIMUS (project 7809).



GGEOWORKS (6339) aims to develop new tools and methods of interconnection that will provide a highly usable environment in which non-technical users can benefit from the integrated multimedia/GIS platform without any knowledge of the underlying structure. The prototype products and services will be pilot tested by two large local government administrations, the City of Lille and the Province of Bologna, together with the Danish national administrative agency for environmental research.

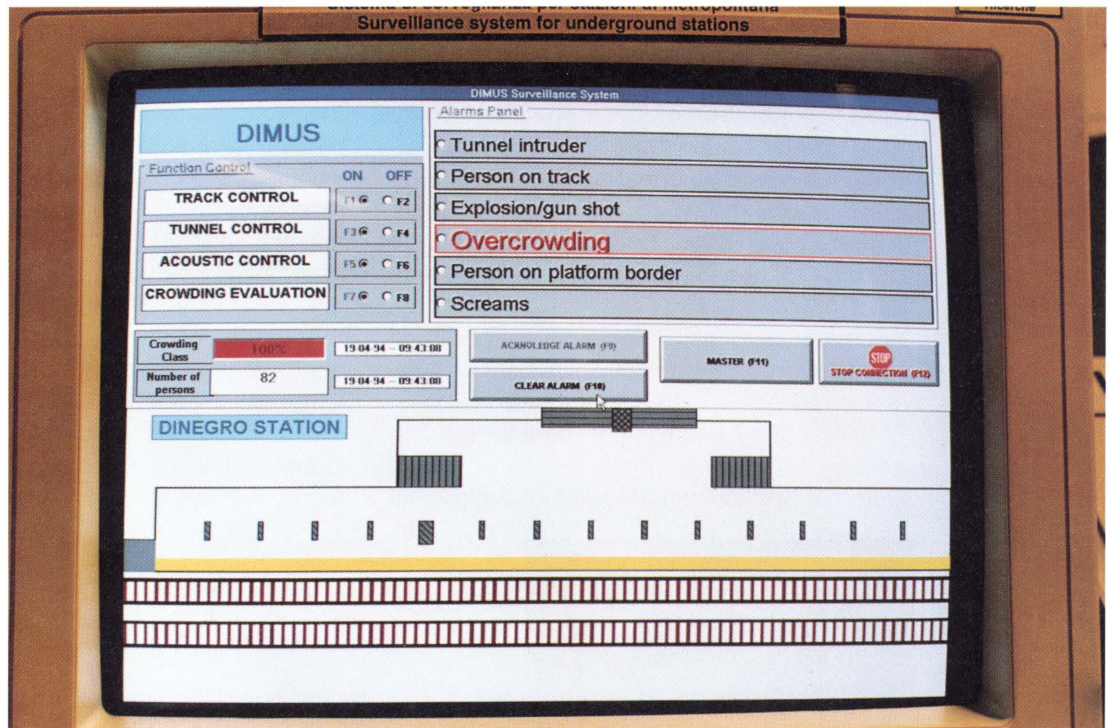
Access to information is the second challenge addressed by work in the area. One such approach is demonstrated in HI-FI (6532). HI-FI provides a set of tools to allow a reader to access, via a hypertext interface, a large body of information managed by external databases of either a multimedia or relational variety. A declarative approach is adopted that translates the hypertext operations (search, queries and navigation) into operations in the underlying information base. The power of the approach has been impressively demonstrated in real-life applications as varied as supporting patient care in a large orthopaedic hospital to guiding a visitor through the Gold of Greece exhibition from the Benaki Museum. SHAPE (5398) has a particular focus on packaged (CD-ROM) databases, and provides a portable software environment comparable to a CASE tool that greatly facilitates the realisation of complex CD-ROM based multimedia applications. Hypermedia links provide powerful and user-friendly navigation through multimedia databases. Again, the project partners plan to exploit both tools and the provision of specific CD-ROM database products.

Increasing the scope of IT applications

Actions in support of this aim follow two major strands of activity. The first seeks to expand the use of IT systems by employing techniques and technologies that make interaction with the system more natural, more robust and, where appropriate, automatic. The second strand employs a selected set of novel software technologies to solve a range of important business problems which current deterministic techniques either address inadequately or not at all.

New and improved means of interaction: New forms of reliable interaction offer both developers and users exciting new opportunities to exploit the power offered by advanced information processing systems. SAIP activities have explored the use of a wide variety of interaction modes ranging from speech, through modes that support collaborative working, to those that involve the analysis and interpretation of a diverse set of complex input signals. Some examples of this work are illustrated by looking at the results of SUNDIAL (2218) and DIMUS (7809).

Visual, acoustic and other sensor systems have been employed in the surveillance system developed in DIMUS (project 7809), now on trial in one of Genova's metro stations.



SUNDIAL, the largest SAIP project concerned with speech, aimed at developing a new generation of dialogue systems allowing spontaneous conversational interaction over the phone. The project involved the development of four language prototypes for train timetable enquiries (in German and Italian) and flight enquiries (in English and French). A close integration of speech and language processing techniques has been achieved for spoken input, together with the use of AI techniques for dialogue management and graceful error recovery.

Evaluation of prototypes in the four languages has been completed with both naive and experienced users. A 96% transaction success rate has been achieved with the flight enquiry application in English over a local exchange connection with untrained speakers. The results of the project have been sufficiently encouraging that commercial exploitation is now underway. Vocalis Ltd, a spin-off from Logica, the lead partner in SUNDIAL, is entirely devoted to developing and selling voice and call processing systems. The Vocalis platform, Callserver, already incorporates some of the results of SUNDIAL and further products are being developed for both telephone and PC applications. Customers using the Callserver platform with advanced speech input include Telia (the

Swedish telephone company) and British Airways. Other partners also intend to exploit aspects of the project.

The DIMUS project is concerned with the real-time automatic interpretation of a range of multi-sensor data acquired by surveillance systems. Systems of this type are growing in importance in view of the need to improve public safety in crowded environments such as metro stations and busy shopping areas. Vision, acoustic and other sensor systems have been employed in DIMUS to help in the safer management of such environments. The vision system can detect dangerous levels of crowding and movement into prohibited or dangerous areas. The acoustic systems can detect and localise, even in a noisy environment, anomalous sounds such as shouts or explosions that suggest the development of a potentially dangerous situation. The system is designed to accommodate concurrent events and is presently undergoing trials in one of Genova's underground stations. Plans for the exploitation of both the complete system or system components are now being pursued by the commercial project partners Ansaldo, Thomson and Signum.

More intelligent software: In a number of important segments of the market the

growth of conventional software applications appears to be slowing and margins reducing. Investments in SAIP have investigated a number of the newer emerging technologies, such as advanced knowledge-based systems, constraint logic programming, neural networks and genetic algorithms. These technologies have now begun to address previously difficult and hard to solve problems, such as intelligent control, automatic diagnosis, decision support and optimisation.

PAYDIRT (5473) has been concerned with building tools for running real-time expert systems. Key technical issues for the project

Applications Ltd. In nearly all sections of industry there are complex, dynamic systems that are controlled in real-time. The activity of many of these is hard to measure, making situation assessment very difficult, yet detecting changes or deteriorations and predicting the development of faults is vital if full availability of the system is to be maintained. TIGER advances real-time qualitative and model-based reasoning techniques in the context of the monitoring of gas turbine equipment in Dassault Aviation and Exxon Chemical Olefins.

Constraint logic programming (CLP) is the focus of interest for the two complementary

The real-time expert system developed in PAYDIRT (5473) is being used in a number of waterway supervisory systems.



were interruptability, guaranteed response time and temporal reasoning. PAYDIRT has made a substantial contribution to the ability to build demanding real-time supervisory systems, and early commercialisation of the results is already apparent. Lyonnaise des Eaux-Dumez have used PAYDIRT technology in the construction of a major system for the real-time management (for flood and pollution control) of waterways in the Bordeaux region. Further major applications are now under consideration together with the commercialisation of the tools.

Automatic diagnosis is the target application for TIGER (6862), led by Intelligent

projects, PRINCE (5246) and CHIC (5291). PRINCE is concerned with improving the underlying tool base, and in the further development of Prolog III so as to support the application of the CLP approach to a wide spectrum of large-scale industrial problems. The practical use of the improved tools is being demonstrated by user partners in the context of tackling a wide range of optimisation problems in areas such as finance, industrial systems engineering and production planning and scheduling. PRINCE-derived improvements have been incorporated into the current Prolog III product, and over 600 licences have already been sold on a variety of platforms. CHIC is designed to

accelerate the exploitation of CLP in industrial environments. The ECLIPSE platform, which progressively integrates results from the project, is in use with the user partners, where application advances are being demonstrated. These comprise improved circuit and finite automata design and verification (Siemens), more effective planning and scheduling for assembly lines (Dassault and Renault), traffic management (in Valencia) and short-term lending and liability management (AIS SpA).

HANSA (6369) and PAPAGENA (6857) illustrate activities that seek to further advance the use of novel technologies in support of new and demanding IT applications. HANSA, with a focus on business decision support, is working to develop an open architecture that can embrace a range of these emerging technologies, such as shells for knowledge-based systems, neural networks and genetic algorithms. Its application involves trials in areas ranging from insurance

case and claim processing, asset forecasting and management to direct marketing database analysis, and has demonstrated a performance superior to that achieved by traditional statistical analysis tools. PAPAGENA has developed a HANSA-compliant environment for the deployment of genetic algorithms, which are particularly suited to the processing, classification and control of very large and varied data. Applications include an economic development model of the Cottbus region (in the Brandenburg), a solution to the difficult protein-folding problem, and financial risk assessment. The project is aiming to set up a European Economic Interest Group comprising leading companies from across Europe to help advance interest in the use of these techniques.

ESSI and the ESI: software “best practice” actions

Software production in Europe is now a major economic activity in all advanced industrial and service sectors. In this context its efficient production is an increasingly important topic and the recently launched “best practice” actions are seen as a natural and necessary further extension of the R&D activities.

The European Systems and Software Initiative (ESSI)

The goal of ESSI is to promote improvements in the software development process so as to achieve greater efficiency, higher quality and greater economy. This is to be accomplished by applying the state-of-the-art in software engineering in a wide range of industries. The full impact of ESSI will be driven by a multiplier effect which is achieved through dissemination across national borders and across industrial sectors. ESSI is an accompanying measure in Esprit that complements the traditional R&D activities. Given the broad base of European software

development and the stated goals for the initiative, it is evident that it is different in character to R&D work in the programme. It addresses a different audience, namely the professional software developer in user industries rather than researchers in the IT industry; it is about the adoption of best practice rather than R&D; and it must have broad appeal and impact as opposed to the more restricted outputs of a conventional technology-based R&D project. Thus new, and where appropriate, more streamlined methods of implementation were seen to be required.

To achieve ESSI's aim of stimulating best practice take up across a wide spectrum of industrial players, three lines of complementary action have been adopted:

Application experiments

These are targeted at building up a comprehensive set of examples to show that the adoption of improved software development practices is both possible and has clear industrial benefits. The experiments involve

the introduction of state-of-the-art software engineering supports (eg management practices, methodologies, tools) into real production environments that address specific applications, and then evaluating the resulting impact.

Support is offered to cover the specific costs that the producer incurs in adopting the proposed element of best practice and in integrating this into the day-to-day software development process. No support is offered towards the cost of the application itself.

Two feedback loops are present: one is internal to the user company, resulting in increased software productivity, and the other is related to the technology supplier and to other users, resulting in more effective and appropriate tools and methodologies. Both feedback loops form the basis for more general dissemination across Europe.

Dissemination actions

The companies directly involved in ESSI will represent only a very small subset of all those that could benefit from the initiative. This line of action aims at fostering specific communities of interest (such as producers concerned with, say, embedded software development) and promoting on a widespread basis the relevant results of the applications experiments and other sources of best practice advice and experience. Overall, the aim is to ensure that companies on a Community-wide basis are aware of the experiences of the users involved in ESSI and of the opportunities more generally available to assist them in improving their software capabilities.

Education and training

Specific training takes place within individual application experiments. However, this line of action is targeted more generally at raising the level of awareness of the need for change, the possibilities that exist, and how best to manage its introduction.

To support the implementation of ESSI, special attention has been given to designing a clear, easy-to-use briefing pack for proposers. An ESSI proposal is

an order of magnitude smaller than a conventional R&D proposal; it involves submission by the lead proposer only, rather than by a consortium. The Community dimension is achieved via obligations in the contract for the participants to cooperate in communities of interest and in the dissemination actions and associated workshops. The proposal format itself is designed to produce rapid evaluation by external experts and, for the successful proposer, the transformation of the proposal into a contract (also different from the traditional R&D contract) follows a clear, well-planned, rapid and low-cost route.

Launch of ESSI

A pilot call for ESSI proposals was launched in 1993. The aim was to test the perceived relevance of the programme to its intended audience and the effectiveness of the implementation mechanisms. The results were aimed at building an initial base of ESSI activities upon which a more substantial set of actions might be further developed. In view of its exploratory nature the call focused only on application experiments and dissemination actions.

Although the declared budget for this pilot call, 25 Mecu, was small by comparison with R&D activities and the associated information events relatively low key, the response proved to be remarkably strong. Some 981 proposals were received, 891 concerned with application experiments and 90 for dissemination actions. Responses were received from all major industrial and service sectors and exactly mirrored the profile of European software development, with 77% of proposals arising from industries other than in the IT sector. Equally good was the spread of responses from Member States as was the response across the main software development types of activity. As expected, SMEs were attracted to the call, coming forward as the lead proposer in nearly half the total number of proposals and taking a further share as partners/subcontractors to large users in the remainder. Overall, the importance of improved software development practice to the broad spectrum of European industry was confirmed.

Current position

Following the call 103 proposals were selected for support, made up of 94 application experiments and 9 dissemination actions. As with the input to the call, the output reflects a continuing strong representation of non-IT sector interests (73% of those selected come from other than the IT industry); the major software development activities also appear well-balanced, with an even split between commercial and industrial styles of application. The strong SME position apparent in the proposals was preserved in the selection made for support.

Given the positive experience with the programme so far, the budget for this pilot phase has been increased from 25 to 35 Mecu and now includes a focused action on software process assessment linked to the achievement of the ISO 9000 standard.

The results to date provide a well-founded base of activities upon which the ESSI communities of interest can be both further extended and deepened. This will be a key thrust in the new Framework Programme.

The European Software Institute (ESI)

Accompanying the launch of ESSI has been the establishment of the ESI. This is a major industry initiative promoted by some 14 leading European companies acting as the founding members and supported in its initial start-up phase by Esprit. The aim of the Institute is to help its members improve their competitiveness through the better understanding and application of advanced software practices. In particular, it has a focus on the continued improvement of the software process both in technical and managerial terms.

Based in Bilbao, the Institute has already increased its span of membership. It stresses its open nature and its aim to secure the widest spectrum of membership from both software suppliers and software users who are, of course, also major producers in their own right. Members will benefit from a pool of shared knowledge and experience concerning all aspects of the software process: management, development, quality and how best to achieve technology transfer. Current full members include Bilbao Bizkaia Kutxa, Bull SA, Cap Gemini Sogeti, ESB International Ltd, ERITEL, FINSIEL, GMD, IBERDROLA, Lloyd's Register, Olivetti SpA, SEMA Group, SNI, Board Telecom Eireann, Enoteam, INRIA and MATRA, with SPRI as an honorary member.





High-Performance Computing and Networking

by Jean-François Omnes, acting Head of Unit

HPCN in industry

HPCN (high-performance computing and networking) provides levels of performance either not attainable or not economically viable using conventional technology. Another notable attribute is that HPCN is scalable, in terms of performance, problem size and technology. In general, HPCN applications fall into two major categories: doing what is done today but faster or cheaper or on larger volumes of data; and doing what is conceivable today but was not previously technologically or economically possible.

HPCN has an important role to play in all aspects of industrial activity, and opens up a host of new business opportunities:

- **HPCN for product design and manufacture:** HPCN enables physical prototypes and experiments to be replaced by computer models and simulations
- **HPCN systems embedded in products:** The functionality of products is being increasingly realised through IT, and HPCN enables new levels of sophistication and added value
- **HPCN for information management and decision support:** HPCN is the enabling technology for effective business processes.

HPCN in Community R&D

The objective of the work undertaken in the HPCN area of the IT programme is to expand the application potential of high-performance computing and networking. The priorities are as follows:

- *promoting the take-up of HPCN, focusing on increasing industry's awareness of the opportunities provided by HPCN and making HPCN easier to use*
- *building European strengths in HPCN, especially in terms of human resources, applications and technological capability*
- *stimulating the development of the information and communications infrastructure.*

HPCN in action

There are around 50 HPCN projects in progress, many of which started as recently as the beginning of 1994. As space does not permit every project to be described here, the reader is referred to the 1994 edition of the HPCN Project Summaries. The eight projects that follow have been chosen to illustrate the scope of HPCN.

Photo-realistic images for engineering design

Many industrial engineering design processes critically depend on the use of sophisticated CAD and simulation tools for the cost-effective development of new products. Providing engineers and designers with visual feedback using photo-realistic rendering and visualisation is an essential requirement for making both aesthetic and physical design decisions. HPCN, in the form of scalable parallel machines, provides the only cost-effective way to do this.

To develop the technological basis for delivering the latest version of its "mental ray" high-quality image visualisation software on scalable parallel machines, Mental Images, a German

SME, has teamed up with Bertin & Cie, Delcam International, Parsytec and Warwick Strategic Technology Laboratories in the DESIRE (6173) project.

Two of the major results that have come from the project so far have been the development of a novel parallel ray-tracing algorithm and the first data exchange

tools and methods for the development of application-specific solutions.

The GALATEA (5293, 7807) project has made significant advances to correct this. Its overall objective has been to develop a complete set of consistent tools allowing faster and easier development of neural network applications. This has included the develop-

Dassault uses "mental ray" product in software platform

In March 1994 Dassault Systèmes announced that Mental Images will be responsible for providing the rendering component of Dassault's CATIA software platform. The CATIA rendering component will be based on the latest (third) generation of Mental Image's mental ray product. Dassault Systèmes is a world leader in advanced CAD/CAM/CAE with its fully integrated CATIA and CADAM software platforms. These are used in a variety of industries, but particularly in the aeronautics, automotive and consumer goods sectors.

A rendering of a car from CAD data: the image was produced using Mental Image's "mental ray" product developed in DESIRE (project 6173).



format able to unify all aspects of visualisation required by industrial and scientific applications today, including geometry, animation, photo-realistic rendering and scientific visualisation.

Pattern recognition makes more sophisticated products possible

HPCN, in the form of neural-network-based solutions, offers a lot of promise in areas where more conventional approaches are not technologically feasible or economically viable. An example is in pattern recognition, though practical exploitation is hampered by the lack of powerful

ment of general-purpose neurocomputer hardware and a sophisticated programming environment, as well as a silicon compiler, one of the most advanced in the world, for the production of ASICs (application-specific integrated circuits).

A range of hardware supporting the same virtual machine language has been developed. The Synapse-1, developed by Siemens, is optimised for implementing large neural networks and is the most powerful machine of its kind in the world. In contrast, systems from Philips are optimised for implementing small networks for use in electronic vision products, such as X-ray diagnosis. Neural chips usable for a range of applications, such as L-Neuro 2 from Philips, or application-specific, such as the OCR chips from SGS Thomson, can be added as application accelerators.

The software environment includes an object-oriented neural network programming language called "N", an algorithm library, graphical tools for building and debugging N programs, graphic development tools and an intermediate level, C-compatible language

Softimage licenses rendering technology

In March 1993 Softimage announced that it will exploit Mental Image's rendering technology in the core of its flagship Creative Environment product and thus integrate the third generation of "mental ray" into its product line. Softimage Inc. of Montreal, Canada, part of Microsoft's advanced technology division, is the leading developer of professional three-dimensional animation and visualisation software for the broadcast, film, advertising and video game development industries.

Sorting oranges

Automatically sorting oranges is a complex matter. For example, it is extremely difficult to avoid categorising a stem as a defect in the fruit. Only one make of orange-sorting machine, from the US, is commercially available, and this is not really suitable for the European market. A pre-production prototype sorter has been developed using Philips hardware and software from GALATEA. This prototype is being turned into a product by AID, the industrial member of the Italian CRAM consortium.

(VML) for parallel implementations. Supported by Mimetics, a French SME, the environment has been designed to support the GALATEA hardware and a variety of other platforms.

A special chip for optical character recognition (OCR) has been designed with tools from the silicon compiler. The OCR chip has been available since the beginning of 1994 and has been integrated into a PC environment for evaluation. Results show that the chip is capable of recognising an average of 1000 characters per second, compared to the 150 characters per second possible with a system based on a digital signal processor chip and the 50 characters per second performance of a RISC-based PC. This impressive figure opens the door to new market niches, such as handwriting recognition.

Decision support for a better quality of life

HPCN, in the form of decision-support systems that exploit the performance potential of parallel processors, is an enabling technology for more effective business processes, public administration and scientific endeavour. ElipSys is a tool for building such systems developed at the European Computer Industry Research Centre (ECRC), the joint research centre of Bull, ICL and Siemens. In the APPLAUSE (6708) project, ECRC has teamed up with a number of advanced applications developers to solve a number of demanding problems presented to them by customers.

Although the project is not yet completed, the applications have already demonstrated

considerable success. In addition to the two applications described here, a production planning system is being developed for aircraft manufacture at Dassault Aviation, and a system for travel agents, capable of producing customised packages for visitors to Greece, is being developed by Expert Systems International, a Greek SME, as a demonstrator for the Greek National Tourist Office.

Information management

The current demands of commercial information processing are stretching the performance of conventional computers to the limit. There is a continual demand for information repositories able to store and manipulate ever-greater volumes of data. Not only fast, shared access to the information is required, but also significant increases in raw processing power to enable more sophisticated analyses to be performed.

HPCN, in the form of scalable parallel platforms and information management systems, can provide solutions to these problems, and this area is the focus of the EDS (2025, 6057) project. Parallel technology not only provides the capacity to manage the volume of information but does so in a cost-effective way. To demonstrate the feasibility of this approach, the project has developed a complete prototype system ranging from the hardware platform to prototype applications.

In order to succeed in such an ambitious project, Bull, ECRC, ICL and Siemens, the main partners, have collaborated together with a pan-European collection of over a dozen associates for a period of more than

Safeguarding the Venice Lagoon

The Venice Water Magistracy is responsible for all aspects of the Venice Lagoon. One of its particular concerns is the monitoring and control of pollution, with more than 20,000 registered sources of discharge into the Lagoon, primarily from factories on the adjacent mainland. Systems & Management, an Italian systems house, has used ElipSys to develop a demonstrator for an environmental management system for evaluating pollution status and planning technical solutions for remedying the situation at an affordable cost.

EasyReader optical character recognition (OCR) system

An early success in the development of an OCR system based on neural networks has been commercialised by Mimetics, a French SME specialising in the application of neural network technology. Their product, EasyReader, is available for PCs, Macintoshes and SUN workstations. This product has proved to be so successful that Apple Computer have licensed it for bundling with their related products. In France, EasyReader is already being bundled with Apple scanners and has been bundled with Apple fax modems since September 1993. It is spreading throughout Europe, and has been bundled in the USA since May 1994. IBM have also licensed EasyReader for distribution with fax products through their UNILOC demonstration system.

Helping cancer research

Many problems in molecular biology and genetics involve finding consistent interpretations of a broad range of heterogeneous data and theories. One such problem being addressed at the ICRF in London is identifying the role and function of proteins in the control of cell growth. This may in turn eventually help our understanding of the events, mediated by proteins, that lead to the onset of cancer. A tool implemented using ElipSys is helping scientists at the ICRF to study protein structures more effectively than was previously possible; what was once a batch job is now an interactive process.

four years. The massive investment required in basic skills and development effort has only been possible through this collaboration.

Exploitation of the results has already made the news with the launch of ICL's Goldrush Megaserver product. Equally important is the effect that integrating EDS technology and know-how will have on the future mainframe and midrange Unix product lines of Siemens-Nixdorf as well as future database products from Bull. Many new innovations based on EDS results are currently being refined and finalised ready for commercial product release in the development laboratories of the project's collaborators.

European HPCN suppliers in the global marketplace

Innovative European companies, many of

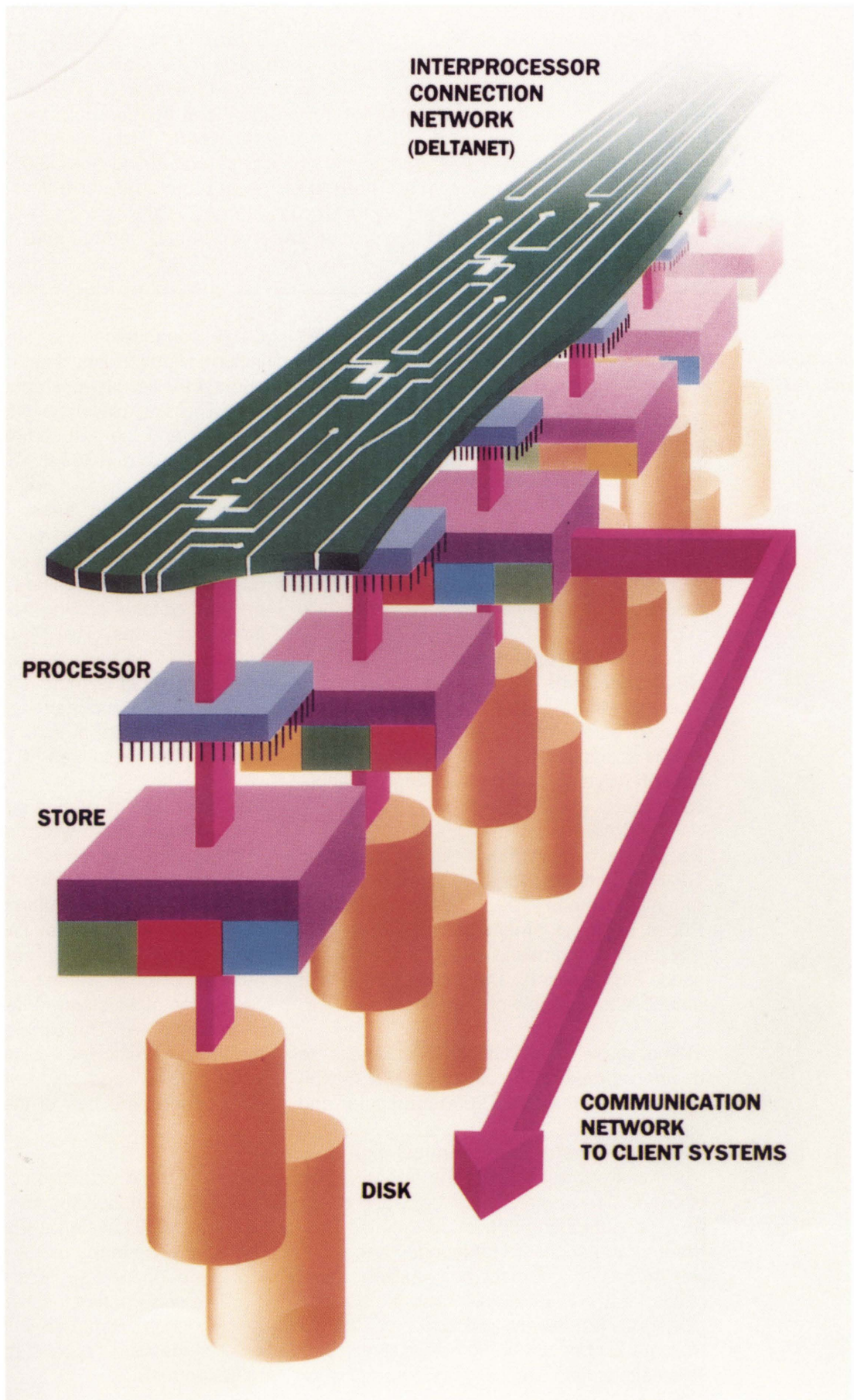
them relatively small, are well-placed to be able to exploit the rapidly growing global HPCN market of massively parallel processors (MPP), thanks to their involvement in pan-European collaborations.

One such collaboration, the GENESIS (2702) project, has enabled Meiko to develop some of the technology required for its new generation of MPP supercomputers. The processor interconnection technology developed in the project is a critical component in Meiko's CS-2 supercomputers. As well as including hundreds of microprocessors, the machine includes an exceptionally large I/O capability and a parallel filing system. This supports its use in large-scale data management applications, as well as number crunching.

ICL's Goldrush Megaserver

Based on the system developed in the EDS project, ICL's Goldrush Megaserver is a scalable distributed memory multiprocessor machine targeted to provide a sophisticated information server for commercial applications. It is capable of performing more than 6000 transactions per second on database applications, approximately ten times more than typical high-end mainframes or Unix systems. Three commercial database systems from third parties have been ported to Goldrush: Adabas from Software AG, INGRES, and Oracle 7. A wide range of configurations are available. Its Unix operating system uses technology from Chorus Systèmes, a French SME.

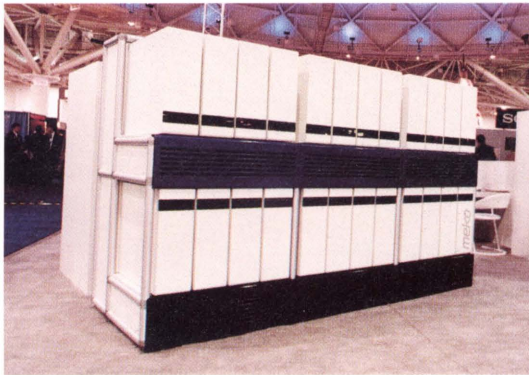
ICL's Goldrush Megaserver, based on work in EDS (project 6057), is a sophisticated information server for commercial applications that easily outperforms typical high-end mainframes or Unix systems.



Prestige US sale by Meiko

The technology developed in the GENESIS project has already allowed Meiko to claim its place as a significant player in the US HPCN market with the \$17.5 million sale of a CS-2 computer system to the Lawrence Livermore National Laboratory. The system will be used in a wide variety of applications including global climate modelling, advanced materials development, environmental simulation, economic modelling, nuclear emergency response and nuclear safety. Using the CS-2 system, breakthrough advances are expected both in terms of basic understanding and increases in prediction accuracy. The Laboratory is internationally recognised as one of the world's most sophisticated buyers of supercomputers, and Meiko won the order against stiff competition.

The CS-2 computer system from Meiko incorporates technology produced by GENESIS (project 2702). Meiko recently sold the system to the US Lawrence Livermore National Laboratory.

**A family of European scalable HPCN machines**

The GP-MIMD (5404, 7255) project has focused on the development of a family of HPCN scalable parallel machines providing cost-effective solutions for a range of applications.

Parsys have used the ideas developed in GP-MIMD to produce a comprehensive range of Inmos T9000-based machines. Prices begin at around 20,000 ECU, and machine configurations extend to some thousands of processors. The Oracle 7 relational database is available on the machines.

Telmat have used GP-MIMD's results to develop a modular, scalable parallel machine based on Inmos's T9000 transputer and

C104 communications chip. Applications include signal processing, image processing and synthesis, process control and databases. The first prototype has recently been installed and the first commercial deliveries were made in mid-1994.

Parsytec has based both their GC/PowerPlus and Power XPlorer ranges of machines on the results of GP-MIMD. The GC/PowerPlus machines are high-end parallel systems scaling from 32 to several thousand nodes. The Power XPlorer was launched at the beginning of 1994 and in the first three months more than 100 systems were sold. An important factor is its price-performance ratio: a small eight-node configuration costs less than 50,000 ECU.

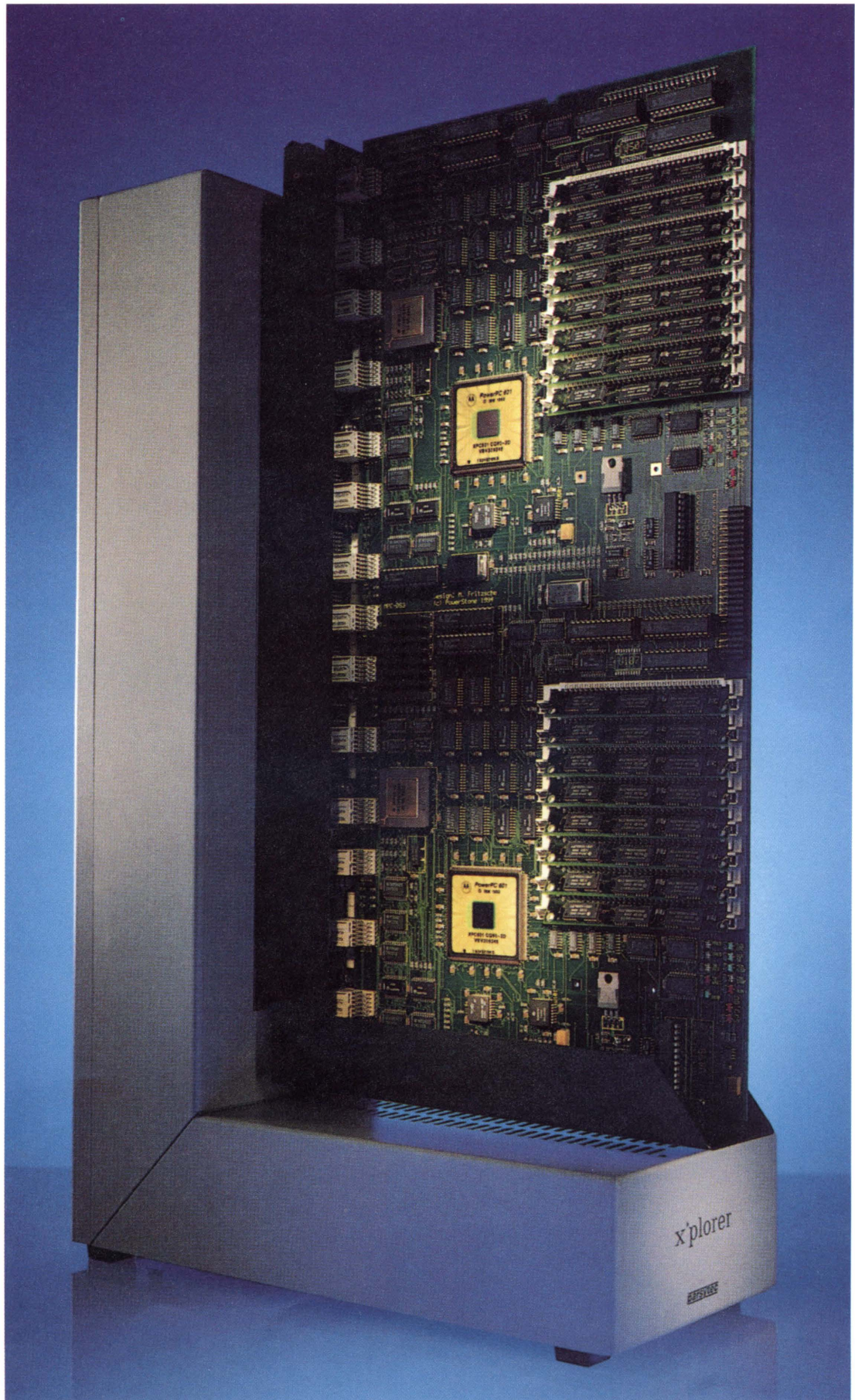
European HPCN operating system is becoming de facto world standard

The demands put on HPCN operating systems are increasing dramatically. One way of meeting these requirements is with a microkernel architecture. The idea is to define a small operating system core, the nucleus, which provides the very basic services on top of which more complex ones can be implemented. This simple model provides the basis for efficient realisations on massively parallel and distributed machines. Furthermore, the part of the operating sys-

Helping industry gain practical experience

An important outcome of the GP-MIMD project has been the establishment of the ZEUS Centres. The centres are equipped with large configuration parallel machines, with from 500 to 1000 computing nodes, constituting Europe's biggest MIMD systems. This resource has been made available for industry to gain practical experience in the use and application of these very large machines. Initially four centres were opened in Amsterdam, Athens, Cologne and Paderborn. These are being joined by five new centres in Chemnitz, Dresden, Glasgow, Heidelberg and Linköping. Many specialist industrial codes as well as more generally used ones are being ported to exploit the power of massively parallel machines by collaborations involving universities and industry at the centres.

Parsytec has based its Power Xplorer range of machines on the results from GP-MIMD (project 7255), which has focused on developing a family of scalable, parallel and cost-effective HPCN machines.



MPP used for aircraft simulation

The latest FAA regulations for aircraft require extensive simulation of the effects of the electromagnetic disturbances that may be caused by passenger use of laptop computers and mobile telephones or by lightning. Massively parallel machines can offer the performance necessary to simulate such complex systems and events. Ziam and Parsytec have been collaborating with British Aerospace, EMA and FECS to develop a simulation package to support this application. The resulting EMA package has been successfully demonstrated running on a 1024-node Parsytec machine at the Paderborn ZEUS centre. British Aerospace is already using the package in a production environment.

tem involved when porting to a different platform is minimised without compromising the level of application and user services that can be provided.

Chorus, developed by Chorus Systèmes, is such an operating system. OUVERTURE (6603) and HARMONY (7253) are two projects helping to develop and prove the basic technology needed for the further success of the Chorus operating system.

OUVERTURE is helping add value to the Unix System V Release 4 (SVR4) *de facto* standard by the addition of Chorus distributed microkernel technology. An important aspect of this project is that the system supports a range of architectures from high-performance parallel machines to real-time embedded systems. Within HARMONY, the Chorus technology provides the basis for a parallel real-time Unix environment for a transputer-based machine. To date, this is the only implementation of SVR4 Unix on a parallel transputer machine. The early adoption of the microkernel approach to the development of advanced operating systems has placed Chorus Systèmes in a unique position. Many established system suppliers have already signed agreements to get access to the technology being produced by this French SME.

Chorus licensed by Unix System Laboratories (USL)

USL has licensed the Chorus microkernel technology for incorporation into their System V product line. This will provide

industry with a mainstream, open, microkernel-based operating system capable of addressing the entire enterprise spectrum from real-time embedded to massively parallel machines. This agreement reinforces Chorus's position as the *de facto* commercial microkernel standard.

Major players license Chorus technology

Together with Chorus Systèmes, Motorola is developing and marketing Chorus/PowerPC open-microkernel-on-chip solutions for embedded systems. The products offered are being developed in response to demands from telecommunications manufacturers for greater modularity and scalability. Alcatel, the world's leading telecommunications equipment manufacturer, has reached agreement with Chorus Systèmes to use Chorus microkernel technology as a standard throughout its extensive operations. Cray Research, a world leader in providing very high-performance supercomputers, has licensed the Chorus/MiX V.4 microkernel-based UNIX system to enhance Cray's UNICOS operating system, and Tandem Computers has licensed the Chorus technology for use in its range of fault-tolerant computers.

Postcode change in Germany

In mid-1993, after the *Bundespost* changed its postcode system, many organisations were obliged to update massive address databases with the new codes. A 1024-node Parsytec machine at the Paderborn ZEUS centre was able to perform this task in four hours, compared with the four weeks required by a mainframe machine. Furthermore, spelling corrections were done at the same time.



Peripherals Systems, Business Systems and House Automation

by Attilio Stajano, Head of Unit

Overview

Work in this area aims to accelerate the uptake by European enterprises of the technological innovations and know-how developed within the Esprit IT Programme, turn the results into market share and other business benefits, and thus contribute to economic growth and the generation of new employment. The objective is to develop open, integrated solutions to users' requirements in four distinct but interrelated fields: professional applications, business applications, personal high-volume electronic devices, and home systems. The technological solutions, which integrate innovative peripheral and multimedia technologies, are generic in nature but always illustrated with specific demonstrators or prototypes. In these fields of application, the traditional distinction between the business and consumer markets is becoming blurred: products in the two domains share common components, compatible platforms and associated approaches to development, and also address two related, overlapping customer bases.

Peripheral and multimedia technologies are an important driving force in this process of convergence. Peripherals address the development of the key components that will shape the future information society, notably flat-panel displays and memory subsystems. Multimedia is a generic and pervasive technology that offers the information and communications technology (ICT) user a variety of integrated communications media and interaction tools. Multimedia extends and enhances conventional ICT use and also opens up new kinds of applications that

involve novel interactions between software and programming houses, publishers, the audiovisual sector, graphic designers, artists and writers. Multimedia interfaces enable the integration of ICT into home systems supporting a wide range of functions and providing benefits in many areas, including energy-efficient home management, entertainment, education and working at home.

The provision of suitable IT systems is not in itself enough. A regulatory framework is required to provide appropriate incentives to authors and owners of intellectual property whilst at the same time protecting privacy, individual freedom and rights of access to information and services. The new systems and services should not be usable only by a technological elite. They should provide a universal, interactive multimedia technological environment that is as easy to use as the phone or fax machine.

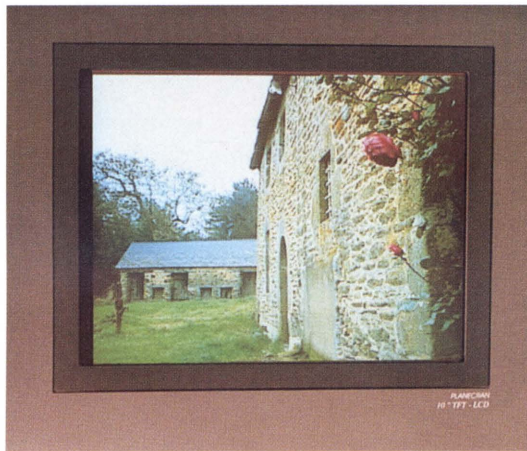
The past year has seen many lines of R&D coming to fruition in developments which have enabled companies to position themselves more effectively in their chosen markets. Other work has contributed to the development of an infrastructure which will be of benefit to companies across the EU in the development of their own particular product lines. A number of alliances have been formed among medium and large companies, often involving small companies as well, and in some cases SMEs have been able to grow their businesses significantly through commercial exploitation of the results achieved.

Peripherals

Flat-panel displays (FPDs) and disc drives are two of the key components shaping the information society for both businesses and consumers. Research co-funded by the EU is enabling European companies to have a reliable supply of these components from European sources and is helping them compete effectively on both quality and price.

FPDs, and especially liquid-crystal displays (LCDs), are the generally preferred type of display across a wide range of systems. They are being used in portable and high-definition projection television sets, data,

Pictured is a 10.4 inch (26.4 cm) diagonal active-matrix liquid-crystal display with full colour capability built using the new 2S technology from CNET, which has been taken up by Flat Panel Display, the joint venture set up by Philips, Thomson and SAGEM. Pioneering work in this area was carried out in the ECAM projects.



graphics and multimedia computers, and interactive and photo-CD devices. Philips, Thomson and Sagem have established the joint-venture Flat Panel Display Co (FPD) BV to manufacture active matrix liquid crystal displays (AMLCD) in diagonal sizes ranging from 4 to 14 inches (10 to 36 cm). The reliable availability of these displays at an affordable price will enable companies to integrate them into a wide variety of business and consumer products where poorer quality, more cumbersome or more costly alternatives currently have to be used. The companies were able to undertake this venture as a result of achievements in the ECAM (7701) and ECAM II (8597) projects.

Multimedia

Multimedia systems and services promise to be one of the largest and fastest-growing sectors of the industry during the 1990s. Alliances formed under the aegis of the Esprit IT programme have made a strategic

contribution towards the development of the industry, laying a sound basis for multimedia developments which are now feeding through to products currently appearing on the market and into current R&D aimed at the next generation of products.

The Personal Communication Computer

Olivetti announced a new family of products towards the end of 1993 which reflects its new position in the telecommunications market. These Personal Communication Computers offer services for person-to-person communication over ISDN. The products directly use results from the M-CUBE (6726) project, which in turn built upon results achieved under earlier projects, especially MIAC (1057) and MIAS (2684). They provide European industry with an important element of the technical infrastructure needed for enterprises to develop and exploit new business opportunities arising from multimedia. They also make a significant contribution to the infrastructure needed to support teleworking, offering the possibility of reducing traffic congestion, encouraging energy and time saving, and improving flexibility in working patterns.

Computers for the mobile worker

The business person who needs to work with forms, reports and other documents whilst on the move needs the functionality of a PC in a portable unit capable of communicating with colleagues, clients and others at base or elsewhere. Using the results of earlier workstation projects and taking account of developments in the field of communications, the TELESTATION (5233) project consortium has developed an application development environment for portable systems using wireless communications and a variety of approaches to the user interface, including pen-based interfaces.

Electronic wallets

An important application in the multimedia area for the consumer and business person is electronic banking, including payments for goods and services. Here the user needs a very small, convenient terminal that is easy to use, reliable and secure - something that has been dubbed an "electronic wallet". Results from several early R&D projects in Esprit, including CRYPTO-CARD (2704), now make it possible for companies to develop this type of unit.

Olivetti's Personal Communication Computer (PCC), shown here in use, is a 486-based PC incorporating a videophone. This product is based on the results of M-CUBE (project 6726), which incorporates the outcome of MIAS (project 2684).



The CAFE (7023) consortium, comprising major European organisations involved in the field, is taking up this opportunity. Their objectives are to select, specify, construct, integrate, trial and evaluate a basic payment system that will demonstrate the feasibility of the approach and

establish consensus within the industry in Europe.

Home shopping

Multimedia services delivered to the home are expected to account for a significant share of the overall market for multimedia.

Electronic wallets

Although the cashless society may still be some way off, the replacement of coins, notes and cheques by various forms of paperless payment is already happening. The magnetic-stripe plastic cards with which consumers have become familiar during the past decade or more are being replaced by intelligent chip-cards and electronic purses. Such cards and the services based on them are clearly evolving towards the electronic wallet. Like the existing type of wallet, the electronic version will contain the means to make purchases, identification (including a digitised photo), driver's licence, medical information for use in emergencies, and a variety of other useful functions. The availability and widespread use of such electronic wallets will stimulate a number of new services to consumers. The development of the concept requires the development of the consumer device (the wallet itself), card-reading equipment, and the technical and administrative infrastructure needed to provide national and pan-European services. The CAFE (7023) project consortium brings together some of the best cryptographers in Europe and the experience of business leaders in the chip-card market to develop such a wallet. The project concentrates on user requirements and interoperability in order to allow payment for many types of goods and services anywhere in Europe, taking account of the role of the ECU as the international European currency. Personal privacy has been built into the system to preserve the user's right to anonymity for certain transactions. Security has been made a priority: this is always a sensitive issue in payment systems, and is a critical consideration for a device that aims to be accepted in many countries by many different service providers. The project has already developed the security protocols required and early prototypes of the wallet. Whereas most current systems are being developed at a national level, with limited possibility of operating across borders, CAFE is developing the technology to provide a truly international payment instrument that will allow European companies to keep abreast of the competition.

The results of several projects have successfully laid the ground for these applications, of which home shopping is expected to be a significant component. A pilot application in HOMESTEAD (6789) has enabled the consortium to better understand the use of CD-I as a catalogue publication format, to develop specific tools for handling this, and to set up a large-scale pilot trial, which is now in progress.

Europe's cultural heritage

Europe's cultural heritage is unique and of world-wide interest. To date, its preservation and dissemination has been ensured mainly by traditional museums and by publishers. What they have been able to achieve has been momentous and yet has still been constrained by limitations of the technological environment in which they have had to operate. In most cases, dissemination is still

limited to displaying objects in exhibition rooms. Museum initiatives in using new technologies to better disseminate information are still limited and scattered. IT systems in principle open up new possibilities that in time may revolutionise the way in which museums work and involve many other kinds of organisation in the collection, preservation and dissemination of cultural artefacts, including the development of new kinds of artefacts based on emerging technologies.

Expectations concerning the presentational aspects of very high-quality colour images have become ever more demanding, and represents a large potential market. The results of earlier projects have been taken even further by the MARC (6937) consortium. The SIAM system, which uses the results of these projects, is now in use by

Barco's model 5000 projectors are based on LCDs developed in ECAM (projects 7707 and 8597).



several large European museums (Le Louvre, National Gallery, Uffizi) for the digital acquisition, storage and handling of colorimetric high-definition images of paintings for printing in high-quality catalogues and other items (see front cover of this report).

Business applications

Document management

Documents and the office procedures to which they relate are likely to persist for the foreseeable future, and R&D during the past year has made further significant contributions to helping European industry improve its competitive edge in this field.

A proportion of the information held within organisations is in a highly structured form (for example, legal contracts and insurance policies). Earlier work demonstrated how it is possible to link the process of creating documents to information in databases. A Windows-based product, Engrafo, was launched during 1992, using the results of MULTIDOC (6882). The research work has since been taken significantly further and has produced results used in a product called Multiflow, launched in May 1994 by Selisa in cooperation with Oracle. This product addresses the needs of local authorities. A related product addressing the banking sector has been launched by Epsilon.

Workstations

Telmat is now selling the TWS 88 workstation for 3D graphics. This result from SPIRIT II (5397) offers a significantly higher cost/performance ratio than the competition for all equivalent configurations. It is 88 Open BCS/OCS conformant and allow a choice of more than 1500 software packages.

The TWS 88 workstation marketed by Telmat uses the results of SPIRIT II (project 5397).



Computer-supported cooperative working

Many corporate, national and international projects depend for their success on the effective collaboration of people working from a number of different locations, often in different companies or even different countries, and often on the move. Triumph-Adler and partners in EUROCOOP (5303) have been developing a European solution to this need, particularly in regard to the project management aspects, and laying a basis for competitive European products in this emerging field.

Efficient translation facilities can greatly facilitate the free movement of people and goods throughout the EU. The results from TWB II (6005) have enabled the companies concerned to develop translation products for two different markets. For the consumer market, TA Electronic Publishing and Rossipaul Verlag developed the GlobeDisk Lexicon and GlobeDisk Translator, launched at CeBIT '94. The products run in a Windows environment and are built in such a way that future extensions can be added easily. For the professional market, Cap Debis will launch Keyterm in mid-1994, and Sietec (in cooperation with TA Electronic Publishing) will serve the high-end professional market with products including Metal, Dover and the Lemmatiser.

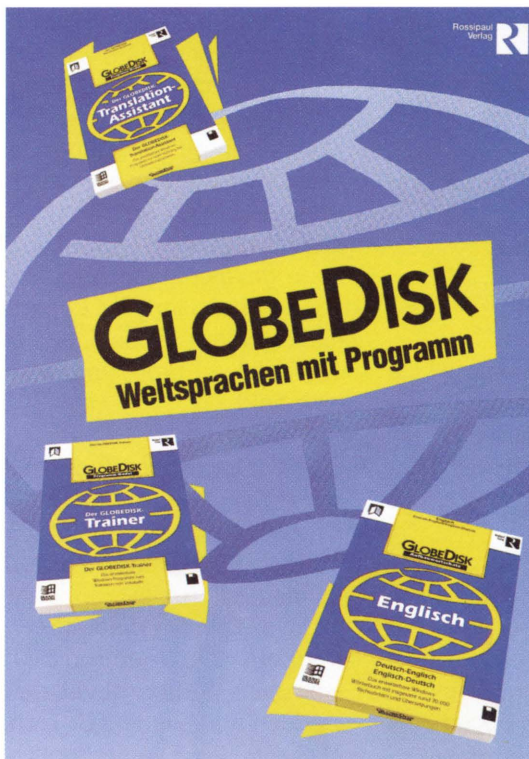
Microprocessor systems

Progressive miniaturisation and portability place stringent performance demands on components in terms of size, weight and power consumption. Based on R&D done in MULTIWORKS (2105, 2713) and OMI-MAP (5386), the ARM chip has the lowest power consumption 32-bit RISC processor and the smallest 32-bit cpu die size available in the world. Its integrated circuits are now used by a variety of international industrial alliances. ARM is a small British company constituted in 1990 as a spin-off of Acorn Computers. ARM demonstrates the kind of success that SMEs can have through the effective commercial exploitation of results achieved through work in Esprit.

Software environments for business applications

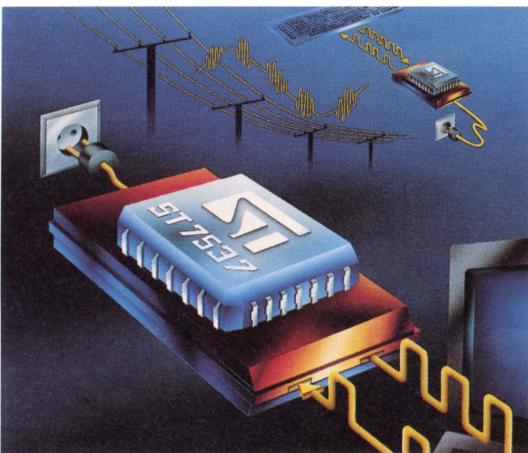
Based on R&D done in MULTIWORKS (2105, 2713), CHORUS, from Chorus Systèmes, is now the *de facto* industry standard microkernel operating system for the

The results of TWB II (project 6005) have enabled Rossipaul Verlag to launch a range of Windows-compatible translation products.



Unix as well as the telecommunications and real-time markets. It has now been adopted by leading companies, including Alcatel, as their corporate-wide real-time operating system. Cray Research plan to use the technology to enhance Cray's UNICOS operating system for use across the company's full range of parallel vector and massively parallel processing computer systems. Chorus Systèmes and Motorola have agreed to develop CHORUS/PowerPC open microkernel on-chip solutions for the embedded systems marketplace. This will provide manufacturers with ready-to-use open systems solutions that will enable them to focus their efforts on developing their own added value, reducing both cost and time to market.

SGS-Thomson has launched a power-line modem based on work in HS-COMPONENTS (project 6782).



House automation

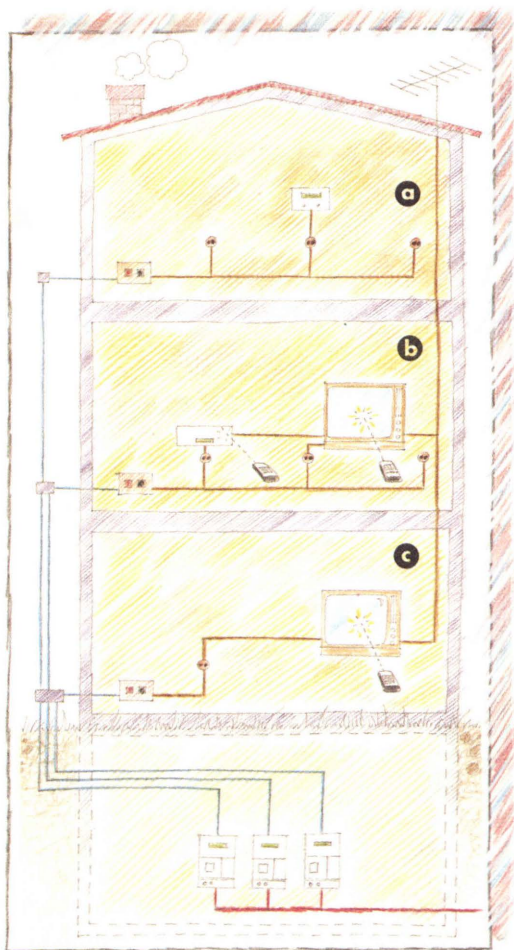
People at home will soon be able to take advantage of the communications capability of next-generation domestic appliances and reap significant benefits in energy management without having to install any special network in the home, thanks to power-line modems developed by SGS-Thomson and partners, who have exploited the results of R&D applying the Home System Specification developed in earlier work. Using a power-line modem, an appliance can use the mains electricity supply not only for power but also as a means of communication. This helps to open up the market by making it easier for house automation products to be introduced. The affordable prices that can be achieved through the use of low-cost integrated circuits is another attractive feature of products now coming onto the market using low-cost components developed in the project HS-COMPONENTS (6782). A further contribution to providing high quality whilst keeping costs down comes from the HS-TOOLS Developer's Workstation from Philips APG. The range of heating system control units being brought to market by AEG/Daimler Benz illustrates the opportunities for new products in this area. Other developments in this field have been initiated by major electricity companies in France, Spain, Italy, the UK and other parts of the EU.

In a related line of development, I&T Com now provide an interactive communication system based on the Home System protocols for hotels, residential homes, schools, colleges and other establishments. This system provides a means of delivering interactive information services to individual rooms within a building using coaxial cable. The system conforms to the Home System Specification and so is compatible with other Home System products.

Stimulating creativity

R&D in the field of business systems has helped companies explore how to use multimedia creatively to achieve business objectives. A prototype multimedia training system developed by Interactive Multimedia Systems in Dublin in collaboration with other multimedia specialists and

The customer interface for the automated home could offer remote display (a) of the electricity meter and a full-screen TV-based interactive terminal (b) able to display messages from the electricity supply company. Such an interface, based on the European Home Systems Standard, is being developed in IDEA-TV (project 7525).



domain experts received a special award from the International Foundation for Computer-Based Education in Banking and Finance. This system, subsequently used as the basis for a commercial training product

marketed Europe-wide, demonstrated how multimedia can be creatively integrated with expert systems technologies to provide an interactive learning environment. The application focus was training for effective uptake of IT within business enterprises and public administrations.

In a different domain, British Telecom and partners in the MIAS (2684) project demonstrated how multimedia technologies can be creatively combined to support live conversations between two or more people at different locations, using ISDN as the means of communication. The results of this R&D are reflected in desktop conferencing products now appearing on the market, including the Olivetti Personal Communications Computer.

Despite these early successes in helping companies gain experience in applying multimedia technologies to business needs, Europe currently lacks sufficient numbers of trained multimedia "writers" to be able to take full advantage of the possibilities opened up by multimedia.

Standards

The importance of standards is now firmly established as a key commercial requirement for the expansion of connection-less broadband services. Standards reduce the complexity of interworking, allowing a more

Multimedia for creativity

Multimedia combines text, data, graphics, still images, sound, speech, moving video and other media to create interactive combinations that match our ability to work with information simultaneously in a variety of forms. It presents challenges in terms of how to use the new possibilities creatively to achieve high-quality results. Esprit R&D has already helped European companies to develop the authoring technologies required. Now it is helping the industry to develop the means of exploiting the technologies creatively. These advances provide the technical basis for exploiting the rich heritage of European films, books, works of art and other assets that in principle are available to this emerging industry. Appropriate education and training in the skills, issues and applications associated with multimedia now need to be provided by schools, universities and training companies in collaboration with the industry. Achievement of excellence in various aspects of multimedia should also be recognised in order to encourage high standards of quality in all areas. A first step towards this has been achieved with the MUSA Prize for the best scenario for multimedia interactive work of artistic and cultural value. The prize was recently launched in Italy by the electronic publishing companies Il Tridente and Sidac as part of the MUSA (7523) project. Recognition of achievement and opportunities for training and education will have an important role to play in helping European industry foster the creative talents needed to compete effectively in the multimedia arena.

global connectivity; they also help the development of inexpensive chip sets through economies of scale. Significant contributions to the standardisation work of ETSI, ESIG and IEEE in the field of MANs (metropolitan area networks) have been made by the MAXI (5193) consortium. In the field of LANs (local area networks), the LAURA (7359) consortium has been responsible for around half of the technical proposals contributing to the industry standard HIPERLAN.

Standards in house automation

R&D in house automation has helped EU manufacturers to catch up and take the lead in the drive towards global standards in this area. A wide range of house automation products conforming to the Home System Specification have started to appear on the market.

Standards for multimedia

Industry standards will play a significant role in helping businesses to exploit multimedia's full potential. Adding to standards developed for other aspects of multimedia, the OSMOSE (5656, 6788) consortium has completed the first stages of work on developing a common publishing format (CPF) for multimedia titles, which will make this type of publication much more commercially attractive by enlarging the potential market for a title produced in a particular format. It will mean that publishers will be able to develop multimedia CD titles that can be played on multiple platforms, such as CD-I and CD-ROM XA, and make possible the portability of CDs between the business PC environment and the home CD-I player.

Copyright protection

Digital information is rapidly becoming the norm in many fields, and the potential for its commercial exploitation is enormous. The creation and distribution of intellectual property such as songs, films and literary works is already estimated to account for over 2% of the GDP of the countries of the European Economic Area (EEA). But as yet unresolved problems relating to copyright is inhibiting the take-off in this market.

EU funding is helping European companies to collaborate in developing technical solutions to the problem of protecting the rights attached to digital information. Eight companies are currently working together to exploit the results achieved in the CITED (5469) project and in EAST (a DELTA project) to develop a generic architectural model for an electronic copyright protection system, COPICAT. In related work, the AMIDE (8265) consortium is promoting the development of multimedia information and services by providing a comprehensive environment capable of integrating the needs of publishers, distributors, media operators, end-users and others in the information dissemination chain. The results from COPICAT and AMIDE will be used to stimulate new applications in a variety of domains, to enforce intellectual property rights, to collect remuneration and to effectively prevent unauthorised uses of information.

 I.T. PROGRAMME • ESPRIT

Computer-Integrated Manufacturing and Engineering

by Patricia Mac Conaill, Head of Unit

Towards 2001

Computer-integrated manufacturing is generally regarded as the unification, through interconnected data-processing systems, of the information used to support all enterprise activities, both physical and logical. The manufacturing and engineering industries are at the forefront of the battle for European economic survival. They account for more than 30% of its gross domestic product and employment. As the twenty-first century approaches, these industries are experiencing unprecedented upheaval. Globalisation of manufacturing and markets continues to push enterprises to lower costs and to enhance their responsiveness to market demands for timely delivery and for new capabilities in products. At the same time, public concern for the environment presents a significant challenge to industry to adapt products and processes to meet this demand.

Information technologies already have a pervasive influence on modern manufacturing and engineering. This ranges from supporting the design and engineering process, through production planning and control, and on to the control of manufacturing equipment and distribution systems. Yet expenditure per employee on IT by manufacturing industry in Europe is less than a quarter of that in other sectors such as banking, insurance and financial services. The scope for IT growth in the manufacturing sector is high, and this market is forecast to expand more rapidly than the total IT market, as the IT infrastructure evolves to support changing manufactu-

ring strategies. The functionality of software systems is a crucial factor in the implementation of any management strategy, whether this relates to just-in-time production, collaborative design or decision-taking in flatter management structures. Future production systems will be based on a high level of automation of simpler tasks, a high level of qualification of the people directly involved in the production process, and close cooperation between manufacturers and their component suppliers. The need to diffuse "lean" production techniques throughout the value-adding chain will result in first-tier suppliers being forced to tackle the problem of managing and optimising their own supply chains. The concept of Lean Manufacturing leads to many methodological approaches to the organisation of production processes, which in turn translate into specifications for a supporting information technology infrastructure.

Work in the 1980s was based on the concept of the integration of traditional engineering functions. These "computer-integrated" technologies are now sufficiently mature to be able to be exploited downstream in an industrial environment. A new culture of work is emerging which pervades all business processes including manufacturing and engineering; this needs advanced ICT and, correspondingly, determines new upstream ICT developments.

R&D activities

The main topics covered by ESPRIT CIME are:

■ **Product data exchange and modelling**, dealing largely with the internal representation of all product-related design and manufacturing data. The work is close to the STEP standardisation activities and has made some significant contributions to the development of standards, including the EXPRESS specification language.

■ **Factory automation**, covering a wide range of activities, particularly for one-off or small batch production, and comprising the development of software tools to support human-centred production concepts; advanced work in robotics and development of the associated controllers; and software developments in the field of simulating products, the manufacturing process, and the design and layout of manufacturing cells, assembly work-stations and entire plants.

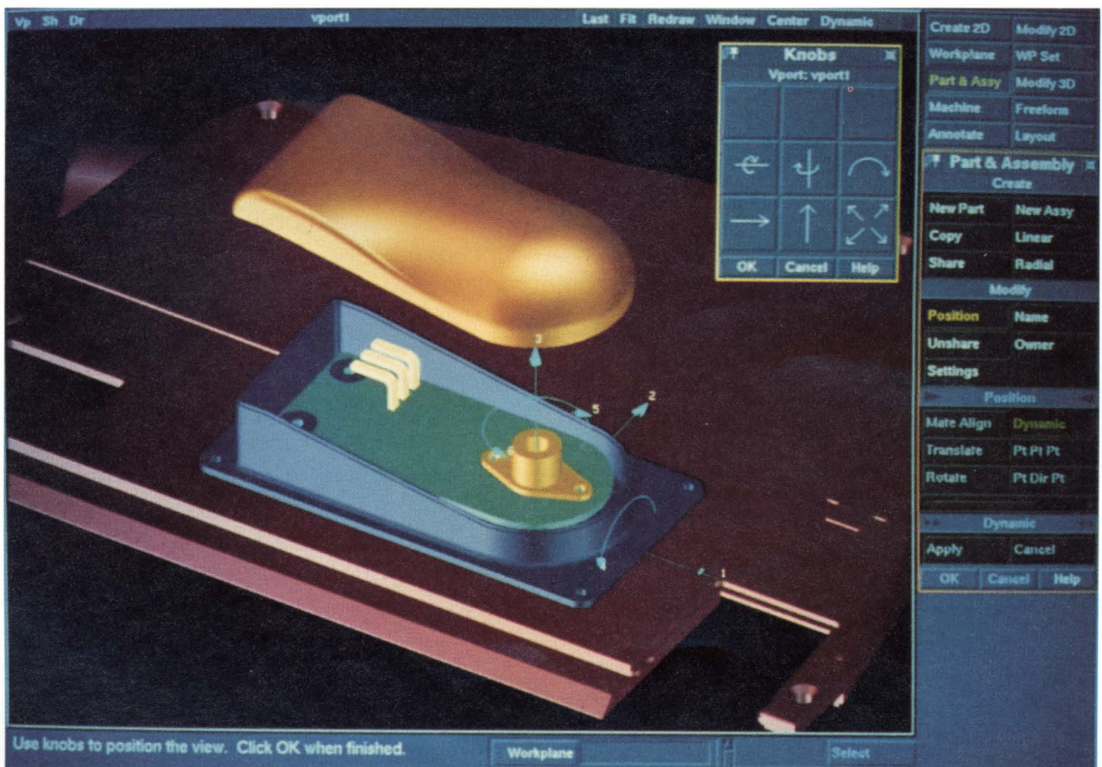
■ **Communications and logistics**, both within a plant and between enterprises collaborating in supply chains. Projects have resulted in interoperable devices for factory automation in line with the general policy of promoting Open System development.

Other developments have enabled collaborating companies to implement EDI systems and other developments again deal with the optimisation of supply logistics.

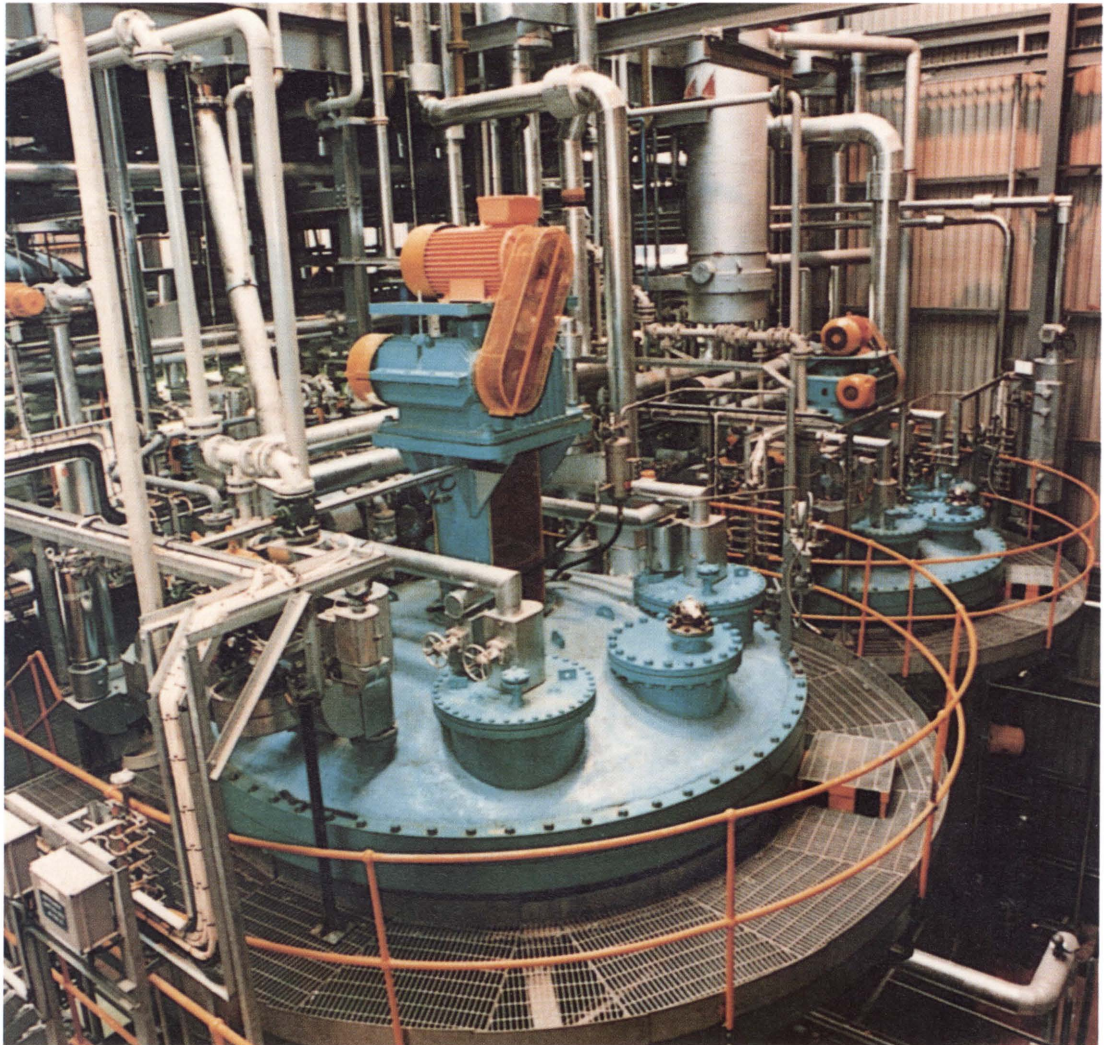
In addition to direct support for R&D, measures to accelerate technology transfer have grown in importance. These tend to be targeted at regions of the Union which experience particular difficulties in participating directly in the R&D projects. Examples of such measures are special actions of a fairly general nature in Spain and Greece; financial support for a manufacturing research centre in Porto, the most heavily industrialised region of Portugal; support, together with the Portuguese Ministry of Industry, for a project aimed at upgrading the ICT infrastructure of a number of suppliers of automotive components; and support for the ATTRACTION project in Northern Ireland and Southern Italy aimed at fostering the rapid uptake of advanced R&D results in SMEs.

In the mid-term review of ESPRIT, the CIME area was regarded as having been successful in developing technologies which quickly found outlets in industry. A large part of this success was attributed to the policy of involving industrial end-users right from the outset of the project. The success of an R&D

The STEP standard allows the easy exchange of surface and solid model representations. Shown is a housing assembly for electronic equipment generated using the CAD and finite-element systems developed in PRODEX (project 6040).



At Zeneca's Fine Chemicals plant in Huddersfield, CAPSICE (project 6168) is providing an architecture to bridge the communications gap between plant-level systems and enterprise-level applications. This should speed information flows and improve responsiveness.



programme of this type also depends heavily on close consultation with industry on the selection of topics on which to focus.

Process industries

As process industries face the challenges of lean manufacturing and improved environmental performance, they must also overcome the problems of increased competition and rapidly changing demand. There has long been a gap in communication between plant-level systems and enterprise-level applications, which has meant the slowing of information flows and a lessening of responsiveness. This problem is being overcome in Zeneca's Fine Chemicals plant at Huddersfield, where CAPSICE (6168) is providing an architecture to bridge that gap and supplying tools to plant management and operators to help them continuously improve and react to change. Products produced as

a result of CAPSICE are PP-PI, part of the SAP R/3 product set, and PDAS from Digital, which makes the connection between SAP and the real-time world of process control. The software is MMS compliant and incorporates, as well as develops, the latest thinking on the SP88/NAMUR standard.

Based on a survey of user needs and a recent independent cross-sector market survey, TENPRO (6169) is developing an easy-to-use framework, an advanced IT architecture and innovative applications aimed at improving the environmental performance of industry whilst enhancing production efficiency.

The key features of the product are a database system that maintains a continuous record of environmental and related parameters and monitors actual compliance against regulatory and other limits; a sophisticated application framework facilitating the development of applications with access to

EFACEC in Porto produces transformers using a labour-intensive assembly line. The site is one of the pilot applications of the CIME open computing environment developed in CCE-CNMA (project 7096).



TENPRO's high-quality environmental information; and generalised model services allowing the integration of modelling tools within the TENPRO application framework.

Product data technology

MARITIME is using advanced IT concepts to reduce the design time of ships and to allow European industry to build more specialised vessels. MARITIME should also strengthen the role of European software vendors by developing new software products (such as the METIS AP Factory) or researching the areas where existing commercial software is planned to be enhanced in the future. As the models developed within the project are to be submitted to ISO STEP, the role of the European ISO STEP activities should also be strengthened.

Developing the means for digital data exchange enables a more efficient communication of product data between business partners/applications to be established, increasing productivity and product quality. The product data generated by one application can be reused by another, reducing the time for approving designs.

CADEX is based on the results of CAD-I (322), which has significantly influenced the emerging ISO standard for the exchange of product model data (ISO 10303).

Project participants contribute to the STEP work within ISO. This includes writing application protocols and reviewing other documents. CADEX is represented in several STEP working groups under ISO committee TC1 84/SC4.

Communications standards

CCE-CNMA (7096) is developing a range of results (a framework architecture and a set of tools, services and interfaces) that will make the development, integration and operation of an open CIME computing environment (CCE) easier for system integrators. The applicability of the CCE is being tested in a variety of pilot industrial applications across Europe. The results should subsequently open up the CIME market by reducing costs and making products cheaper and more affordable to end users, particularly SMEs.

The four pilot sites are the Magneti Marelli factory in Corbetta near Milano, producing

display panels and control instruments for the European automotive market; a Mercedes-Benz flexible manufacturing system in Stuttgart processing components for engines, gear-boxes and axes for the new S-class car; the Aerospatiale joint research centre near Paris, where the pilot simulates Aerospatiale's Nantes industrial cell, used for the production of composite material parts for the Airbus and ATR72 aircraft; and a transformer assembly line at EFACEC in Porto, one of the largest companies in Portugal's industrial sector.

Planning systems

TRUTH (6463) addresses the creation of rapidly reconfigurable systems capable of scheduling and reactive re-scheduling. The solution of large complex scheduling problems is a computer-intensive and usually time-consuming activity. The output of computer-based systems in this field is very extensive, and scheduling systems are normally poor in self-explanatory power and inflexible and cumbersome when schedule alterations are required. TRUTH addresses these issues through cons-

Iberia is trying out the scheduling system developed in TRUTH (project 6463).



traint based reasoning and truth maintenance systems to provide schedules which are understandable, explicable and which can be easily modified with a minimum of disruption. The system has been tried out by the industrial participants in tyre production (Pirelli) and airline operation (Iberia).

Decision support tools

COMPASS (6617) set out to improve the take-up rate of CIM among SMEs. The project partners saw that if SMEs could be supported in the development of clear business strategies with tangible objectives, then these objectives

could be tied to IT solutions. If this could be taken up further and periodic performance measurements taken, quantified proof could be provided of the value of the CIM investment in the SME community. The COMPASS team, lead by the Kewill Group Consultancy Services, completed the development of a set of PC-based tools which have been highly successful. Already in use in Spain, the UK and Finland, the tools are now being prepared for use in Siberia (with funding from the European Bank for Reconstruction and Development), where they will be employed in helping to develop market-economy based models for newly formed SMEs.

Mechatronics and robotics

PANORAMA (2483) developed an advanced perception and navigation system that enables autonomous navigation by automated vehicles operating in poorly structured outdoor environments such as construction sites, forests, farmland and quarries. The technology enables fine localisation, motion control, obstacle avoidance, environment modelling, mission and route planning, intelligent control and their integration within relevant test-bed vehicles. The Panorama system was recently transferred to a drilling rig machine that has performed autonomously in an open-cast mining test area.

Regional actions

The AICIME action addresses the problem of CIME implementation in four Portuguese SMEs which are potential automotive component suppliers of Auto-Europa, the Ford/Volkswagen consortium that is setting up a factory near Lisboa. The results of this pilot could be extended to other companies and other sectors of Portuguese industry. The introduction of CIME technologies into Portuguese suppliers of automotive components will enable them not only to act as local suppliers to the new Ford-Volkswagen plant but also to position themselves as credible and qualified suppliers to other supply chains in the European automotive sector.

The AICIME action is in line with the objectives of the PITIE subprogram of PEDIP, and will be co-funded by IAPMEI (the department of the Portuguese Ministry of Industry responsible for the support of SMEs).

The Intelligent Manufacturing System (IMS)

The feasibility study to look at international collaborative R&D in advanced manufacturing began in February 1992 and was completed in January 1994. It involved the EU and five EFTA countries (Austria, Finland, Norway, Sweden and Switzerland), Japan, the USA, Australia and Canada, and was managed by an international steering committee supported by technical and intellectual property rights (IPR) committees. Membership consisted of a broad geographical spread of high-level representatives from industry and academia.

The feasibility study consisted of two distinct parts: the development of a framework for international cooperation to ensure genuine joint management, balanced contributions and benefits, work of industrial relevance, and an equitable IPR regime; and test-case R&D in accordance with commonly agreed topics, aimed at gaining practical experience of collaboration. The EU-EFTA teams, funded under Esprit, were involved in all test cases and led in two, and involved partners from the automotive, aerospace, chemical, IT and equipment suppliers sectors of industry. The test case on "Clean Manufacturing in Process Industry" identified the key technological

developments that are technically and economically feasible in the next 5 to 20 years in order to arrive at clean manufacturing operations. A comprehensive overview of relevant legislation and standardisation in Europe, Japan and the US was also produced. "Global Concurrent Engineering" established the extent to which concurrent engineering is practised world-wide in various industrial sectors and developed an outline of an architecture for a concurrent engineering system for global manufacturing. "Globeman 21" developed a methodology to assess best practice in manufacturing and put this methodology into use in a range of industrial sectors. "Holonc Manufacturing Systems" developed the concepts and an approach to building holonic systems. A "holon" is an intelligent, autonomous, cooperative agent. Holons can have different functions, and complete manufacturing processes can be designed by combining the appropriate holonic machine controllers. "Rapid Product Development" investigated, tested and demonstrated a set of technologies and business practices that could significantly improve and shorten the product development cycle, focusing on rapid prototyping and measurement technologies. Finally, "Gnosis" dealt with the systemisation of design and manufacturing knowledge and explored the concept of the virtual factory.

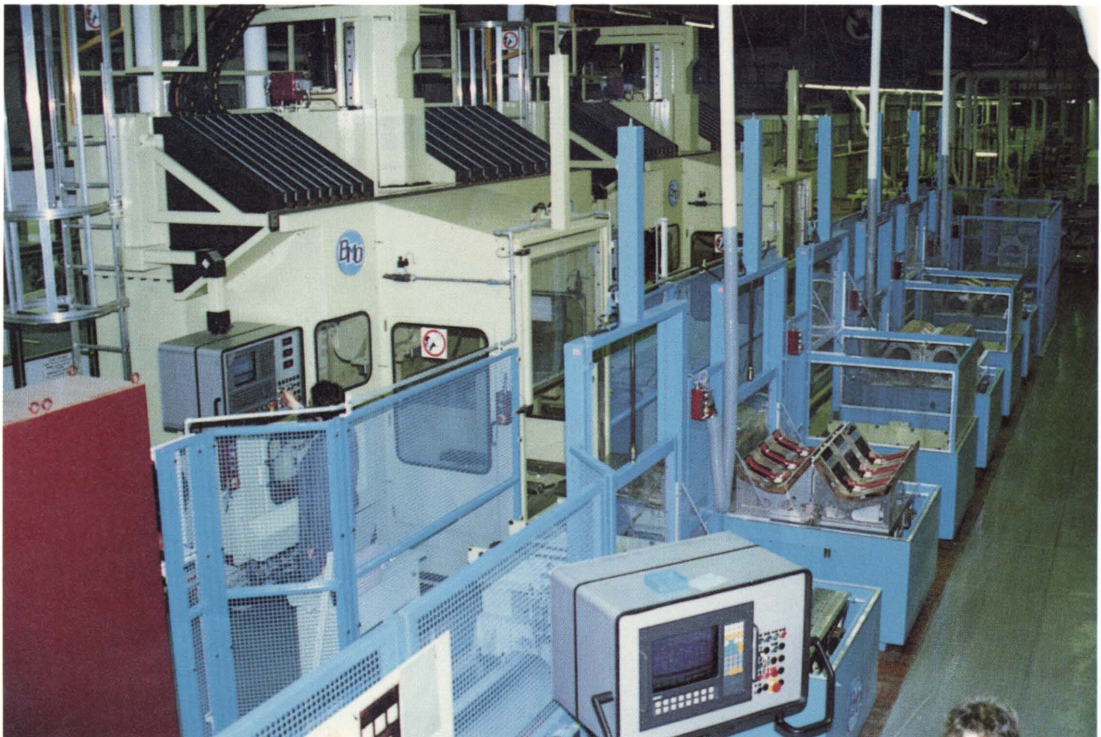
AIT

The AIT project brings together all the major European players in the automotive and aerospace industries, as well as companies in the capital goods and component sectors, in an attempt to specify and prototype radically new IT solutions to their business problems. The rationale for this development is the consortium's claim that historically the IT industry has not responded at the right time with the right products to meet their requirements, despite the fact that the industrial partners regard IT as a key factor in their efforts to increase productivity. The consortium's combined IT expenditure runs at an estimated 2000 Mecu per year. The planned outcome of the 18-month pilot phase, which began in November 1993, will be requirements definitions, specifications, *de facto* standards, demonstrators and prototypes. If the project is successful, it will enable the participating organisations to improve their own competitiveness and will also provide the European IT industry with an opportunity to take an appropriate share of the market. Led by Daimler-Benz, the consortium involves Aerospatiale, ALENIA, British Aerospace, CASA, DASA, Dassault Aviation, SAAB, VW/AUDI, BMW, FIAT, Mercedes-Benz, PSA, RENAULT, ROVER AEG and Magneti Marelli. User groups are currently being established involving large numbers of companies (including SMEs) in the supply chain and involving the vendors of industrial IT, both hardware and software. The main innovative aspect of AIT is the dominant role of a powerful user consortium in defining the course of future IT developments.

A Ruhrkohle AG (RAG) coal mine is one of the pilot sites for the MAP-based communications infrastructure developed in AMICOS (project 6147).



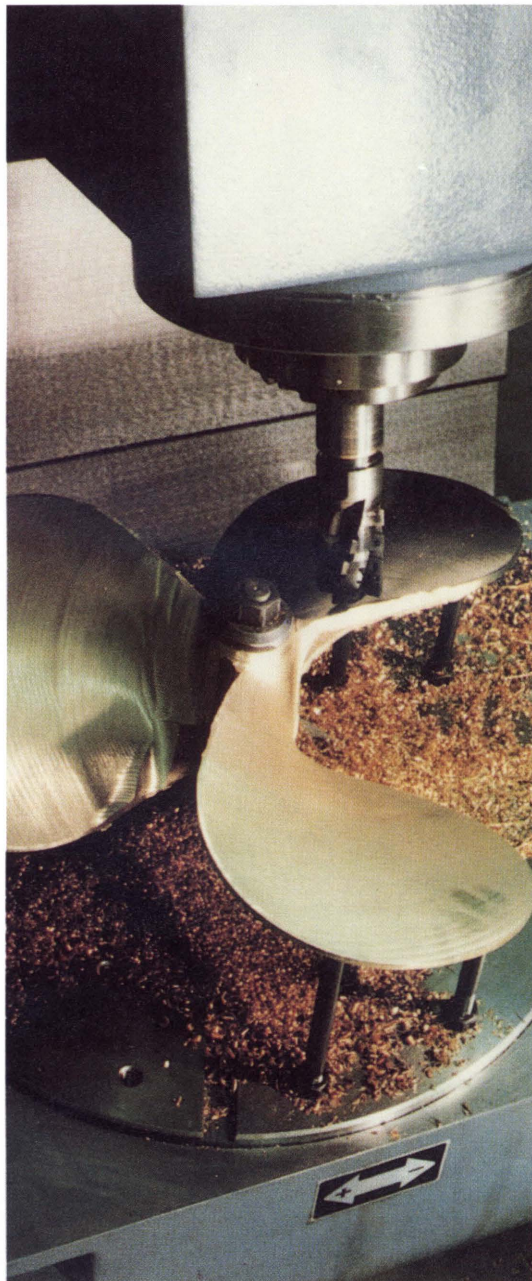
A Mercedes-Benz flexible manufacturing system in Stuttgart producing components for the S-class Mercedes is one of the test sites for the CIME open computing environment developed in CCE-CNMA (project 7096).



The international steering committee concluded in January 1994 that the results of the feasibility study were sufficiently encouraging to merit the launch of a full-scale IMS activity. The committee proposed a 10-year programme with a global budget of between 1 and 5 Becu.

A clear breakpoint at the end of the IMS feasibility study now follows, and a period for internal consultation in each country and region, examination of the results, and consideration of the recommendations of the expert committees has begun. These will form the basis of the decision in each region concerning continuation.

The HIQU (6293) project, involving Italian and German companies and research institutes, is working on control algorithms to improve the quality and accuracy of the processes involved in milling operations.



CIM-Europe

The initiatives supported by CIM-Europe have contributed to enhancing the interaction between users, producers, researchers and policy makers in the field of production technology and related engineering applications. The R&D tasks carried out under Esprit-CIME have produced a technological library of CIME solutions, emerging from the experiences of the user partners, which is now available through a growing number of publications.

The dissemination of those results and experiences has in turn contributed to the establishment of a common base of understanding on CIME problems, approaches and methodologies which is a major achievement in a community characterised by its multi-cultural and multi-disciplinary operation.

The dissemination of the knowledge developed and acquired in Esprit-CIME, the contribution to the awareness and transfer of CIME technologies, and the enlargement of the network of CIME actors have been, in summary, the main results of the CIM-Europe activities. These have been implemented along three main axes: annual conference, formation of interest groups, workshops and concerted actions.

The highlight of 1993 was the CIM-Europe Conference in Amsterdam, which was jointly organised and supported by the European Commission, Holland Elektronika, VIFKA, BIRA and the Netherlands Ministry of Economic Affairs. The conference provided an open forum for exchanging experiences gained in developing and implementing CIME technologies, and consisted of presentations of selected papers by invited speakers, workshops, posters and industrial demonstrations. The conference attracted over 220 participants.

New perspectives

Despite the heavy involvement of user industry in the CIME area, the overall approach pursued in the 1980s by the Esprit phase of the IT Programme was based on a technology-push policy aimed at a growing IT industry. The focus in the 1990s is on the development of an IT information infrastructure.

Pictured is a drilling rig machine fitted with the advanced perception and navigation system developed in PANORAMA (project 2483) that enables autonomous operation.



One of the targeted domains is “Technologies for integrated information and communication systems”. With ever-increasing system complexity, ICT support for function integration in manufacturing aims at the development of new ICT solutions in support of manufacturing and engineering operations, in order to achieve increased competitiveness as well as greater efficiency and environmentally clean and safe operations sup-

porting a lean manufacturing approach. A specific ICT infrastructure and advanced ICT technologies for distributed multi-site operations will be developed to support innovation. Activities will be targeted at exploiting new organisational approaches integrating basic technologies of software engineering, open systems, data modelling and database design, and computer-aided design, microelectronics, microsystems and mechatronics.


 I.T. PROGRAMME • ESPRIT


Open Microprocessor Systems Initiative

by Rosalie Zobel, deputy Head of Unit

Overview

The Open Microprocessor Systems Initiative (OMI) continues to mobilise European strengths and resources in the critical area of microprocessor systems. In the less than two years since its inception, the significant advances made are signalling that Europe is well on its way to achieving world-class European capabilities in this field.

Aims and objectives

OMI aims to provide Europe with a recognised capability in microprocessor systems, and to promote their use in applications systems worldwide. Through this pursuit, OMI will contribute to improve the long-term prospects and competitiveness of microprocessor suppliers, software developers, and their user industries. OMI is a key R&D programme for the European Union. Microprocessors are one of those technologies whose strategic importance for industry and society is easily visible and recognisable. These technologies are all-pervasive, and their potential impact is so widespread that they quickly gain the reputation of being truly revolutionary. Microprocessors and their associated software and tools are responsible for the ever-increasing diffusion of "intelligent" electronic systems. They provide the building blocks of information processing and account for much of the versatility and high performance of every type of computerised process and equipment from household appliances to cars, aeroplanes and flexible manufacturing systems. The substantial and rapid increases in microprocessor integration and performance are having a major impact on industrial competitiveness. A closer relation between industrial users and chip suppliers is increasingly required

to facilitate speedy access to suitable technology and reduce time to market. The problem is that 80% of Europe's microprocessor needs is currently dependent on technology from abroad. The microprocessor industry is at present dominated by two large suppliers who account for more than 80% of the world market for the most advanced products, which they do not license to others. These products are based on complex instruction set computing (CISC) architectures. The risk for Europe is that without equal access to leading-edge microprocessors and their associated software and tools, system companies and software developers will find themselves at a disadvantage in global markets.

An opportunity for Europe

A combination of factors and trends, however, is providing Europe with a real opportunity to change its currently disadvantaged situation:

- *The gradual increase in the market position of reduced instruction set computing (RISC) microprocessor architectures.* RISC aims to offer superior performance at a cheaper cost. Companies from both the US and Europe have put RISC chips on the market, with leading US suppliers prepared to license their technology.
- *On-chip integration,* leading to complete systems as well as multiprocessing on a single chip. By the year 2000 chips are expected to achieve a level of integration involving between 50 and 100 million

transistors compared to today's maximum of 3.5 million. Low energy consumption is also a major factor in developing portable devices and eco-technology.

■ *The evolution towards open systems*, manifested in the pursuit of software portability and so-called architectural neutrality (the ability of software to run on different hardware platforms). The key to the market dominance of leading CISC suppliers is the architectural dependence of operating systems such as MS-DOS and their huge accumulated base of applications software. This is changing. The portability of operating systems is improving through advances in

■ *The pull of system integrator industries* consuming and driving microprocessor technology, especially given the increasing importance of closer user-supplier relationships.

The OMI strategy

Europe has particular strengths in the telecommunications, automotive, consumer and industrial sectors. OMI builds on these factors. Its strategy is the result of careful deliberations begun in the early 1990s by representatives of the European industry, universities and research institutions. The name of the initiative encapsulates well its emphasis

Microprocessors and their associated software form the intelligence of a wide range of electronic systems.



design and especially the development of microkernels, minute operating-system cores providing the base for modular, portable extensions. Simultaneously, software technologies such as ANDF (architecture neutral distribution format) are improving the portability of applications software.

■ *The growth of the embedded control market* and the emergence of new markets such as that of the PDA (personal digital assistant). Both of these developments reinforce the movement towards architectural neutrality and tend to remove the software advantage of CISC suppliers.

on openness and microprocessor systems. This is a key aspect. With tens of millions of transistors on a chip, the concept of open systems is set to progress to the level of on-chip microprocessor systems and their associated software and tools. OMI has taken the lead in this process. Its work is forming a technical bridge where possible between European and non-European technology, as well as between existing architectures and future generations. This OMI-led development has important implications. Increasingly, users are asking for choice, flexibility, portability, and inter-operability, and this contrasts strongly with the oligopolistic approach of the companies domina-

ting the market. The users of future generations are unlikely to accept a monopoly situation if there are alternatives. This is why OMI is committed to open standards and to ensuring upgradability and software portability.

Several major strands of work realise OMI's strategic emphasis on openness and micro-processor systems:

- Applications demonstrators provide an important source of user input and, indeed, a mechanism for users to shape the development of OMI technology from a very early stage.

- Operating systems and microkernels realise the openness of OMI at the level of operating systems. The approach is to add value to an open, market-standard operating system, SVR4 Unix. The aim is to advance open systems state-of-the-art in a rapid and cost-effective fashion.

- Architecture neutral distribution format (ANDF) realises the openness of OMI in the area of applications software. ANDF frees users from being locked into particular proprietary systems, thus allowing new microprocessor architectures to enter the market with an improved chance of success. By porting their applications from one system to another, users are able to capitalise on their software investments.

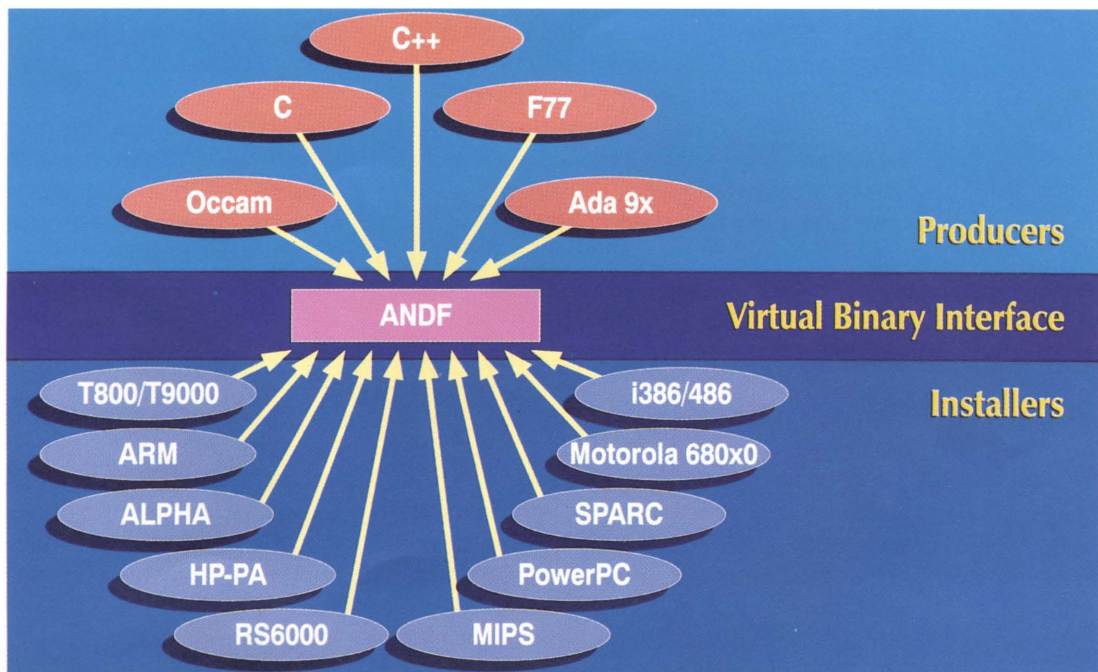
- The Eurocell Library realises OMI's path-breaking effort to carry open systems right down to the level of silicon. A fully fledged library will contain a large variety of conformant cells including microprocessor cores, peripheral logic and application cells. These interworking components will provide for a wide range of system performance and functionality and will be accessible under commercial terms to all systems integrators.

- Standards are a key factor for success, and those adopted and developed by OMI are expected to become the strategic standards for on-chip integration for the 1990s.

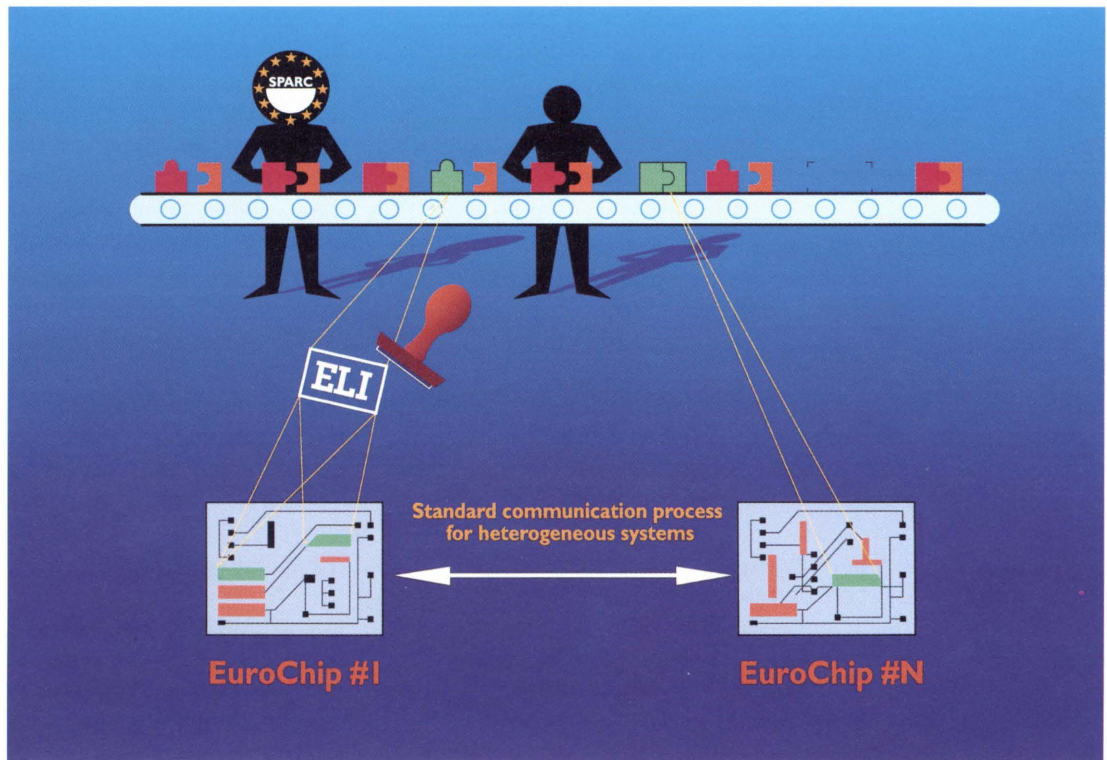
The organisation of OMI

Complementing the technical work is OMI's distinctive policy and organisational approach. OMI has pioneered the concept of a "focused cluster" - a set of projects and accompanying measures contributing in a complementary fashion. The initiative does not start from scratch: it builds on existing microprocessor architectures and on the strengths of the European systems industry. OMI is also responsive to established trends and standards and seeks to create new ones only where this is necessary. Furthermore, the initiative has not adopted a "fortress Europe" line. Its open systems approach has an institutional correlation. All institutions that can genuinely contribute to OMI may participate.

The architecture-neutral distribution format (ANDF) frees users from being locked into particular proprietary systems.



OMI has solved the technical problem of high-speed inter-connection between heterogeneous systems by the development of the OMI macrocell library, ELI (Eurocell Library and Interfaces).



OMI also fosters close user-supplier relations and there is effective user involvement in all projects.

The effective realisation of a focused cluster demands some specific activities and organisational conditions. In OMI, common standards are taken care of by a coordinating project which acts as a consensus-building mechanism. An OMI advisory panel composed of senior industrial managers meets regularly to provide the strategic direction of the programme. An OMI office supports the panel and the projects in their work, and is responsible for dealing with critical issues such as intellectual property rights. Finally, a dissemination activity stimulates internal and external awareness about the work and progress of the initiative.

OMI projects and results

The initial phase of OMI saw the launch of 20 research projects involving more than 60 organisations from every country of the European Union. At this early stage, the emphasis was very much on laying the technological foundations of the programme both in hardware and software. A second call for proposals took place in 1993 leading to a further 22 projects. This time greater emphasis was put on soft-

ware as well as on industrial applications in order to reinforce the user-pull of OMI technology. Today over 150 organisations are collaborating in hardware, software and applications relevant to the success of the initiative. Most importantly, this growth has been accompanied by some significant organisational, technical and commercial progress. OMI has gradually consolidated its focused cluster structure while fostering good understanding and relationships among partners, particularly, among the competing semiconductor companies in Europe.

Portability and operating systems

In software portability, the technology at the core of OMI has attracted solid international support. The Open Software Foundation (OSF) and Novell's Unix Systems Laboratories have become members of OMI, and X-Open has stated its intention to promote ANDF as a standard. In operating systems, the value of OMI's work has been recognised worldwide and has resulted in major commercial and technical alliances, including the involvement of Cray, Alcatel and Novell's Unix Systems Laboratories. Chorus Systèmes' distributed, real-time microkernel technology has been integrated into standard SVR4 Unix.

Microchips

In microchips, the ARM microprocessor

family is the world leader in low-power, small die size, high-performance products. GEC (UK), Sharp (Japan) and VLSI Technology and Texas Instruments (USA) are manufacturing the ARM, and Apple has chosen it as the processor for its personal digital assistant (PDA), the Newton MessagePad. In the high-performance area, OMI has contributed to the development of the latest T9000 transputer, which with a performance of 200 MIPS matches DEC's Alpha as the world's fastest single-chip computer.

Eurocell Library (ELI)

OMI has now solved the technical problem of high-speed interconnection between heterogeneous systems. This technology is being accorded worldwide recognition and an IEEE committee has been set up to standardise it. Several standards have also been jointly defined by the European semiconductor houses who, as competitors, are showing an unprecedented degree of collaboration, clearly demonstrating the European spirit of the initiative. One of these standards is for a common application-specific bus, the PI-BUS. The specification and patent of the PI-BUS is currently under negotiation by Siemens, Philips, Inmos, ARM and Matra MHS.

The future

These early achievements of OMI show that the initiative has the potential to fulfil its goals and provide Europe with a technological capability critical for its industrial and economic growth. A successful OMI will bring much closer user-supplier relations, providing systems integrators and software developers with speedy access to a technology adapted to their competitive requirements. Openness will give users a much greater choice, which together with the simpler design approach implicit in the Eurocell Library will make possible an improved return on investment and overall competitiveness.

This process will in turn reinforce the presence of European microprocessor systems suppliers in global markets. The long-term realisation of this potential, however, demands sustained and increased efforts to consolidate and build on the gains already generated by the initiative's focused cluster approach. This will take place under the Fourth Framework Programme, where further action is planned in order to advance key areas and plug the technical gaps still present in the broad technological front covered

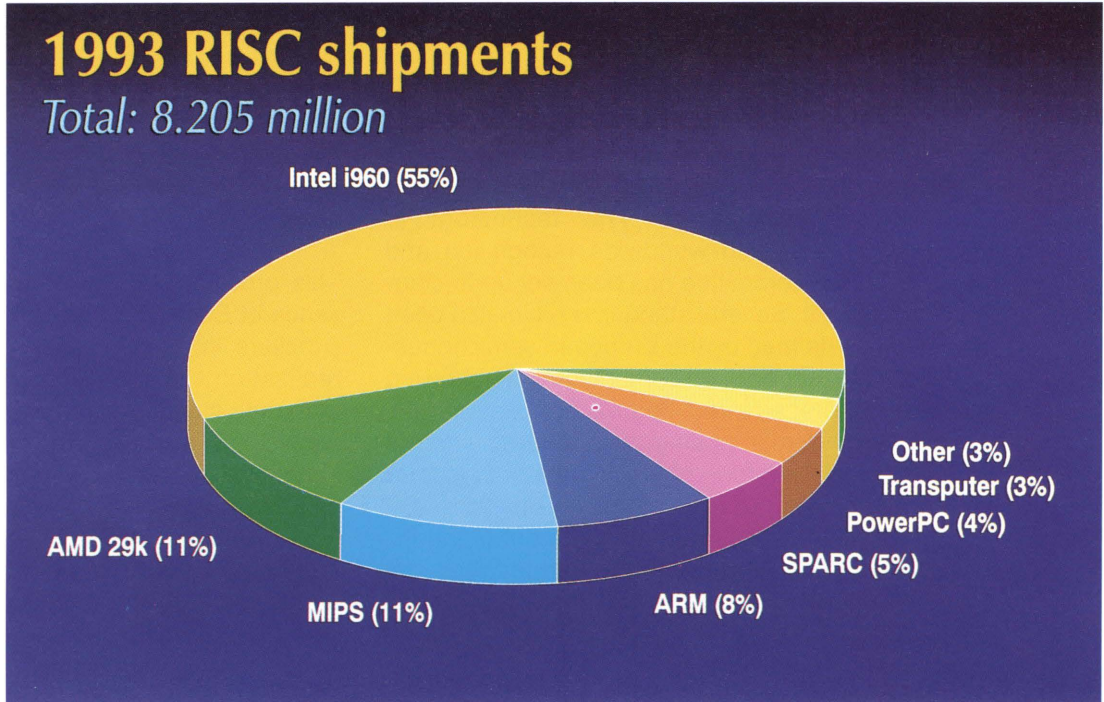
Apple's Newton "personal assistant" is based on the RISC processor chip developed with contributions from several Esprit projects.



by the initiative. A larger number of targeted applications projects are also planned to tune the development of the technology more finely to the requirements of users in key industrial areas. Simultaneously, further dissemination actions will be implemented with a view to reinforcing and expanding the awareness and diffusion of OMI technology worldwide.

parts of their new products. This will check the rise in development costs and will enable the more efficient and faster development of applications and customer-specific designs based on their core microprocessors. In turn, system companies will have access to much better design tools, enabling them to specify and design complex on-chip systems and to examine alter-

RISC chip sales figures: both demand and the range of applications are growing rapidly.



A key area of attention will be microprocessor systems design. This is an area where European chip suppliers and systems integrators stand to gain huge benefits. The high complexity and dynamism of the microprocessor industry has been accompanied by escalating development costs. The 3.1 million transistor Pentium from Intel is reckoned to have cost around \$5 billion to develop. As chips move towards the 100 million transistor mark, it is difficult to envisage the development of new very-high performance microprocessor systems in a cost-effective fashion. Without a rethinking of the design process, microprocessor and industrial systems designers are facing a daunting future. OMI's ELI and design environment work is designed to counteract this threat. With macrocells, companies will not be obliged to design entire systems afresh. Microprocessor suppliers will be able to re-use many subsystems and to concentrate their resources on the really critical

natives and tradeoffs before committing designs to silicon. They will be able to weigh the software/hardware tradeoffs more efficiently and cost-effectively. As a result, they will enjoy the benefits of "right first time" designs, easier product customisation, and reduced time to market.


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