Esprit

European Strategic Programme for Research and Development in Information Technology

1989 Annual Report

Commission of the European Communities
DG XIII-A: Telecommunications, Information Industries and Innovation
Information Technology - ESPRIT



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of the basic criteria on which they are based: the industrial orientation, the strategic objectives, the pre-competitive and pre-normative approach, the cross-border cooperation and the provision of access to the results of a project on an equal footing by all participants to the project.

ESPRIT, in particular, has proven to be highly successful in setting up and promoting industrial cooperation. The programme has not only led to many outstanding technology results as well as technical standards which are put in evidence in this report; it has also acted as a catalyst between large, medium and small-sized companies and universities and research centres. The catalytic effects often extend beyond the R&D phase. Cooperation in R&D has led to a remarkable change in the attitude of companies and has fostered the process of restructuring which has had a strong impact and an overall positive influence on European IT industry.

Overall, and compared to what its situation was a decade ago, the European IT industry has made remarkable progress and undergone substantial restructuring. It is better prepared to face the challenges of the future. However, these challenges will also be far more demanding in the coming decade. Not only will the European market attract more competitors from overseas but technology is also moving at an accelerated pace. Under these conditions, it is essential for industry to substantially increase its investment in this area. The European Community, for its part, will continue to provide the framework in which these efforts can best be brought to fruition, and match the increasing efforts required from all actors.

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Introduction

by J -M. Cadiou, Director, Information Technology - ESPRIT

Highlights Of The Year

It is a pleasure for me to report that the total number of **major results** arising from ESPRIT projects has almost doubled during 1989. This is due to the fact that many of the projects launched during the first years of ESPRIT came to fruition during 1989 and that most of them were successful. Indeed, as of the end of the year, a cumulative total of 313 major results had been reported by ESPRIT projects, as compared to the figure of 166 reported by the end of 1988.

1989 also saw the major part of ESPRIT II becoming fully operational with the launch of 137 new projects. Despite the pressures created by supporting and administering the total of 384 active ESPRIT projects, another record for ESPRIT in 1989, we also launched three important new initiatives. These were the Basic Research actions, which have brought together the leading actors in the European R&D Community in Information Technology - including several Nobel prizewinners, one action aimed at improving training in VLSI design skills and one on parallel computing technologies.

Also of major significance in 1989 was the preparation of future ESPRIT initiatives in the context of the 1990-94 Community Framework Programme for Research and Development. Furthermore, 1989 also saw the completion of a full independent review of the ESPRIT programme at its 5 year mark. The review was designed to evaluate the effectiveness of the programme and its management procedures, and the overall assessment was very positive. Specific suggestions for improvements identified during this process have been taken into account.

ESPRIT is an industrial programme and therefore the achievements and the further development of ESPRIT need to be seen in the broader economic context of industrial and market development on a European and global scale. In 1989, the European IT market for Information Technology IT grew by 16% to a total value of $133 billion. On the world stage, the European market increased in importance with a higher growth rate than the world-wide average.

For the first time, three European companies can be found amongst the top ten of the world-wide information systems suppliers. In semiconductors, the three largest European suppliers, taken together, increased their sales by significantly more than the market as a whole even though their market share remains subcritical. A more detailed account of these developments is given in a later section of this report, "Industrial developments in IT".

These positive elements should, however, be seen as a motivation to increase our efforts, and not as a reason for complacency. The pace of change continues to quicken in Information Technology and challenges are greater than ever before. The market environment is dynamic and changing all the time as industrial restructuring continues. Whilst overseas competitors are strengthening their manufacturing base in Europe, the trend from proprietary to open systems continues. New technologies are being introduced and prices are still falling in real terms. All these factors represent both risks and opportunities to which Europe's IT industry must respond promptly. One major opportunity is being created by opening up the European market in

1992 and it is of great importance that our IT industry is well prepared to grasp it.

Results

In 1984 when the European Strategic Programme for Research and Development in Information Technologies was launched it had the overall goal of providing European information technology (IT) industry with the technology base needed to become and remain competitive with the US and Japan in the 1990s. In addition to this primary objective, it aimed to promote European industrial cooperation in IT and to contribute to the development of internationally accepted standards. These long range objectives remain as valid and relevant today as they were five years ago.

This report bears witness to the many good technological results which have emerged from ESPRIT so far. The choice and presentation of a few of them in this short introduction is meant to give the reader an incentive to refer to the main chapters of this report for a full account of these results.

Cooperation remains an objective of and a methodology within ESPRIT. Industrial cooperation on precompetitive ESPRIT projects has proved highly successful. Increased levels of mutual respect and trust has been achieved between competing companies so that they now find it possible to agree on cooperative work programmes which are much more central to their mainstream activities than would have been thought possible at the start of ESPRIT. Cooperation has shown that work sharing and risk spreading leads to more efficient projects and catalyses the process of industrial reorganisation into new structures. The ESPRIT cooperation experience has also strengthened the links between industry and universities, which has led many of the latter to concentrate more and more on industrially relevant topics. It has, last but not least, also helped to establish new cohesive links between enterprises in the smaller and larger Member States.

Furthermore, the cooperation patterns within ESPRIT are now involving users, both large and small, to a much greater extent than before. This is proving valuable in helping projects keep sight of customer needs and in encouraging the exploitation of results. This strengthening of ties between European IT manufacturers and users is of major importance for the future of the European IT industry.

In the Basic Research area, even though this part of the programme only started this year, significant catalytic effects are already visible. For example, top researchers who traditionally used to take their sabbaticals outside Europe, now tend to take them to work in the laboratories of their Basic Research partners. Similarly, doctoral and post-doctoral students tend to spend much of their time in other partner's sites. Overall, there is a substantial increase of the level of awareness between European researchers in IT, new collaboration patterns emerging, and in fact, the shaping of a European IT academic community.

Direct technology results from ESPRIT projects can be classified into three broad categories. First are those consisting of advanced technology to be incorporated into products or services reaching the marketplace, these include technology results used as enhancements to existing products. Second, projects may produce tools, methods or processes which enhance the development of manufacturing operations within industrial enterprises. The benefits of this type of project are seen indirectly in the marketplace through shorter development times, higher quality, better yields and reduced costs. Finally, certain projects produce results in the form of a contribution to international standards. During 1989, projects have produced results of all three types and these have come from all work areas of ESPRIT.

Table 1 shows an analysis of the 313 major results reported as of the end of 1989.

Table 1: Results of ESPRIT Projects by the end of 1989

Contributing directly to products or services	152
Tools and methods used outside ESPRIT	118
Contributions to international standards	43
Total Results	313
(Results in 1989	147)

211 of these results come from the 155 projects that had completed by the end of 1989. 93 of these 211 were obtained in the year 1989 alone. For illustration purposes some examples of results in the various categories are given below.

- A technology which allows designers to realise ASICs rapidly and economically, CATHEDRAL, has been developed in project 97. An example result from CATHEDRAL was the reduction in size of CD player circuitry from a 100 cm^2 pcb to a 1 cm^2 single chip. Simultaneously, the design time for the circuitry was reduced from one month to one week.

- A world class, high speed, bipolar semiconductor technology has been developed in project 281. The resulting process can provide circuit densities of more than 5000 devices per mm^2 and delay times of only 70 picoseconds per gate.

- An optoelectronics component developed by project 263 has achieved world-record receiver performance (-32.7 db at 560 Mbit/s) and is capable of operating in a 10 km video link without needing intermediate amplification

- The cluster of projects devoted to the PCTE concept, which was developed in ESPRIT, continues to be highly successful. The tools for software integration and developments have been taken up by all European computer manufacturers and IBM. PCTE is rapidly becoming a worldwide industry standard.

- DMA, project 940, produced a prototype of a state-of-the-art robust, trinocular stereo system for computer 3-D machine vision.

- The T800 floating point transputer developed in ESPRIT project 1085, SUPERNODE, has become an outstanding commercial success, being adopted all over the world, including Japan. On the world market the transputer ranks first in the 1989 shipments of 32-bit RISC microprocessors.

- Project 295, PAPER INTERFACE, has allowed new advances in optical character recognition to be applied commercially. Using this new technology, AEG won a $300 million contract from US Mail after its system out-performed those offered by competitors. The system can recognise 250 different type fonts and handwriting at the rate of 400 characters per second.

- Project 563, has developed the world best algorithm for digital image compression, PICA. This algorithm was selected in a worldwide competition by ISO and CCITT as a basis for standards in that area. The exceptional performance of this algorithm made it possible to use conventional HF radio for transmitting colour images of the recent "Whitbread Round-the-World Yacht Race".

- In the CIM area, project 623 has developed new off-line programming systems for robots. These allow robots to be programmed in the safety of an office environment and without interrupting the production process. These systems are now extensively used at the partners' sites in industrial operations.

- Through the CNMA project, Europe has achieved leadership in the setting of standards for factory communications. The follow-on project, 2617, builds on the early successes and, as well as the live factory implementation at BMW, British Aerospace and Aeritalia, new communications systems are being installed by Renault, Magneti Marelli and Aerospatiale.

- Project 1561, SACODY, has developed new control technologies for robots which dramatically reduce the vibrations they experience during uninterrupted repetitive operation. As well as leading to a new generation of lighter, faster, cheaper and more durable robots, the technology is being applied to large flexible structures as used in the building and construction industries.

A total of 971 organisations were, by the end of 1989, contributing to the programme and benefiting from its results. I am particularly pleased to note that the number of SMEs participating has more than doubled from 146 in 1988, to 386 one year later. Table 2 provides details about ESPRIT participation.

Table 2	
Large Companies	292
SMEs	386
Universities	184
Research Institutes and others	109

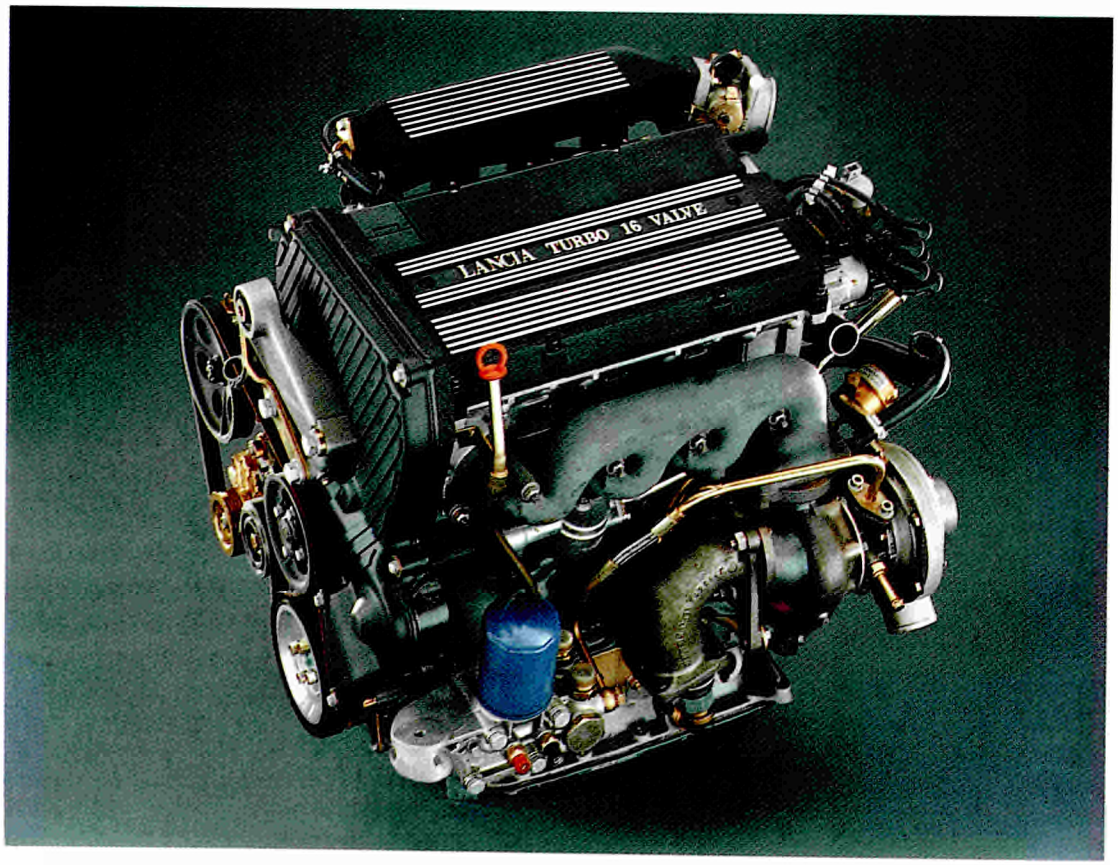
The Future

The third Framework Programme for Research and Technological Development has now been agreed for the period 1990-1994. A substantial part of it will be devoted to a new phase of ESPRIT.

The new phase of ESPRIT will consist of four technological areas and Basic Research as outlined below.

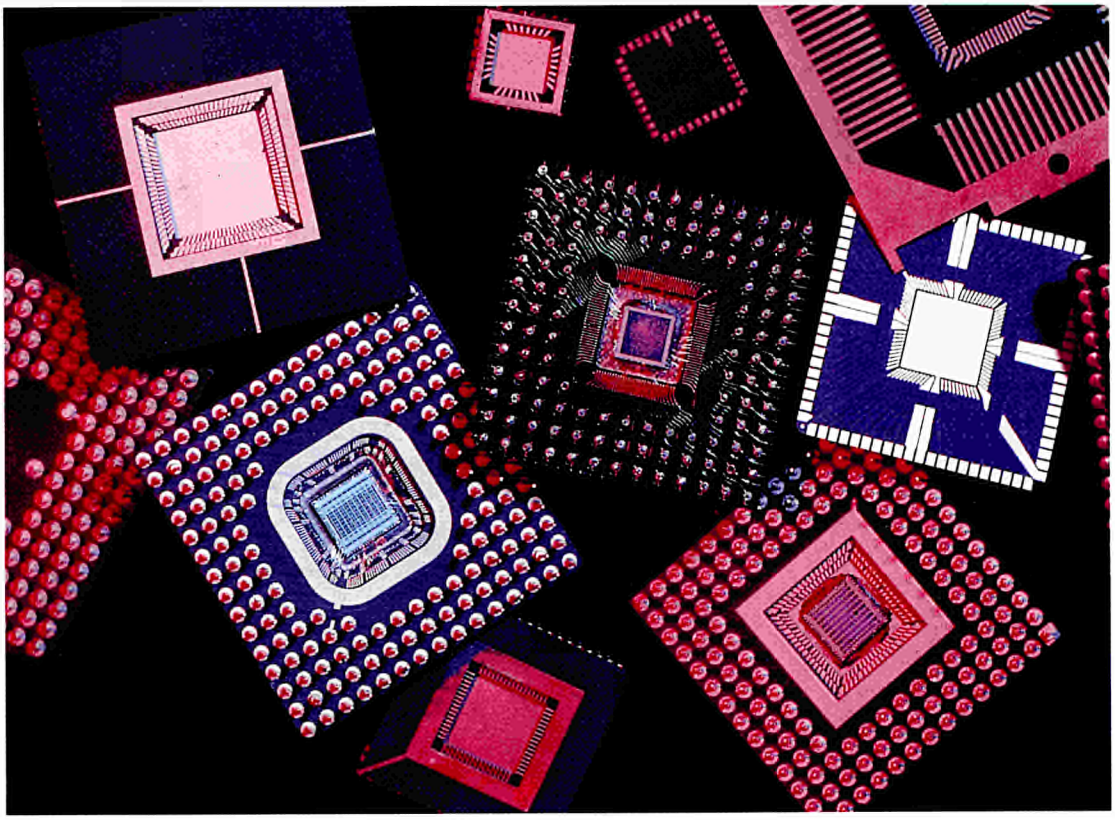
Microelectronics - The key objective is to ensure the ready availability of microelectronic solutions to a broad range of user industries. Future work within this area will therefore continue to place emphasis on Application Specific Integrated Circuits. It will contribute to the establishment in the Community of a world competitive source capable of supplying a broad range of leading edge ICs. This work will build on the results obtained in ESPRIT and in the national programmes to date. Work on the very advanced submicron-CMOS related technologies needed for ultra-high density chips will be carried out in conjunction with JESSI. This work will be organised in such a way so as to link users and producers, and to ensure broad Community participation for the benefit of all. CAD, equipment for semiconductors processing, packaging and advanced materials will, in particular, receive strong attention.

Information Processing Systems - Newly emerging parallel architectures, improved man-machine interfaces and technologies to perceive and synthesise highly complex signals will determine future systems. Future generations of computers will need to perform more cost effectively, be more reliable and have better interfaces. Work on concurrent architectures will focus on target applications with around 10^5 computing elements and at the same time will seek improvements in system reliability and security. In the majority of IT systems software is now seen as a dominant



The application of IT to the car of the future will increase fuel efficiency, reduce pollution, lower noise and improve safety.

Application Specific Integrated Circuits playing a key role in ESPRIT strategy.



element. Therefore, attention will be paid to increasing software productivity through new software tools, portability and reusability and the design of standardised modules.

Despite significant advances in software engineering methods, European professionals are still not sufficiently encouraged to adopt state-of-the-art methods. Therefore special emphasis will be placed on the transfer of modern design methods into common use in order to improve productivity and software quality. Specific measures will be undertaken to promote the use of new software production technologies and to increase skill levels on a broad scale.

Advanced Business and Home Systems - A major aim is for functional integration in both business and home environments. Work on integrated business systems will address information flow throughout an enterprise enabling close integration of activities between functional units and an increasing degree of cooperative working. In this context, the integration of mobile terminals is an important new area. Distributed computing including data base management, the corresponding workstation and microprocessor systems and technologies are of major concern. Work in distributed computing will, in particular, concentrate on loosely coupled and heterogeneous systems. Increased emphasis will be placed on intelligent homes and buildings where information technology can integrate such diverse functions as security, voice and document communication, heating and energy management.

In the context of business and home systems, workstations and peripherals take on an added importance. Especially on the latter, a competitive technology base needs to be established to enable new generations of peripherals which are reliable, and low cost, to be produced in large quantities.

Computer Integrated Manufacturing and Engineering - The ability of the manufacturing and engineering sectors to compete in the international markets of the future is critically determined by the timely application of computer integrated manufacturing technologies. Europe has particular advantages in this field since it can build on engineering strengths and skilled personnel. The vendors in this sector

Computer Integrated Manufacturing improves working conditions and productivity on the shop floor.

include a high proportion of innovative small and medium sized companies. The main thrust of future work will be to create open system, multi-vendor environments. Emphasis will be put on system integration aspects and the pre-standardisation work required for multi-vendor solutions. The advanced IT solutions developed for manufacturing and engineering will be validated within strategically selected industrial applications.

Basic Research - As well as work in the four industrially oriented areas described above, continued efforts will be needed to maintain and expand the European reservoir of knowledge and expertise, which provides the foundations for Information Technologies. Research topics will be clearly upstream of industrial R&D and selected for their potential to produce important advances in fields such as superconductivity, nanometre electronic circuits, the formal foundations of computer science, and neurocomputing. Throughout the work, steps will be taken to establish and strengthen close links within the industrially oriented activities within the programme.

Conclusion

1989 has been a very successful year for ESPRIT. The consolidation of the programme's second phase, the new initiatives associated with Basic Research and skills development and, particularly, the large increase in the number of tangible results from ESPRIT are exciting and positive developments.

On the global scale Europe is much better positioned than it was five years ago. However, the next five years ahead can be expected to see a considerably more difficult and competitive environment for the IT industry in Europe. A substantial increase in R&D investments and a qualitative improvement in the speed of transfer of technology into marketable products will be necessary for the European IT industry to maintain and improve its position.

Microelectronics

Overview

Microelectronics activities in the ESPRIT programme contribute substantially to the technology foundation for European electronic companies, enabling them to increase their ability to compete on a world scale by providing indigenous capability to create new and differentiated Application Specific Integrated Circuit products. The ESPRIT Microelectronics research programme is focused on stimulating the creation of the necessary design tools, process technologies, equipment and support industries to enable European electronic goods manufacturing companies to create their own Application Specific ICs. This market is one in which the user captures his most proprietary system know-how in silicon, thereby requiring an especially close customer-vendor relationship. The market therefore would benefit enormously from an indigenous supply capability and is well suited to investment in a European context.

ASIC complexity is extremely varied and can contain relatively simple functions used as customised interfaces to standard parts through to fully customised systems on silicon implemented on advanced mixed technologies. ASIC designers also need access to leading edge technology in order to gain maximum competitive price and performance advantage and avoid technical obsolescence. Fast turn-around and "first time right" have become key features of the marketplace as ASICs are often designed late in the end-product development cycle. Production volumes can range from a few thousand through to many hundreds of thousands of pieces, therefore flexible manufacturing capabilities are needed to cope with variance in production.

In 1989, the number of projects increased from 50 to 57, 13 projects were completed and 22 new projects started. Project results achieved in 1989 attracted interest from visitors to the 1989 Esprit Conference exhibition. A project receiving particular attention included a demonstration of a state-of-the-art integrated Indium Phosphide Opto-electronic transmitter/receiver. The project has produced devices which have achieved world record performance. Another project (ADVICE) also attracted a great deal of attention, demonstrating electron-beam verification and diagnosis of active VLSI chips. Further to previous work on materials studies for optical/magnetic recording and liquid crystal displays, 1989 marked the effective start of activities in peripheral devices.

In order to secure the supply capabilities of the European IC industry, and the capability of other sectors to skilfully apply them, several collaborative and concurrent actions have been started in the Community, partly inspired by the awareness created by the success of collaborative Community undertakings such as ESPRIT. Amongst these is the Joint European Sub-micron Silicon (JESSI) programme, the main objective of which is to address the whole spectrum of activities related to bulk CMOS technology and its advanced applications using memories as the main technology development vehicle and main volume product.

At the same time as JESSI was defined, the 1989 Workprogramme for Microelectronics and Peripheral Technologies has been established. The contextuality of these actions has created a unique opportunity to exploit the synergy of these programmes, bringing together a critical mass of qualified expertise directed towards a set of goals which should secure for the European electronics industry a rich spectrum of technology options. In June 1989, at the Eureka Ministerial Conference in Vienna, the Commission declared its readiness to support a start-up phase of

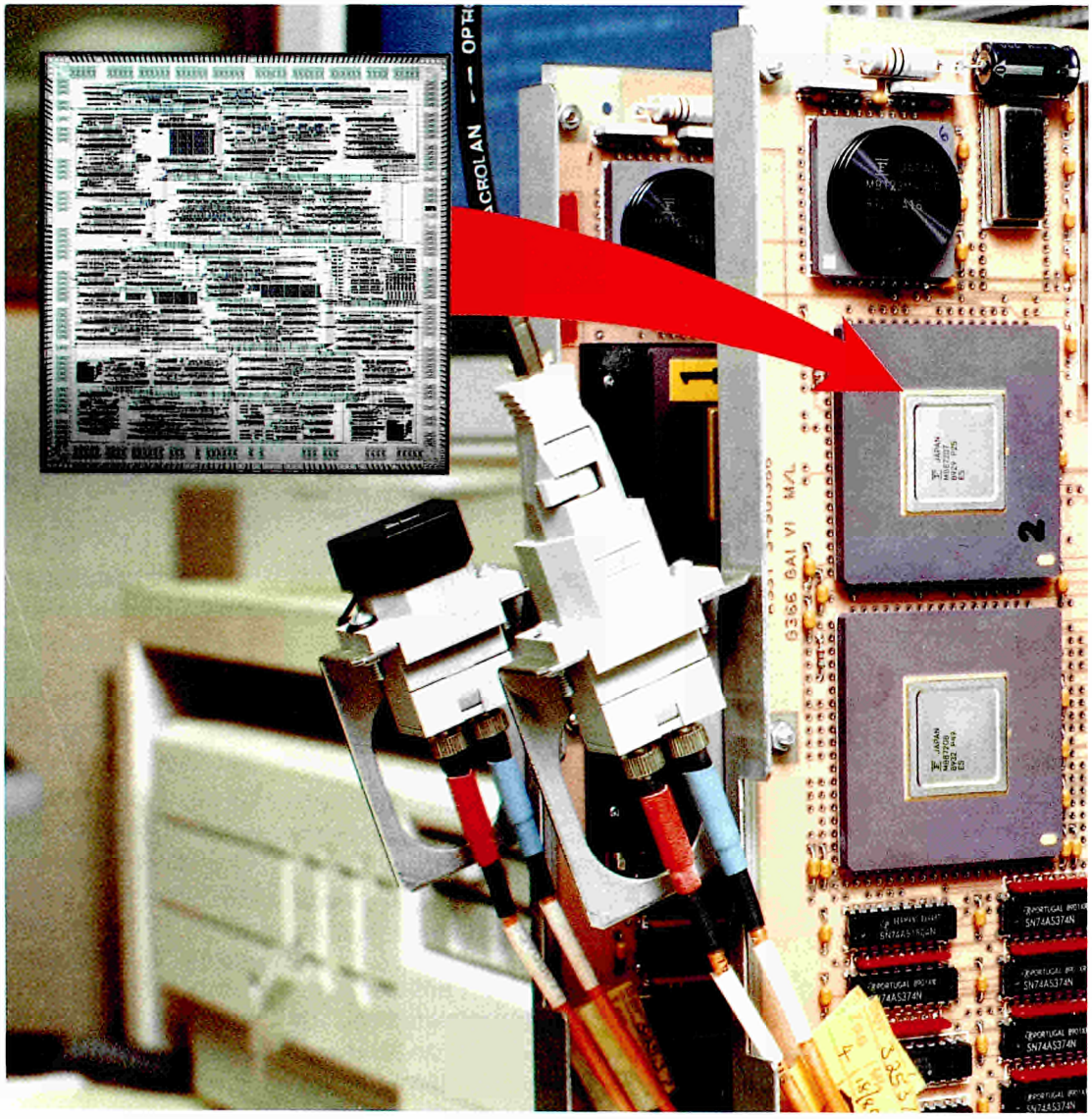
JESSI by participating in the pre-competitive part of the work, either through existing ESPRIT projects including those launched as a result of the 1989 MEL call for proposals, which address the goals of JESSI (in CAD, mixed silicon technologies, reliability, equipment) or through projects which will focus on selected topics such as Manufacturing Science and Logic.

Design, Validation and Test

The main aim of the Computer-Aided Design (CAD) and Computer-Aided Test (CAT) activities in microelectronics is to stimulate the development of new tools and systems to allow European designers of electronic equipment to master the design and test of complex chips containing millions of transistors.

The methodologies incorporated into these tools need to be targeted according to the application. For example, different users (Consumer Electronics, Telecommunications, Data Processing and Automotive) have application driven requirements in terms of complexity, performance and balance between digital and analogue circuitry. The potential production requirements (very high volume memory chips or lower volume consumer products) dictate different cost parameter optimisation. Additionally, large companies often need highly complex CAD systems with sophisticated design management controls, while smaller companies or those just entering the field will need simpler single user systems.

ESPRIT microelectronics developments in CAD and CAT for VLSI aim for maximum flex-



CAD tools developed in AIDA were used to design this ICL 200,000 transistor local area network controller chip which incorporates built in self-test modules.

ibility in terms of the resulting systems by developing and implementing standard interfaces.

Design

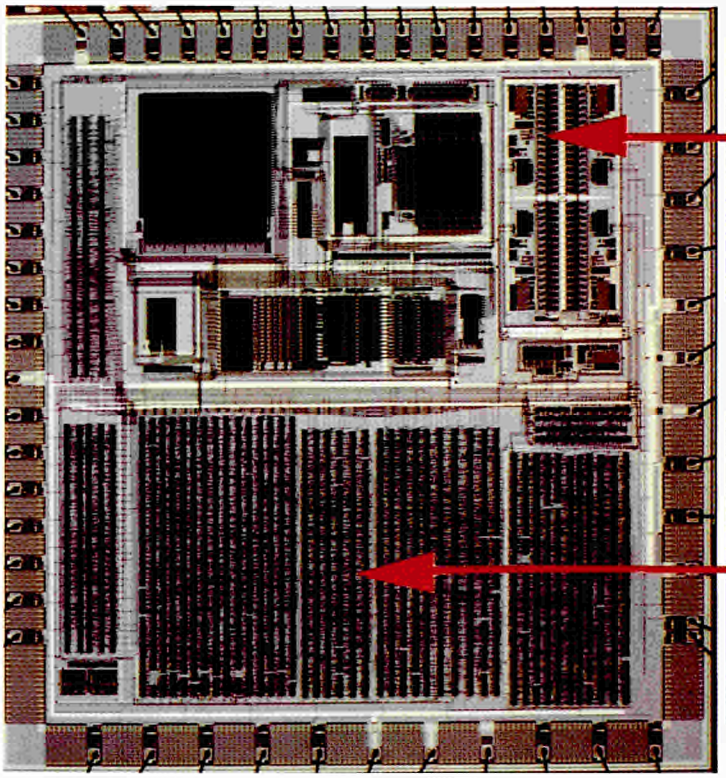
Four CAD projects which have just completed their work illustrate the breadth of work in CAD tools and systems which has been carried out in ESPRIT so far.

Multi-view VLSI-Design System (ICD), project 991, was directed towards providing the most powerful system possible on a low-cost workstation. This has been achieved by exploiting to the fullest possible extent the hierarchy of a design. A number of sophisticated synthesis and verification tools have been created around a new concept in database design. The design system has been implemented on a variety of commonly available workstations and the individual modules have been made available to software development companies. ICD has been used to implement a number of chips including an image processing array at British Telecom and a mathematical processing chip at TU Delft.

Efficient and effective communications between CAD tools is an essential ingredient for creating powerful, ergonomic design environments. Knowledge-Based Design Assistant for Modular VLSI Design, project 1058, has developed a Structural Procedural Interface (SPI). The interface defines a mechanism which allows different CAD tools to operate in parallel and permits direct interaction between the various tools in realtime. The concepts of SPI are now available to the European CAD community and they create an opening into the market for small software companies who will now be able to link their own CAD tools into design environments sold by the larger software vendors. Although SPI can be exploited as a general purpose interface it has emerged from a project which has its main emphasis in CAD tools for Digital Signal Processing applications. In this context the partners are developing tools to perform hierarchical timing analysis, optimisation and electrical verification thereby reducing the need for extensive simulation, which is always a time consuming and hence an expensive step in a design cycle.

A CAD system specifically aimed at solving the problems of mixed analogue and digital chips for use in telecoms systems has been the prime objective of CAD for VLSI Systems

This experimental signal processing chip was designed and laid out by Philips automatically from a high level description using tools developed in CATHEDRAL.

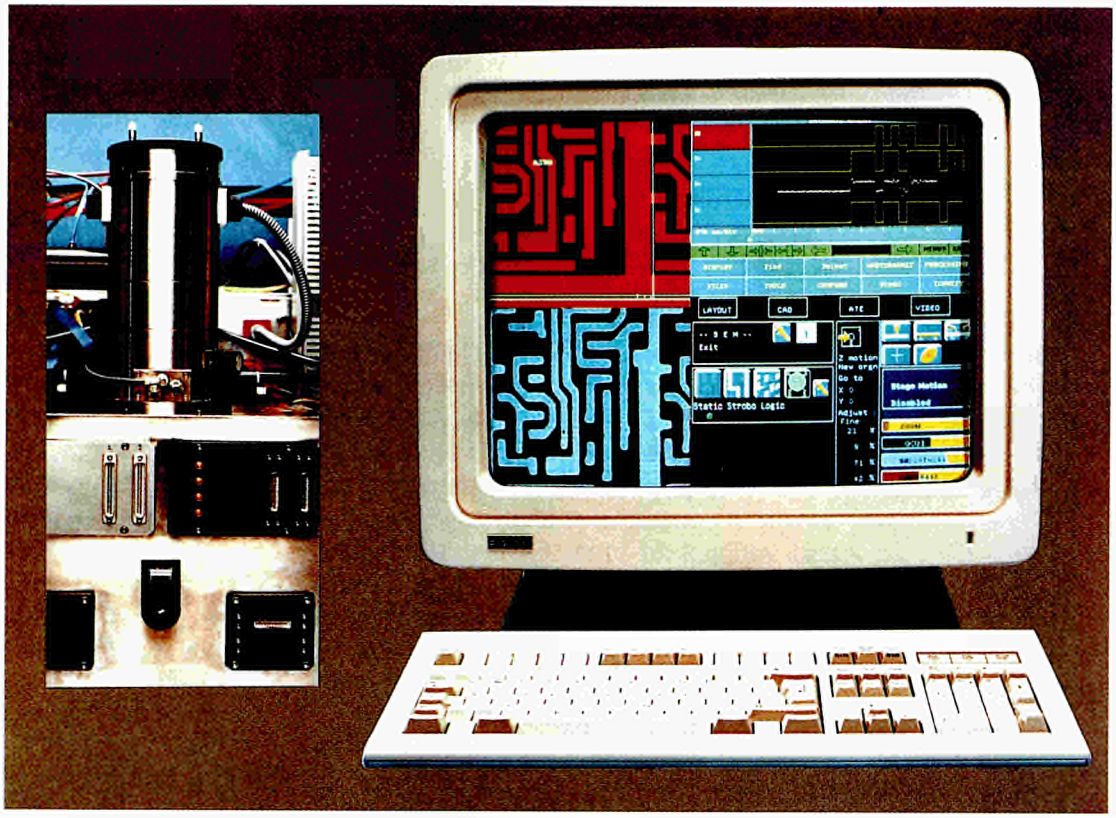


parameters	unit	value	min.	max.
bandwidth	Hz	1.5M		
signal-to-noise ratio	dB	30		
sampling frequency	Hz	8.5M		
order			1	3
# of bits quantizer			1	4
linearity	dB	50		
type of input signal		current		
.....				
input impedance	Ohm			
noise opamp	V			
mode of input signal		bipolar		

D. Input description typical for the automatic generation of a multiple bit ΣΔ analog-to-digital convertor.

```
func f1(s1,s2,s3,s4,c1:W1;i1:W1{2};i2:W6)
r1:W12 =
begin
  m1 = if (i1{0} & i1{1}      ->  d4 ||
          if (i1{0} & !i1{1}    ->  d3 ||
          if (!i1{0} & i1{1}    ->  d2 ||
                                    d1;
  x1 = W6(m1) & i2;
  y1 = W12(c1) & z1;
  z1 = W12((x1 + y1)@4);
  x2 = W6(m1) & !i2;
  y2 = if c1 -> z1 ||
             -> r1;
  r1 = W12((x2 + y2)@4);
end;
```

A: Part of the high-level description typical for standardcell-based bit-parallel filters.



User interface for chip validation using the scanning electron microscope (on left of picture) developed in ADVICE. The display shows the design layout in red and the microscope's view in blue. It also shows the test waveforms applied together with the expected and observed waveforms.

(CVS), project 802. A system has been created using a set of novel tools for automatically constructing designs from a description of the required behaviour of the chip. The cells used in the designs are synthesised and optimised from the given set of parameters. The cells are then automatically placed in an optimum arrangement and interconnected to complete the physical chip design. The system which provides built-in testability has been used to design a complex chip which is a part of a mobile radio system. Some of the tools created by the project partners have been selected for exploitation in future products marketed by a small German CAD vendor (ANACAD).

The efficiency of the CAD tools developed in Advanced Integrated-Circuit Design Aids (AIDA), project 888, has been proven by one of the partners in the design of a local area network controller chip containing 200,000 transistors which is believed to be the first commercial chip of this complexity to contain built-in self-test. Recognition of this was achieved when ICL were awarded the best paper award at the Integrated Circuit Test Conference (ICT-89), the first time the award has been given to a European paper. The CAD modules developed by the partners include a number of tools that operate at different levels of the design hierarchy. The embedded "built-in self-test" modules, mentioned in the example above, make it possible to perform production and in-service diagnostic testing at a much lower cost.

CAD Frameworks will allow users to customise design systems to suit application areas. Some of these applications take particular advantage of digital signal processing techniques and therefore need CAD facilities which can exploit this design methodology. In this context it is worth taking a look at some recent design work done using the results of CATHEDRAL, project 97. In this example a complex system chip, incorporating signal processing and control for compact disk players, was defined in a high level behavioural description language SILAGE. The CAD tools are used to animate this description until the designer is satisfied with the performance, then the mask layout is directly compiled by the CAD system from the same high level description. This is a very significant achievement in terms of allowing system designers to develop ASIC products within their own domain of expertise and without having to be too concerned with target technology.

Validation and Test

In the context of efficient design of complex application specific chips, design validation and the diagnosis of faults received increased attention.

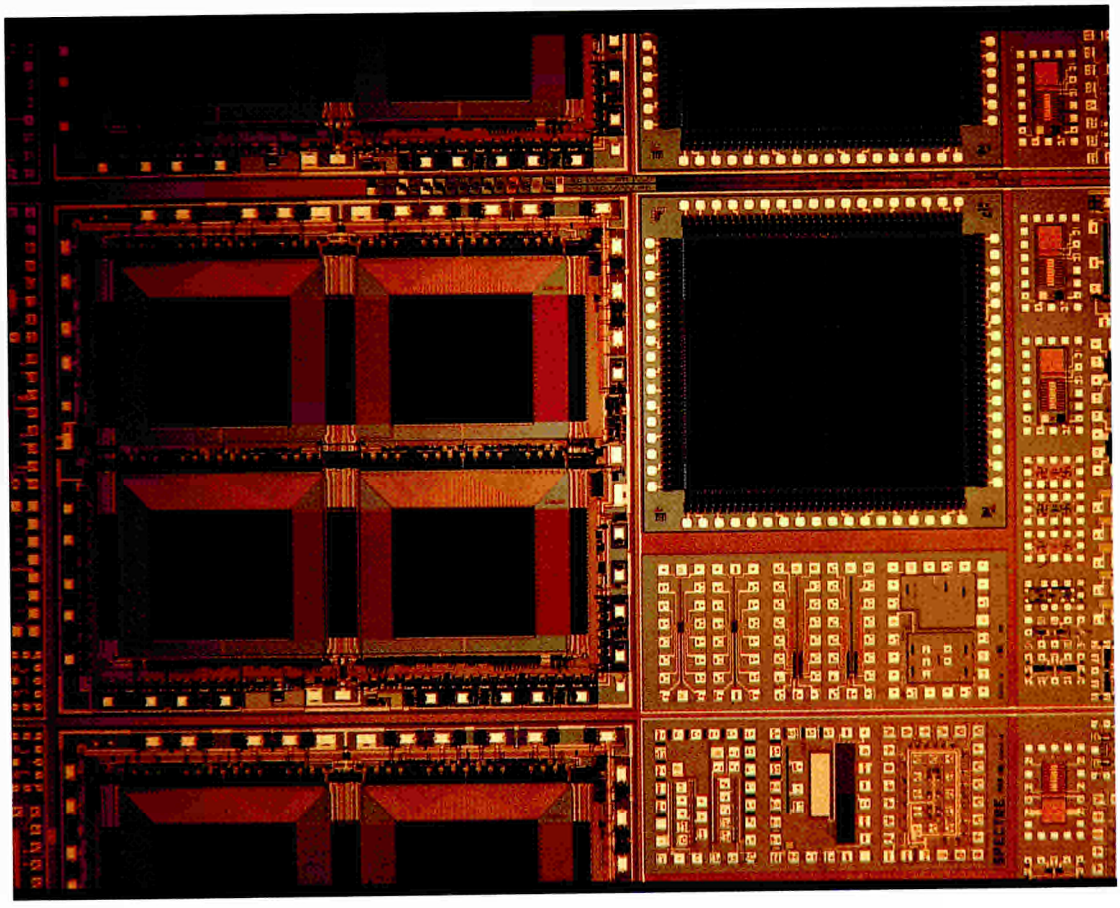
Project 271 (ADVICE) has successfully integrated Electron Beam Microscopy and CAD to produce the prototype of a world class system for diagnosing faults in complex chips. The linking of the CAD system (containing the original design data) with the E-beam microscope, coupled with automatic correlation between the two systems using pattern-recognition techniques, has resulted is a system which can allow validation and diagnosis several times faster than the current generation equipment. Up until now such systems have not been available from European vendors and an agreement has been reached with ICT, a German SME, to produce a product based on the results of the project. Two further projects in this important domain addressing low cost chip validation and reduction of system board testing cost were started in 1989.

Technology

The Microelectronics research activities of ESPRIT encompass a wide range of process technologies, equipments and manufacturing methods. The projects bring together a large number of players from European microelectronic industrial and academic establishments. The work focuses on silicon- based technologies. In addition compound semiconductors are addressed.

Silicon Processes

The trends of Silicon IC technologies towards structures with finer sub-micron dimensions lead to new and very complex processes. A substantial part of the work being performed within ESPRIT is aiming at consolidating and strengthening existing advanced capabilities in process development and on application driven technology adaptation to produce complex, high performance ASICs in the areas of High Density, High Speed and Multi-function Integrated Circuits.



This high density chip with 0.8 micron feature size was developed by SGS-Thomson and demonstrates the achievements of SPECTRE. A "sea of gates" ASIC array is seen top right, 1 Mbit EPROM in four sections on the left and the process validation logic, bottom right.

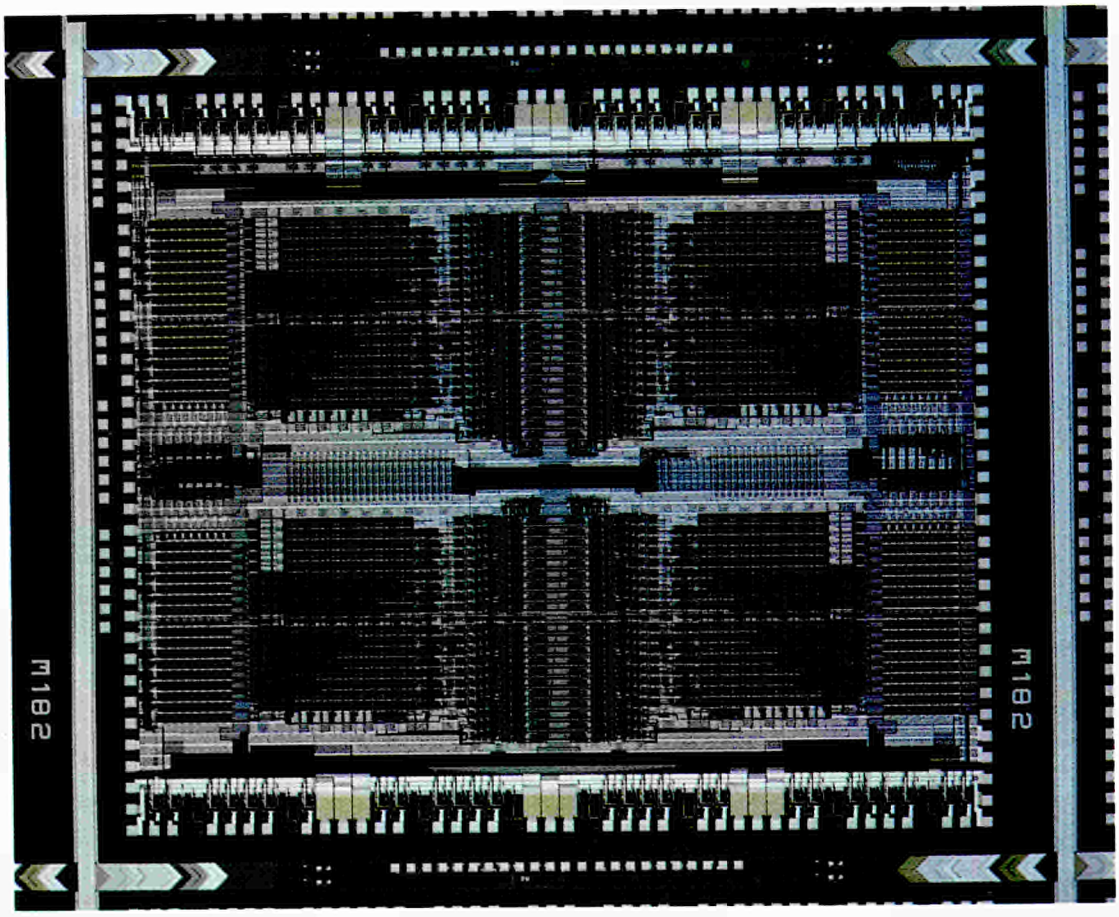
High Density Silicon

In the strategically important area of high density ASICs research has been concentrated on developing a sub-micron CMOS technology. SPECTRE, project 554, has paved the way towards a multi-sourced CMOS ASIC capability for Europe.

All the project goals have been met and the five SPECTRE partners have demonstrated and test, functional circuits designed using common design rules and fabricated at each of the five manufacturing locations. The industrial partners, SGS-Thomson and MATRA-Harris have manufactured large, high density chips with minimum feature size equal to 0.8 micron - notably 256 Kbit static RAM and a multi-function chip incorporating a sea of gates array and a 1 MBit EPROM memory. The research centres, CNET, IMEC and BTRL have fabricated demonstrator circuits which include process validation modules and test circuits containing 0.5 micron features as advanced building blocks leading the way to future processes.

SPECTRE has defined a coherent set of process modules which can be individually developed and validated. The modules can then be combined to create a complete process. The project defined two processes out of the set of modules, one suitable for exploitation in the short term and another, more aggressive process, to allow investigation of advanced techniques in laboratory sites.

Improved fabrication techniques have resulted from the intense collaboration which took place around the central lithography, device and interconnect tasks. For example, the lithography task not only achieved the level of accuracy required for sub-micron process but also made substantial improvements in the methodology of equipment set-up procedures. This has resulted in minimised risk of error and reduced installation time. The project also developed a polysilicon gate with spacer technique, which has been used by British Telecom to realise the 0.5 micron gates of a 155 Mbit/sec cross-point switch circuit. In addition to completing the development of the high density interconnection task, the laboratories Harwell, CNR-LAMEL, University of Arrhus and Telettra have carried out a very effective reliability study and materials analysis of double level metal interconnect where Tungsten is used as first level metal.



A digital filter chip from Plessey demonstrating the submicron bipolar achievements of Project 243.

High Speed Silicon

The creation of a world class high speed bipolar capability has been pursued in two projects, both of which completed their work in 1989. The projects have met their original goals, indeed in a number of cases key milestones have been achieved ahead of time.

In project 281, the process developed has demonstrated circuit densities in excess of 5000 devices per mm^2 and delay times of 70ps. The demonstrator contains 8k gates and has shown that future exploitation should realise high speed ASICs of up to 30k gates. The process has been carefully designed to be compatible with the process steps used in a CMOS process thereby retaining a degree of compatibility with BICMOS technologies. Meanwhile, project 243 has been equally successful and culminated with the demonstration of a sub-micron digital filter circuit.

To further exploit the results of these two projects the principle partners have combined their efforts in BASE, project 2016, where they are developing all the steps (in terms of processing, assessment of novel structures and modelling) required for the fabrication of fast (40 psec gate delay) complex (50-100K gates) chips for digital signal processing. The five project partners are the most competent manufacturers of bipolar circuits in Europe. In the BASE project each partner concentrates on specific optimisations of the technology towards speed, complexity, analogue and digital functions.

Multi-Function Silicon

Multi-function ICs cover a wide range of applications requiring the concurrent use of different technologies on the same chip. This goal has been pursued in three distinct areas: the inclusion of non-volatile circuit elements (to remove the dependence of continuous standby power being applied to complex circuits), the mixing of CMOS and Bipolar devices on the same substrate (in order to exploit the combined advantages offered by the two technologies simultaneously), the combination of high density logic functions with high power driver devices (to create "smart-power" devices).

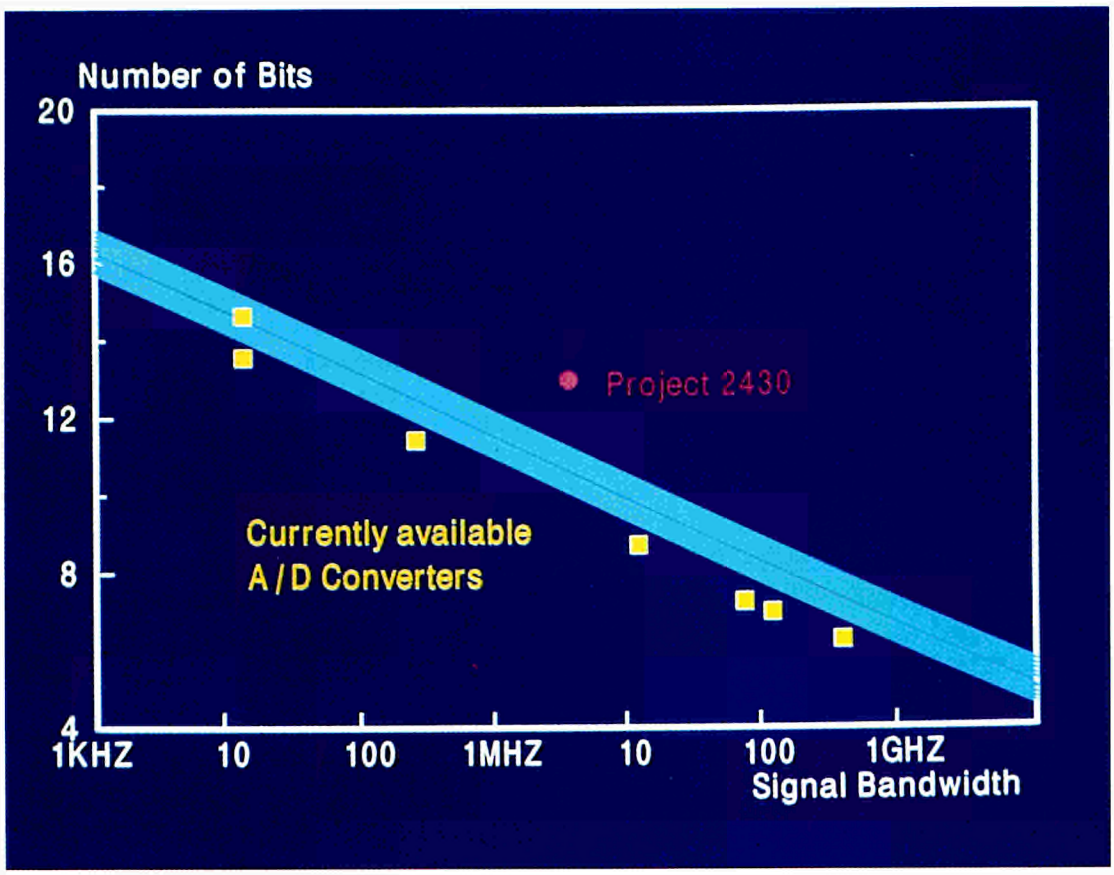
Non-Volatile ASICS

Provision of a European capability in non-volatile ASICs is the goal of APBB, project 2039. The project, which started at the end of 1988, is aiming at the integration of re-programmable read-only memory devices (PROMs) into both sub-micron and low voltage (1.5V) CMOS processes. This technology will be exploited in areas such as micro-controllers, adaptive hardware, smart cards and chip tagging circuits. During the first year of the project several types of memory cells have been designed, processed and characterized, with promising results, in terms of programming voltage and data retention. To increase the impact of the project and encourage potential users to have earlier access to the technology, a workshop was held with users and manufacturers, in Brussels, during the 1989 ESPRIT Conference. As a result a number of demonstrators have been identified. They will be designed by SMEs within the project and then be processed by the three main industrial partners - SGS-Thomson, Plessey and Eurosil.

BiCMOS

The BiCMOS market is doubling each year: 100M$ for 1988, 210M$ for 1989 and forecast to reach 2000M$ by 1993. The emphasis today is on the exploitation of BiCMOS in real world interfaces (analogue to digital and/or digital to analogue convertors) although the technology has the potential for a much wider market penetration. A key factor in BiCMOS realising its full potential will be the availability of integrated design tools which can cope with mixed analogue and digital designs. Therefore the provision of design tools has become an integral part of the projects. There are two BiCMOS projects in ESPRIT, one targeted to maximise performance whereas the second aims to provide a low cost production process while maintaining good performance targets.

In project 2430 the work at Philips and Siemens has proceeded to the development and full characterization of an advanced, high performance 1.2 micron BiCMOS process, including self-aligned double-poly emitter and vertical p-n-p transistors as well as to the design of large demonstrator circuits. In particu-



The use of Bipolar CMOS technology in Project 2430 enables analogue/digital converter performance well beyond the existing state of the art.

lar, Philips has designed a video bandwidth analogue to digital converter of 200 K transistors complexity, 432 MHz sampling rate and with an accuracy in excess of 10 bits. Due to the high complexity of the circuit, which aims at world record performance, the total circuit has initially been split into two parts which have been separately processed and successfully tested. The next step is a single chip implementation. Siemens is concentrating on purely digital applications and has developed a process which is among the best in the world. Transistors have a cut-off frequency of 11.5 GHz, a gate delay equal to 65 psec (which is the shortest CML gate delay time of a BiCMOS process reported so far), and a power delay product of 60 fJ. The process demonstrator is a 6k gate array incorporating an embedded 16K bit Static RAM.

The second BiCMOS project, 2268, has established a common process at ST and Telefunken. They started with a standard 1.2 micron CMOS process and added five extra masking steps to allow the incorporation of bipolar devices (including vertical p-n-p transistors). This process requires a total of 17 masks compared with more than 20 typically required to define very high performance processes; hence resulting in a low production cost process. An important feature of the process is that the emitter-base structure has been optimised to achieve both high voltage (analogue circuits at 12V) and also high speed (7.5 GHz). Several demonstrators (High Definition TV and Pan-European Cellular Radio chips) are being designed for processing next year. One of the partners, DOSIS, is developing a silicon compiler based design system which will automatically translate both the digital and analogue sections of CMOS and Bipolar chips into BiCMOS. This clearly increases the accessibility of the technology by providing users with a means of evolving previous designs.

Modelling and Analysis

In the initial stages of designing new process steps, the process engineer can make good use of modelling programmes to establish the basic recipe. These simulators provide predictions of device parameters enabling early evaluation of a potential process without embarking on its realisation on a fabrication line.

The processes being developed within the ESPRIT programme are very complex and the use of such tools leads to improved development timescales and costs. An example of this type of work is given by EVEREST, project 962, which has improved available simulation tools by adding a 3-dimensional modelling capability. The improved simulator has been used by SGS-Thomson during the development of a 4Mbit EPROM to assess the effects of the interaction of closely packed neighbouring devices, essentially a 3-dimensional problem. It is estimated that the EVEREST tool saved several manufacturing loops and reduced the product/process development time by at least six months.

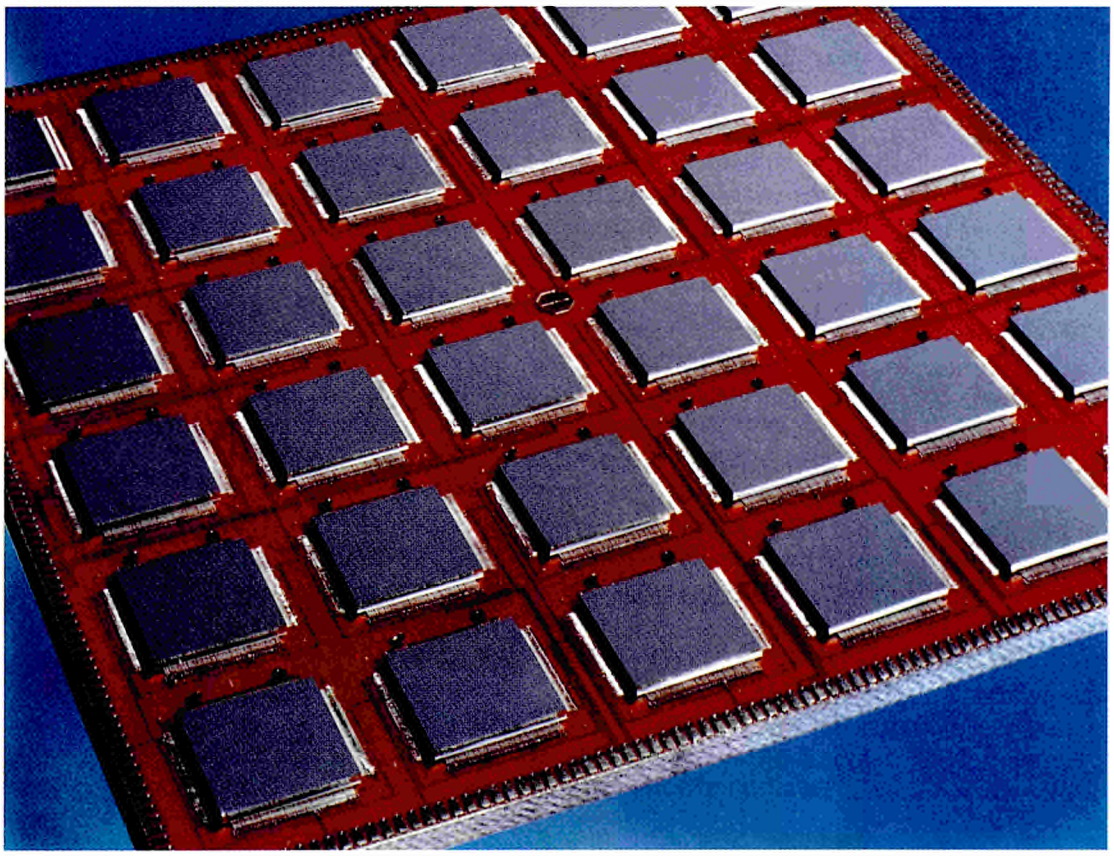
Related work has been initiated in STORM, project 2197, which has the objective of further improving the accuracy of the process simulation techniques, while including procedures for device optimisation. The project involves eight companies and institutes and is connected to a number of ESPRIT process development projects such as the BASE project.

Improved measurement techniques are also essential to optimising the process development cycle times. Project 519 perfected a specific technique, known as "Spreading Resistance Measurement", for producing accurate determination of dopant profiles. The technique is now being exploited commercially by a spin-off company (Semiconductor Assessment Services) which is regarded as providing one of the best services of this kind in the world.

VLSI Packaging

In order to gain maximum benefit from new technologies it is clearly necessary to create compatible packaging and assembly schemes. These packages need to be able to accommodate both high pin count functions as well as handling high speed signals without degradation.

The VLSI packaging project, 953, has achieved all the goals established in 1986, by demonstrating bumped chip Tape Automated Bonding (TAB) and multi-layer stripline interconnect technologies. The demonstrators produced by Bull and GEC have included de-



Multichip laser drilled system board carrying 284 pin chips at 125 micron pitch. Silicon occupies 36% of the board area which is approximately five times more dense than with traditional packaging techniques.

vices with up to 284, 125 micron pitch, leads per chip mounted on compatible system boards which required 50 micron laser drilled holes. A complete set of design, mechanical and thermal management tools have been developed and also proven in functional demonstrators.

Activities in the packaging field have been enlarged in a new project 2075, APACHIP, in order to cover multi and single chip packaging, air and water cooling systems, package supplies, e.g. TAB tapes and ceramic materials. The goals are also much more aggressive and include a final demonstrator showing surface mount technology with devices having 300-600 pins on an 80 micron pitch.

Compound Semiconductors

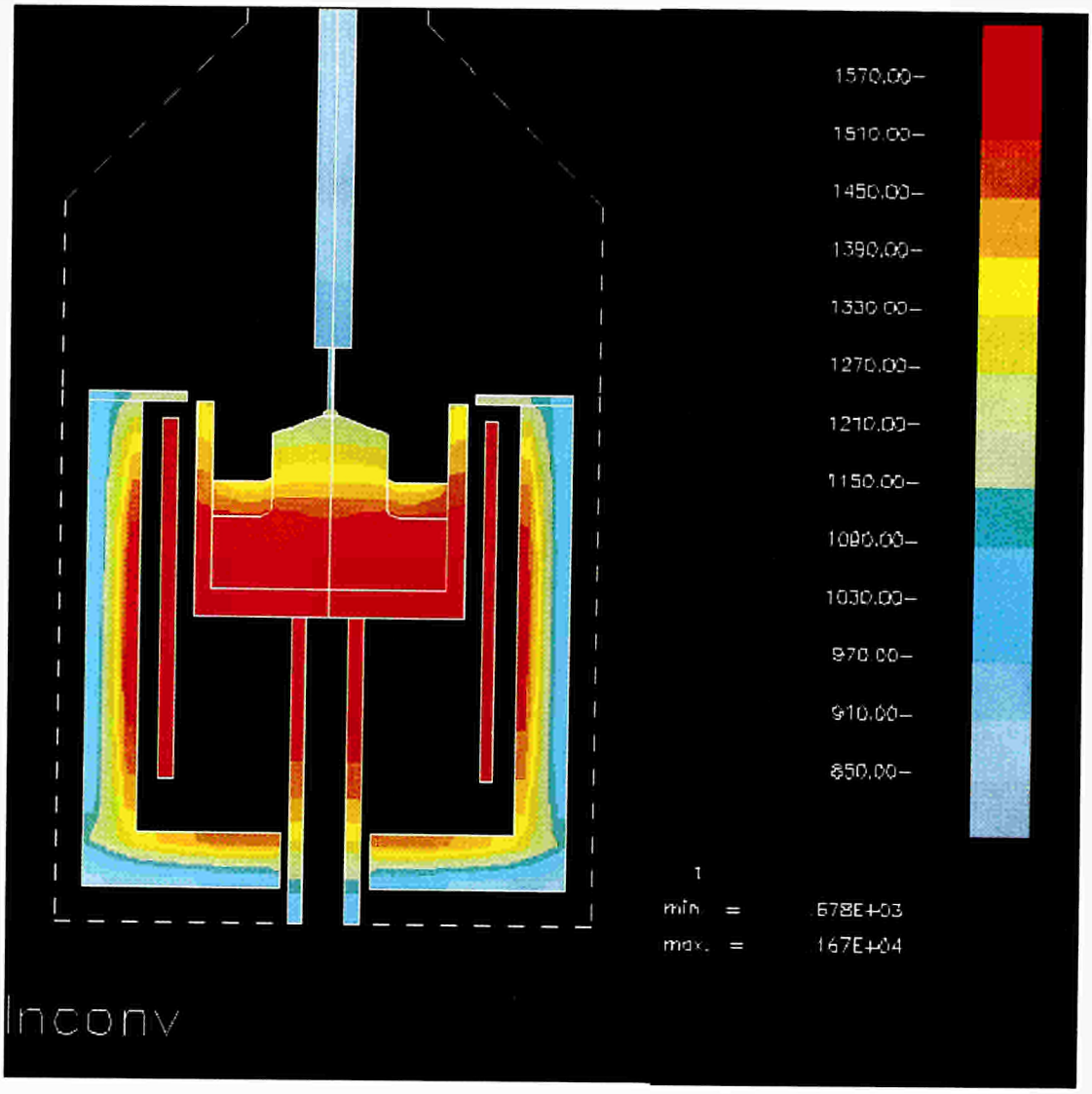
The family of compound semiconductor (III-V) materials has focused mainly on the Gallium Arsenide (GaAs) and Indium Phosphide (InP) based components which offer a number of unique properties compared to silicon such as lower power consumption, higher speed of operation and opto-electronic capability. III-V components are suitable for analogue, digital, mixed-analogue-digital and opto-electronic applications. GaAs is a sufficiently mature technology to yield complex microwave and digital ICs. Discrete optical devices are being used for optical links and compact disc applications. The optical properties of InP make this material system the best candidate for long-wavelength optical communications. Devices based on III-V materials open up a complementary and wide range of applications with respect to Silicon ICs. Although, at present, these devices command a relatively high price their intrinsic properties confer benefits to system manufacturers in the fields of optical communications, radio-links, space applications etc. which are out of proportion to the value of the component itself by enabling full system integration. Their degree of maturity is much lower than for Silicon and as a consequence important research efforts in Europe and world-wide are being made in order to improve manufacturability. As a consequence the price of the devices is expected to decrease over the next few years and as a result the devices will be designed into a wider spectrum of consumer products.

Provision of secure access to these technologies has been identified as a priority in Europe in order to maintain a share of the relevant system markets in communications, computing, instrumentation and the automobile industries. During 1989 efforts in this field have contributed to significant increases in manufacturing yields while maintaining the drive towards higher performances.

Gallium Arsenide

Maturity in the manufacturing process depends strongly on the uniformity, reproducibility and size of the wafers. In the framework of project 1128, Wacker-Semitronic has developed uniform 3" and 4" GaAs wafers. These large diameter substrates are now commercially available, making Wacker, today, one of the most important suppliers in the world. The uniformity is high enough for volume IC production requirements primarily due to a new thermal processing technique developed in the project. The crucial modelling of high volume GaAs crystal pullers was carried out by the University of Louvain-la-Neuve. The software developed in this project has now been made commercially available and is used by Wacker for the modeling of their Silicon pullers. The University of Louvain-la-Neuve is now a world leader in this field and has created a small commercial activity for the exploitation of their know-how.

Another project which contributed towards increasing the manufacturability of III-V devices is project 1270. In this project the Research Centre of Crete has developed a new laser-assisted growth process which has increased the quality of the deposited layers. In fact the quality of the epi-layers is so high that the High Electron Mobility Transistors, HEMT, developed with a gate length of 0.75 micron, have a noise figure of less than 1dB at 12GHz and their lifetime is higher than 10^7 hours. State of the art devices with similar performances use much shorter gate lengths, which can only be achieved by sophisticated lithography processes with a resulting decrease in the yield of the devices. This HEMT process is suitable for high volume production as required in applications such as direct broadcast satellite receivers. Commercial exploitation of this process by a start-up com-



Thermal image of silicon ingot puller from Wacker showing the accurate control of temperature across the wafer as it is pulled upwards from the liquid (scarlet) to the solid state (yellow). (The scale is in °C.)

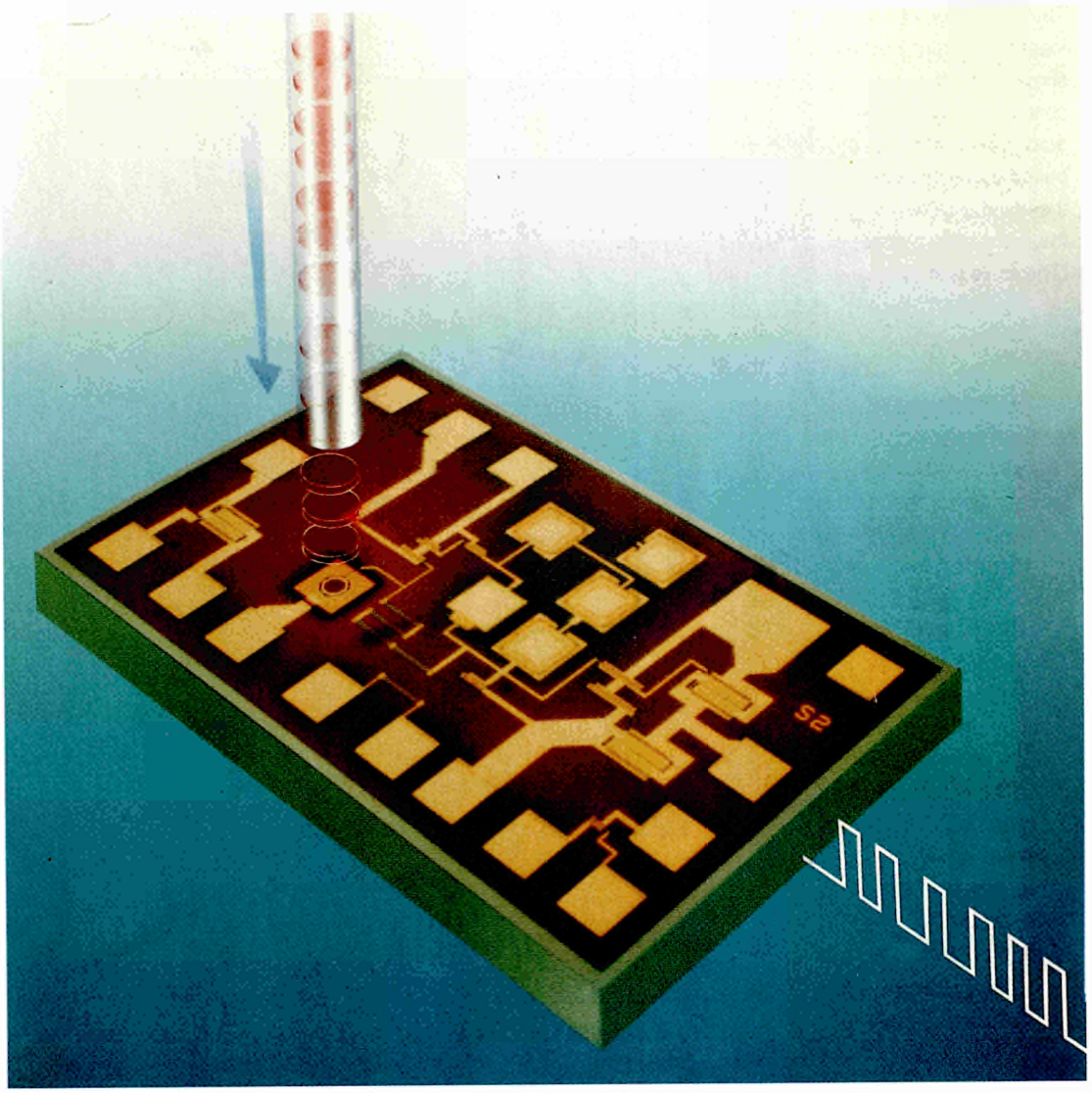
mercial activity in Crete is expected during 1990.

Another example of technology transfer occurring in the compound semiconductor field was within project 971. In this project the growth technology for GaAs Hetero-junction Bipolar Transistors (HBT) developed by CNET has been transferred to PICOGIGA (Paris) an SME involved in commercial exploitation and supply of epitaxial wafers for the world market.

An SME, Aixtron from Aachen in Germany, active in the semiconductor equipment sector, is now world leader in supply of MOCVD equipment for the growth of III-Vs. The contribution of ESPRIT projects 927 and 2518 to this success is certain as the novel growth process developed in the projects is now sold together with the necessary equipment as a package which includes customer training.

Indium Phosphide

In the area of opto-electronics, project 263 is developing the technologies required to integrate both optical and electrical devices on the same chip using a single fabrication process. This technology offers the potential for reduced size, reduced cost and improved performance in optical fibre based communication and information systems. The project has been extremely successful in demonstrating the complete integration of a transistor and laser transmitter, a result which has been achieved by few other companies anywhere in the world. They have also



Schematic of an integrated Indium Phosphide opto-receiver developed by STC which has achieved world record performance at 560 Mb/s.

achieved world record integrated receiver performance figures (sensitivity of -32.7 dBm at 560 Mbit/s) and state-of-the-art integration complexities. These prototype components have been used in an experimental 10 km optical fibre video link.

The major impact for such components is likely to be felt in two major areas. The first of these is associated with the drive to make better use of the enormous information carrying capacity of optical fibres. The full advantage will become increasingly apparent as optical frequency division multiplexing techniques are used to achieve multi-gigabit data rates. The second area is in the realisation of fibre-to-the-home systems where cheap components will be required to make the installation cost competitive with copper.

Process Equipment

From the 1988 ESPRIT call for proposals, it became evident that the Semiconductor Fabrication Equipment (SFE) sector had become the object of particular attention, in recognition of its strategic importance. The equipment market is currently about 10% of that for ICs, but its importance is amplified by its enabling characteristics. The rapidity with which IC generations (and associated packing densities) succeed each other gives advantage to IC manufacturers having early access to the most up-to-date processing equipment. Hence, the urgently felt need to assure a European sourcing base for such types of equipment.

At the beginning of 1989, five new projects

were launched in the domain of SFE under ESPRIT. Two are involved with Advanced Lithography, two with Multi-chamber/Multi-process equipment, and one with Advanced Etching processes. The ESPRIT MEL call of Autumn 1989 added six new equipment projects, four concerned with lithography and two in the area of Multi-process/Multi-chamber equipment.

Lithography Equipment

ESPRIT provides a comprehensive coverage of all the main aspects of advanced lithography. This coverage includes equipment, materials and the related processes for deep UV steppers, metrology, E-beam lithography, reticle processing and handling.

A wafer stepper is one of the most strategic types of equipment which allows IC manufacturers to imprint, in volume production, the microscopic patterns that define the ICs on the surface of the semiconductor wafers. At present minimal feature sizes in production are in the 0.7 micron region and are expected to reach 0.3 micron by 1995 in state-of-the-art memories, with ASIC applications following close behind.

While the capabilities of present generation g-line and i-line steppers (the names denoting

Deep Ultra Violet stepper equipment from ASM-L.

the wavelength of the light used for the illumination) can probably be stretched to 0.5 micron features, new techniques will have to be developed for the range below this scale. The use of deep ultra violet light for illumination poses formidable problems principally in the lens optics, precision of alignment, resist materials, and clean-room adaptation. All these aspects are being tackled in project 2048. Within the first year a prototype lens has been fabricated by Carl Zeiss and delivered to ASM-L where it has been installed on a prototype machine for testing. Significant progress has also been made in constructing the through-the-lens alignment sub-system, whilst on the resist front suitable mono and multi-layer resists have been developed by Hoechst and Siemens, respectively. IC manufacturers Siemens and Philips are closely involved in the project as potential users of the developed equipment and materials. LETI at Grenoble, the University of Edinburgh and FhG-IPA at Stuttgart are also providing their expertise. This work on resists is complemented by DRYDEL, project 2265, which is extending a technique called DESIRE to cover the deep UV region.

Multi-Process/Multi-Chamber Equipment

The increasingly stringent constraints on the quality of thin films constituting the ever more miniaturised ICs designate a new trend in wafer processing: the grouping together of many related process steps which are performed in a sequential fashion in several clustered vacuum processing chambers, with the wafer transfer between chambers also taking place under vacuum. The current practice is to perform the various steps in separated pieces of equipment with consequent degradation of overall performance and yield, but it is believed that with feature sizes of 0.5 micron and below the use of multi-process/multi-chamber vacuum sealed equipment will be a necessity for certain critical process steps. This approach requires new equipment designs and the development of modified and/or new processes.

McBRIDE, project 2403, which includes ASM-L, LETI and ST, is developing a multi-chamber batch reactor in which inter-poly silicon oxide and silicon nitride films, combined in a so called ONO configuration, can be produced in one reactor system. The ONO films will be implemented in the floating gate structure of 1 and 4 MBit EPROM circuits. It is also planned to process the APPB project test structures, incorporating both EPROM and EEPROM, at ST. In the first year of work, several system modules have been designed, manufactured and tested by ASM-L, including, HF cleaning modules, LPCVD reactors, robotic wafer handler and elevator units. These equipments are now being assembled into a prototype system.

Process Automation

The requirements and concepts needed for efficient ASIC manufacture are driven by Automated Manufacturing System (AMS), project 1551. This has tested software packages and developed experimental tools in both the large manufacturing facilities of ST (in France and Italy) and a smaller facility of Marconi (UK), in order to demonstrate the potential benefits and to define specifications for interfaces and communication protocols needed by the European equipment, automation and software industry.

The two major elements in the automation of integrated circuit facilities are data processing and material handling. The first is essentially the management of complexity. A production facility can have up to 50 different process flow charts to process a lot of wafers, each composed of 200-300 separate operations performed on one of 100-150 different items of equipment which are capable of utilising a range of different process recipes. The total work in process can include up to 1000 separate wafer lots distributed across the wafer fab. The project partners have experimented with current Computer Aided Manufacturing (CAM) systems and are now in the process of deriving detailed specifications. The second major item involves the use of robotized handling to reduce particle generation or when difficult physical conditions occur, such as at high temperature (furnaces) or when hazardous chemical processing is involved. The AMS partners have performed experiments with robotized handling in the process steps most sensitive to particle contamination which are photolithography and diffusion. The results obtained are very attractive in respect of contamination and yield improvement.

Peripheral Devices

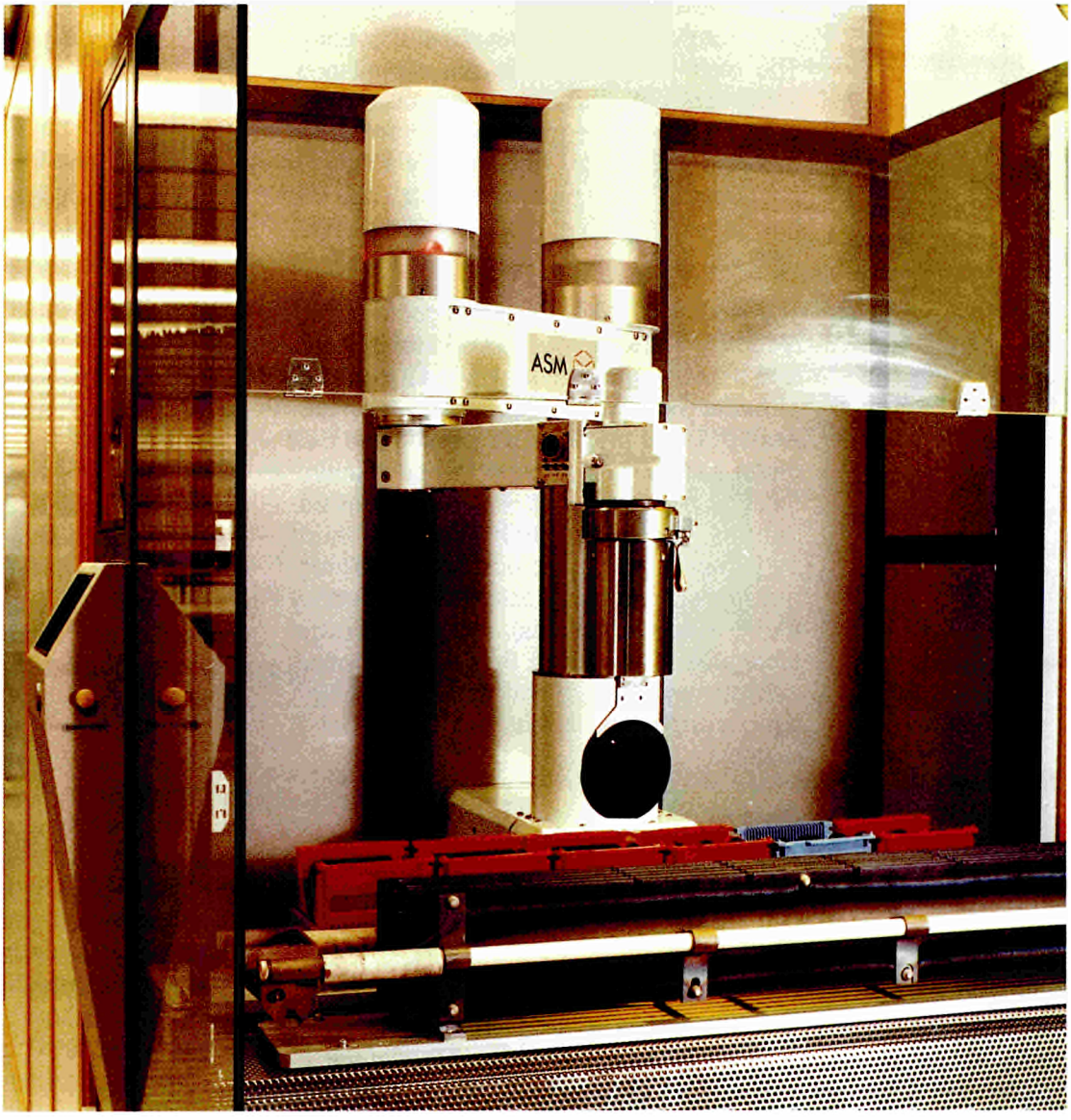
1989 marked the effective start of work on peripheral devices. The four ESPRIT contracts deal with materials studies, mainly for optical/magnetic recording and for Liquid Crystal (LC) Displays using thin film transistors. Now the results of these projects are to be exploited in the new projects that are to deliver first prototypes of devices that will be demonstrated from 1992 onwards. They include A4 size flat panel displays using both multiplexed and active matrix technology, high capacity magneto-optic 5.25" disk drives, improved electro-thermal printing heads and ribbons, and improved magnetic tapes for high density data storage.

Flat Panel Displays

The emergence of new market opportunities for high definition colour flat panel displays for use in portable computers and High Definition Television systems, push the world-wide component industries to increase their R&D efforts in the field. There are currently two teams working in this area.

The first, project 2283, on active matrix liquid crystal, whose partners developed deposition know-how for both amorphous and polysilicon layers, characterised by low temperature deposition processes (suitable for glass substrates) and the realisation of small area pixel and drive transistors. The consortium, whose industrial partners include AEG, GEC and

Robot wafer handling at SGS-Thompson.



Eurodisplay, aim to produce an A4 format full colour display with 16 grey levels by 1992.

The second, project 2360, is oriented on ferro-electric liquid crystal material studies. Large multiplexed panels with both high contrast and switching speeds can be achieved by using the bi-stability of these materials. The goal of the projects is also an A4 multiplexed full colour display by 1992. Ten partners are involved in the project, including Merck and BDH who have a strong world-wide position selling Liquid Crystal products. An early spin-off of the project has led to the marketing of a complex waveform generator.

Mass Memory Systems

Early ESPRIT projects dealt with material studies for longitudinal and perpendicular magnetic recording and studied head and disk technology for magneto-optical recording. The main results include the definition of equipment and processes for sputtered deposition of both the magnetic and protective coatings suitable for high density floppy or hard drives. These results are being used in a new project aiming at producing a one gigabyte 3.5" drive.

The results of the work on magneto-optical recording methods utilising metals and ferrites with a carbon protective layer are the subject of further research work carried out by project 2013. The project is developing two disk drives each aiming at performance improvement by a factor of four. The technology advances needed to achieve such high performance devices include: enhanced magneto-optical recording techniques (especially the re-writeable features), integrated optical technology (small and light-weight optical heads), new magneto-optical media and high performance mechanical and servo-control systems.

Call for Proposals 1989

A new Workprogramme was prepared in the first quarter of 1989. It was intended as a tool for indicating the main technology directions for the collaborative work resulting out of the 1989 call for proposals. It included a list of the topics that were perceived as fundamental to achieving the objectives of the programme with reference to the technical issues which need to be addressed. The call was focused into three areas:

Technology

In this area, the main topics identified were 0.5 micron CMOS for ASIC applications, silicon-on-insulator 0.5 micron CMOS and High Speed GaAs-based ICs.

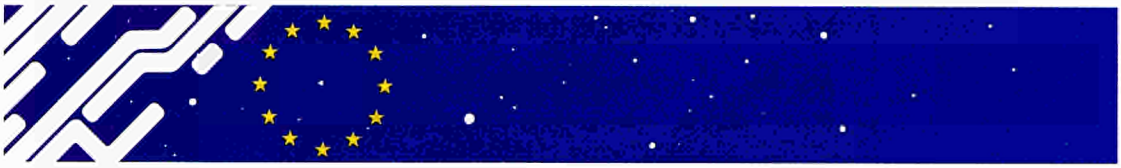
Equipment and Automation

The topics selected for inclusion were multi-processing multi-chamber systems, automated lithography stations, fast reticle generation and automatic wafer metrology. Success in this area will allow the equipment suppliers to satisfy a greater proportion of the European market and to become competitive on a global scale.

Peripherals

The topic identified here was magnetic disk storage, the objective being to demonstrate the feasibility of advanced disk drive components and to implement them in a new high capacity small form factor hard disc drive.

Even though the call was sharply focused 56 proposals were received requiring resources of about 550 MECUs. The size of the response was in line with expectations, representing a request for between two and three times the level of resource which could be funded under the call. Many proposals were aimed at the central theme of enhancing European ASIC capabilities and a number were retained in this category. The interest shown in this call for application oriented III-V semiconductor work was significant and demonstrated a growing awareness, in system houses, of the potential of III-V ICs for high frequency applications in the communication sector. In the equipment area the consortia enabled by ESPRIT will form the necessary critical mass of effort for the development of the next generation of products. Success in this area is crucial for the whole microelectronics industry.



Information Processing Systems

Overview

The work in Information Processing Systems (IPS) aims to provide the underlying and generic technologies which will support the development of IT products which will be on the market during the next decade.

These technologies include:

- advanced systems architectures, where the work is leading to significant improvements in the cost/performance ratio of high performance, multiprocessor systems;
- knowledge based systems, where methods of representing knowledge and constructing rule based systems have application in most IT sectors;
- those relating to system design, where the emphasis is on putting the entire software development process onto a sound engineering footing. By providing better methods of specifying requirements, better development tools, new quality measurement techniques and standard ways of managing development, improvements will arise throughout the software industry in terms of both productivity and software quality;
- signal processing systems, in which large quantities of complex data have to be recorded and analysed in real time. Speech and vision systems are notable areas of application of signal processing technology.

Significant advances in parallel computing, knowledge based systems, system design and sensor based systems have been made in 1989. Instances of the creation of spin-off companies or the launching onto the market of products derived from ESPRIT results are becoming increasingly numerous.

1989 also saw the initiation of measures aimed at increasing the skills base in European universities and research institutes for subsequent transfer to industry. As well as actions in the parallel computing field, further steps are being taken to encourage more widespread use of the best software engineering tools and methods. 47 new projects were added to the existing portfolio as a result of ESPRIT II's first call for proposals, most of which commenced in 1989.

As well as continued emphasis on generic technologies, two strands can be identified within the new activities. A particular effort is being made to support those prototypes, methods and tools which have already demonstrated excellence and potential for market success. For example, work to enhance advanced computer architectures with comprehensive software facilities are contained in important follow up, consolidation projects.

Second, new research areas are being explored, of which the behaviour and potential of multi-processing systems which behave like the human brain (so called "neurocomputing") is an important example.

The IPS area of ESPRIT addresses two critical concerns for those engaged in developing advanced IT systems.

The first is the development of a range of generic architectural and software technologies required for the production of IT products capable of world class competitiveness in the 1990s.

The generic technologies addressed within IPS (e.g. a methodology for KBS development, algorithms for 3-D vision, etc..) are applicable to a broad spectrum of problems. Relatively slight expenditure of resources on

these technologies produces a strong "multiplier effect" in terms of market impact.

Another aspect the IPS area has sought to encourage and develop is the effective integration of a wide range of technology components. Care has been taken to carry out research and development to create effective platforms of development (e.g. software environments, or low-cost, high-performance parallel systems) which have gradually been made available to the developers.

The second concern within IPS is the management and control of system complexity, reducing development and operational costs. Quality, reliability and performance must be continuously improved in the context of a market place which demands products of ever increasing complexity.

Activity has been focused on four main strands of techniques (Advanced System Architectures, Knowledge Engineering, System Design and Signal Processing Systems), each characterized by a distinct combination of market potential and challenging technical problems. Progress recorded in these sectors has undoubtedly contributed to advancing the state of the art and opening up new market opportunities.

Of the 137 projects currently in hand, 55 were demonstrated during the 1989 ESPRIT Conference. Project results are having an impact on the market either directly as products or through further application developments in manufacturing, office automation, telecommunications, medical or transportation systems.

Activity in IPS is now entering a new phase which has two aspects:

(i) Consolidation. Techniques and methods developed in many projects are now reaching levels of completeness and maturity. Some derived products are occupying interesting positions in a number of market segments, usually where high performance and high quality prevail. Some success stories (transputer T800, Supernode machines, PCTE-based products) have been recorded, which are generating significant and substantial sales.

    A particular effort has been made in the past year to stimulate conditions critical for success. Communities of projects have been fostered (e.g. by holding workshops on environments, parallel systems or vision). Views from these permit project goals to be reassessed in the light of market evolution. Projects which bring together all the work in a particular field have been launched for example in the areas of software certification and European speech processing. A series of accompanying measures designed to transfer knowledge of advanced technology emanating from ESPRIT more widely have also been taken, for example through the parallel computing action.

(ii) Continuing Research. The marketplace is changing rapidly. Development of new technology has to occur against severe time constraints. New techniques can be converted into products very rapidly once they have reached a critical stage. Neurocomputing is one such example, for which some applications are already operational, whilst the theoretical foundations of the discipline are still in their infancy.

    This time pressure, together with the need to investigate new but potentially rewarding combinations of technologies and ideas, justifies the careful attention being paid to some extremely innovative paths, which it is hoped, will later on enter the consolidation phase themselves.

Advanced System Architectures

Technology forecasts suggest that the cost/performance ratio for high performance systems will continue to decrease dramatically. This can only be achieved by systems which are scalable in size and technology.

Scalability in size comes from modular architectures, where processing units can work concurrently. Scalability in technology relies essentially on the introduction of ever more powerful microprocessors and interconnection networks. Both aspects are two sides of the same coin, which has fundamentally to do with the notion of *parallelism*.

To this end, actions have been adopted in the architecture sector, all converging towards the

strengthening of a technology based on parallelism in Europe. A standard component (the transputer) has been improved and intensively studied in several projects. Prototypes have been built to test and optimize the necessary trade-offs, and on a longer timescale, the skills problem has been directly addressed.

Commercial exploitation of this new potential is the responsibility of industry, and there are good reasons to believe that the European IT industry has already started to take up this task, as the success of the Transputer and the Supernode machines exemplify.

Work on parallel computing architectures addresses efficiency and cost effectiveness. Another area of the utmost importance concerns security, reliability and fault tolerance. Early on, it had been decided to pay attention to these problems, for which new solutions are now being proposed.

Lastly, as the Neurocomputing case will illustrate, the strong focus on techniques with immediate commercial potential does not mean that more speculative and longer term issues have been neglected.

Transputer and Supernode success stories

ESPRIT has been instrumental in supporting the development of new versions of the transputer, Europe's only 32 bit microprocessor family. Faith in this technology has been justified both by outstanding technical results, and also by the manner in which commercial exploitation is accelerating. The transputer has now been selected by design teams all over the world, including Japan. This component is at the centre of many types of applications, ranging from simple add-on boards for embedded systems to high-end scientific workstations. In this latter market segment, two companies, Parsys in the UK and Telmat in France, are now offering Supernode-based machines, as a direct commercial follow-up of the Supernode project. In order to facilitate the acceptance of these machines, further software developments are now underway.

Parallelism, hardware and languages

Many general purpose computational tasks have a structure which does not make it easy to exploit the full potential of parallel machines. Therefore, considerable effort has been devoted to developing new computational models, in particular for those languages which are used in the most advanced symbolic applications, namely LISP, PROLOG, and object-oriented languages. "Language-first" prototype machines have been built to explore these architectural concepts. PALAVDA, project 415, has developed a 100 node machine, supporting the parallel object-oriented language, POOL. In PADMAVATI, project 967, novel memory arrangements have been developed to run LISP and PROLOG efficiently. A machine derived from the ESPRIT work is being marketed for signal processing applications.

ESPRIT Parallel Computing Action

The ESPRIT Parallel Computing Action is designed to help develop the necessary skills and to push forward the state of the art in several key areas of the technology (basic software, programming tools, environments and applications). The initiative aims to improve interaction between European computer development and software engineering activities; to encourage innovative contributions from academic and research organizations; and to build up practical awareness of parallel computing among undergraduates and graduates for subsequent transfer into industry.

A competitive call for proposals from academia and research centres was issued in February 1989. Out of the 188 submissions, 55 were selected. Each of these has been granted state of the art parallel equipment for experimentation. Project participants will be required to attend twice-yearly workshops to disseminate the results of their work.

Fault-tolerance - a commercial niche

Like parallelism, fault-tolerance is a pervasive concept which has a considerable potential for commercial spin-off. Entirely dedicated to this technology, DELTA 4, project 818, has been completed and has delivered an interconnection equipment for heterogeneous systems. A significant achievement is a software environment with which to develop fault tolerant distributed systems. The design methods and the resulting systems are now

being tested in a subsequent project in a manufacturing organisation (Renault) and in a banking environment (Crédit Agricole).

Opening up new horizons: Neurocomputing

It is a strength of ESPRIT to be able to sponsor the most innovative ideas. Neurocomputing which is concerned with computer algorithms or hardware which mimic the human brain is one such technology. It has the potential to offer a cost and performance effective alternative approach to some classical problems (especially in the field of pattern recognition); it may also enable new classes of problems to be dealt with.

To explore these possibilities, two projects have recently been started within ESPRIT II addressing neural networks. PYGMALION, project 2059, is creating a European technological base for neurocomputing, whilst ANNIE, project 2092, aims to find out which of several problem areas are best approached using neural networks. It will, for example, consider the recognition of ultrasonic images in non-destructive testing (such as in many medical applications), and the parallel signal processing of acoustic emission from multiple transducers (such as in turbines).

Knowledge Engineering

During the 1990s and beyond, information systems will exhibit increasing characteristics of so-called artificial intelligence. This will be particularly characterized by the ability to handle knowledge rather than data and to be much more responsive and helpful to the human who wishes to use IT systems.

Knowledge Engineering techniques can be applied in most IT sectors. It has therefore been a priority for this sector to maintain a continuous flow between upstream R&D and industrial exploitability, which calls for the provision of an adequate set of techniques and tools to build such systems.

What were, a few years ago, only fundamental theoretical works on Prolog or expert system shells for example have now developed into fully-fledged industrial products.

Needless to say, the technology has been extensively put to test. Several projects have sucessfuly demonstrated the usefulness of knowledge engineering in a variety of commercial and industrial applications.

European platforms for developing A I systems

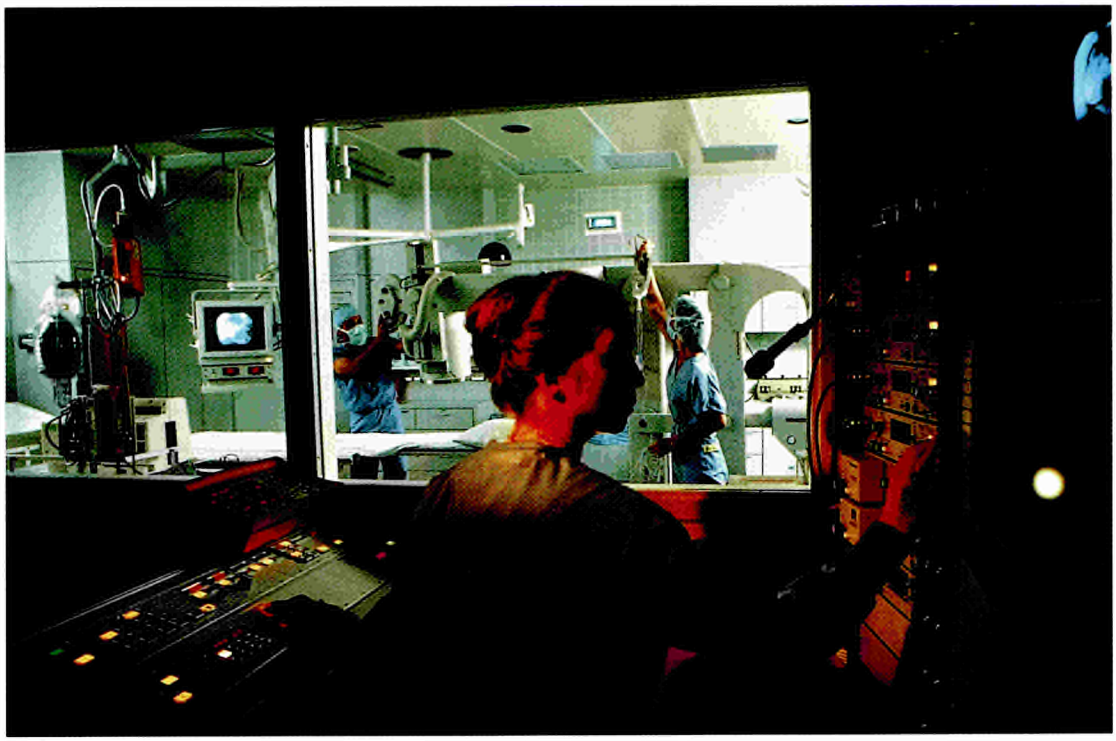
Logic programming languages are particularly suitable for knowledge engineering since their structure maps closely to the structure used for formulating the rules which guide and control such applications. Europe has an acknowledged leadership position in such languages. BIM-Prolog which evolved from the work of LOKI, project 107, is one of the most complete and efficient versions of Prolog in the world. New advances to the language, such as arithmetic operators, inequalities and constraints are included in Prolog III which was launched in October 1989. This was developed in part within project 1106. Prolog III has already been integrated within industrial prototypes at Bosch and Daimler-Benz. The latter have built a system using Prolog to test and diagnose faults within electronic ignition systems.

Successful results have also been achieved in providing knowledge based System Shells. In 1984 all such products were marketed from the USA. Now, following the commercialisation of the results of ESB, project 96, a product, ESB-96 is on the market as a European alternative which is faster and lower cost than its American competitors.

ESB-96 provides a complete environment for developing expert systems. It combines object oriented programming, advanced modelling techniques and rule based reasoning systems. It is available to industrial participants within CEC funded programmes for 10,000 ECU. Applications have been found in road traffic flow analysis, electronic system design and the optimisation of resources within power station operations.

Testing the technology: numerous applications of knowledge engineering evaluated

At the start of ESPRIT, not only were knowledge based systems relatively scarce but the extent to which they could be applied to real situations was also unknown. ESPRIT projects have explored the applicability of this technology in fields such as:



Results of TAO are being used to support doctors' decisions on cancer treatment in four European hospitals.

- medical diagnosis;
- financial portfolio management;
- industrial process control;
- interpretation of legal documents;
- satellite control;
- manufacturing process planning.

TAO (both the Chinese word for healing and the acronym for "Therapy Adviser for Oncology"), project 1592, has built a system which now has the support of ten experienced medical practitioners in the U.K., France and Spain. The system stores details of the patient's history, clinical symptoms, pathology laboratory test results etc. A treatment protocol is decided when the diagnosis has been made. This may have to be amended over time as further test results become available or if evidence of side effects arises. The rules which govern the application of the patient protocol are incorporated into a knowledge base so that the system can offer advice about possible alternative treatments and can provide prompts at the right time for a drug to be given.

MUMP, project 865, creates a detailed list of the sequence of manufacturing operations which are required to create a given machined part (for example a rib in an aircraft wing). The preparation of such a list, starting simply from drawings of the component to be made would typically take a trained professional one or two days. MUMP can produce a suitable list in well under an hour and, indeed, will produce alternative sequences if feasible. These can be used directly on the shop floor to fabricate the part.

The MUMP demonstration contained about 400 rules describing how to machine the part plus 200 objects which embodied the process operations available on the various machines within the factory.

This project was typical of successful projects in the Knowledge Engineering evaluation area in that it contained an experienced and co-operative user (Alitalia) and industrial partners with a keen interest in exploiting the results. Italcad will sell a system based on MUMP, Elsag are using the results within their own factory and Battelle will exploit the expertise they have gained in their general system consultancy business.

Yet another example of a result from an ESPRIT knowledge engineering project being commercially exploited comes from KADS, project 1098. The software technology from this project is being used at Barclaycard Visa to detect credit card fraud which currently costs an estimated £12 million per year. A database of an individual's historical pattern of use is established. It classifies usage by type of store, location, amount, frequency etc. The rule based software considers whether recent patterns of use (over the last one or two days) are consistent with the history. In this way a short list of perhaps 1000 possible fraud situations can be located amongst a population of several million card users.

Real time process control

QUIC, project 820, has developed software which represents knowledge of various types (e.g. procedures, the physical structure of systems, rules with uncertainty). The project has also developed some novel inference techniques for reasoning and decision making. This overall toolkit of software has been validated in three applications each under the control of different industrial partners.

Ansaldo and CISE are evaluating an application in a thermal power plant. The system detects the state of, and malfunctions within, a steam condenser. It then deduces the primary cause of the problem and advises the operator. F.L. Smidth have completed an evaluation of on-line monitoring and control of a cement manufacturing plant. Framentec have been using the technology for interpreting data received from a satellite. The system can diagnose fault conditions and provide assistance with correction manoeuvres. Following some further development work sponsored by the French Ministry of Space, the QUIC results will be used in this application.

System Design

Within IT systems, the software component is becoming the dominant element of cost, moving from approximately 45% of cost at the beginning of the decade to just short of 80% in the early 1990s.

From the outset, emphasis has therefore been placed within ESPRIT on the need to improve productivity and quality in the software industry. Work in the System Design sector has focused attention on developing improved methods, providing new tools to support these methods, and establishing a "standard" framework within which these tools can be deployed to support project teams engaged on producing software for different applications.

More recently, this technical infrastructure has been complemented by a project which is considering European software certification procedures.

PCTE continues to gather momentum

The ESPRIT Portable Common Tools Environment cluster of projects is continuing to prove a success. The work on PCTE is intended to help solve the recurring problem of how to produce better quality software more productively.

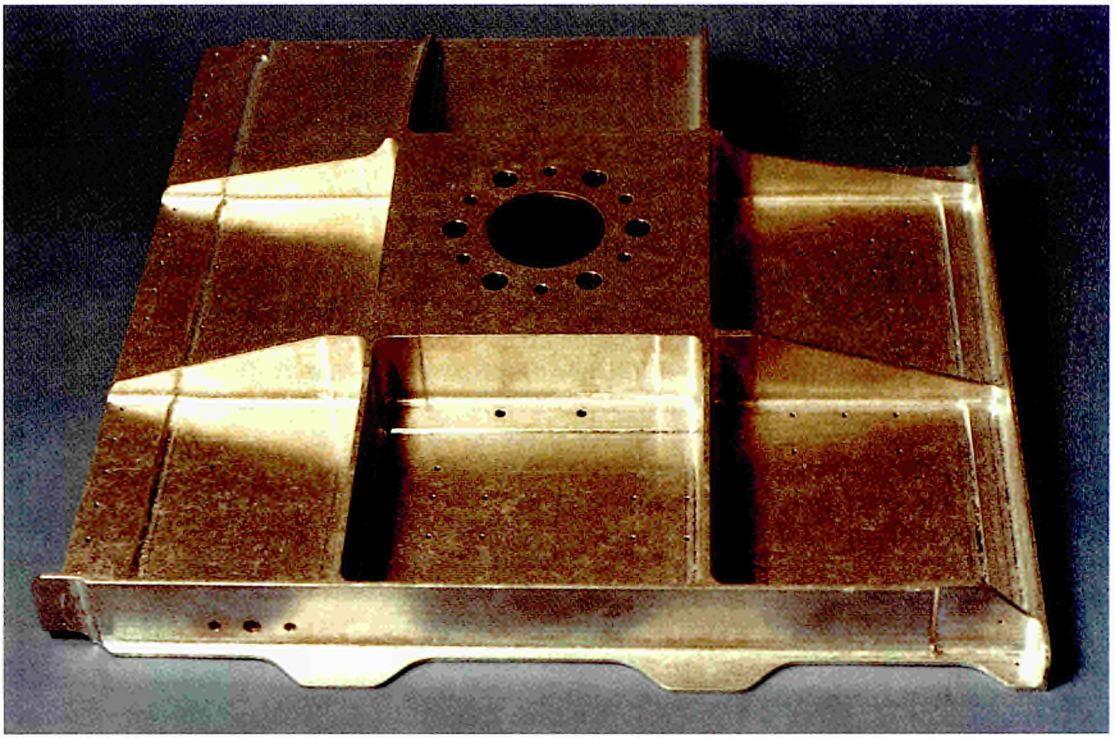
PCTE, project 32, created the original infrastructure for a software development environment, whilst PACT, project 951, is primarily concerned with the development of the tools which populate this infrastructure.

As long ago as 1987, PCTE was available in both C and ADA language versions.

By 1988, a PCTE package had been distributed to over 150 universities, and over 200 licenses had been released. It had become available on a variety of workstations (Bull SPS7, IBM PC/AT, DEC, Hewlett-Packard, Sun..). In addition, the first versions for non-Unix based machines became available.

Over the last year, projects enhancing the functional scope of PCTE (e.g. GRASPIN, project 125, SAPPHIRE, project 1277) have achieved results building both tool based and methodology based environments on PCTE. The work of porting PCTE to the equipment of a wide range of suppliers has continued. Efforts to make PCTE into an international standard have progressed to the point where it will become an ECMA (European Computer Manufacturer Association) standard in 1990.

In Europe, sales continue through GIE Emeraude in France and IPSYS in the U.K. Elsewhere, both DEC and Apollo have announced plans to bring PCTE into their standard product offerings. The French Ministry of



Knowledge engineering techniques developed in Project 865 reduced the process planning time of this aircraft part from 12 hours to 30 minutes.

Defence has defined and sponsored a PCTE based environment, for use by the aerospace industry and other major French defence contractors in the development of future systems. At the same time, there is now a body within NATO sponsoring PCTE+ , a security-enhanced version of PCTE.

At this stage, it has become clear that PCTE has much to offer in the industrial production of large, complex and software-intensive systems. Moreover, by means of its inherently modular and standard approach, PCTE and related projects provide operating system independent tools and environments that allow mixing and matching of Computer-Aided Software Engineering (CASE) tools to meet a user's specific needs.

Increasing the use of formal methods

The correct design and realization of software intensive systems is of growing importance with the increasing pervasiveness of such systems in all aspects of society. This is particularly true of areas which are safety- or cost-critical. Formal methods have emerged to facilitate the expression of system requirements and design in a consistent and rigorous manner.

RAISE (Rigorous Approach to Industrial Software Engineering), project 315, has made significant contributions to the Vienna Development Method (VDM), which is a technology enabling specifications to be formally proven to be correct. By and large, formal methods have found application in situations such as nuclear power station control (where safety is paramount), VLSI chip design (where the value of getting the design right at the first attempt is high), and in telecommunication protocol software (where the specifications lend themselves quite easily to the use of formal methods).

The major industrial partners in the project, STC and CRI, are both using this new technology, which has generated considerable interest within the microelectronics and computer community in the U.S.A. STC Technology have used the results to describe certain aspects of ICL 3900 mainframe computer functionality. Having done so it has been possible to consider alternative designs which achieve greater functionality at lower cost. CRI are using the results to specify the control system for a Danish X-ray telescope which will be part of the payload of a satellite to be launched in 1992.

On the Telecommunications side, SEDOS, project 410, has brought considerable improvement to the specification of complex services and protocols, which were traditionally written in natural language. This imprecision was the source of lengthy and ambiguous specifications, which led to error prone implementations in software and hardware.

The International Standards Organisation has approved two standards on formal description techniques, one for Estelle, the extended state transition language and one for LOTOS, the language for temporal ordering of specifications. Both language developments were actively supported by SEDOS.

The project also demonstrated the effectiveness of these techniques: Estelle was used to produce specifications of the open system network, transport and session services (layers 3, 4 and 5 of the OSI model), and LOTOS was shown to be applicable to eleven different communications standards.

A small French company, Verilog, has had considerable success in the software quality assurance market and in commercialising versions of Estelle enhanced with ESPRIT results. The managing director recently received an award as "Manager of the Year" of a high technology small business.

Towards a European software certification procedure

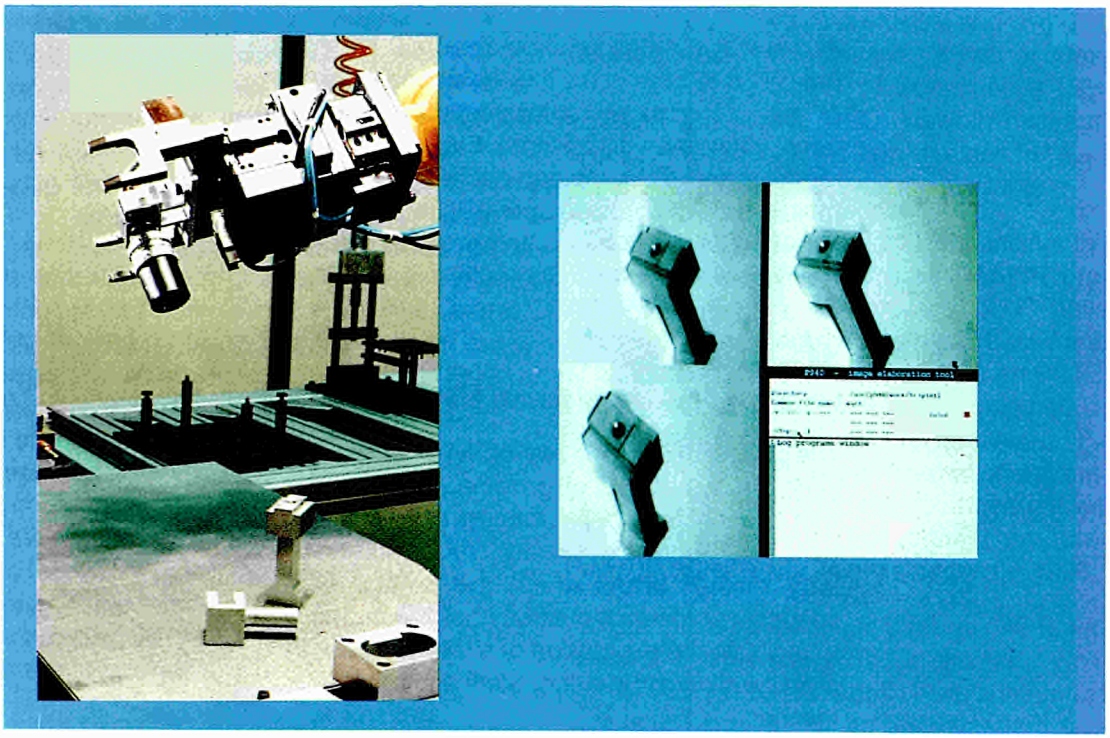
The aim of SCOPE, project 2151, is to support supplier/customer relationships throughout the internal market by facilitating product certification. Product certification will assist customers in the selection of IT products, and clarify the legal position of suppliers.

The project aims to demonstrate the feasibility of a European software certification procedure, applicable to all types of software, acceptable and legally recognized throughout Europe. SCOPE is therefore industrially important in the harmonization of European standards.

Signal Processing Systems

From highly complex signals to sophisticated interpretations

With the advent of Digital Signal Processing techniques rapid improvements in technology have occured bringing with them corresponding increases in the potential for market exploitation. Importance of work in this area is



This vision system, developed in Project 940, works with edge detection, edge linking and stereo matching hardware and software to determine object positioning and orientation with great accuracy.

significantly enhanced by crossfertilizing links with other areas of Information Technology, notably Computer Architecture and KBS.

These types of systems are characterised by the necessity to record and process a large range of complex signals, reflecting various characteristics of the external world, under the general and pressing constraint of time. Their complexity stems both from the heterogeneity of the signal sources and channels, and from the "noise" inherent to any non-strictly controlled environment.

Of outstanding importance are achievements in computer vision and speech technology. Not only have these technologies advanced but a community of teams, necessary for achieving more generic solutions, has also been encouraged.

In parallel with these undertakings, research with longer-term objectives has also been successfully conducted in the field of optical computing.

Work on computer vision leads to marketable products

With the advent of powerful and low-cost processing capabilities, computer vision systems have become capable of performing sophisticated algorithms and thereby interpreting complex images, ranging from medical applications to the visual inspection of manufactured goods. Many issues need to be resolved to interpret the most relevant available clues in the shortest amount of time, including those from three-dimensional or moving scenes.

DMA, project 940, is concerned with the development of a robust, trinocular stereo system for both static and mobile camera platforms. The application of such vision systems are numerous. They include the control of robots which can pick items of various dimensions up in the correct orientation even when the items are randomly oriented. Another application enables a robot to navigate within a complex three dimensional environment. For all these applications, common requirements placed on the system are effective extraction from images of important features and high-quality 3-D reconstruction.

The project has provided innovative solutions to these problems, and has developed algorithms to carry out various steps in object identification. These have been embedded in special purpose digital signal processing hardware in order to demonstrate the techniques at acceptable speeds. It is a credit to the quality of the collaboration within project 940 that printed circuit boards from different partners work together on a common task. Hardware was developed for edge detection (University of Genoa), edge linking (Elsag) and stereo matching (Matra).

Robots that see, visually equipped vehicles that steer themselves and computers that read handwriting and recognize signatures are typical examples where the near-instantaneous coordination of artificial vision and movement are important. IMU, project 419, has been working on the basic software needed, with technical inspiration derived from studying human coordination mechanisms. The software packages developed include MAVIS, which provides research workers and teachers with a cheap, versatile and easy-to-use set of image processing routines.

One partner is marketing these tools, which run on a standard personal computer. Competitive products exist from the US but usually require a larger environment in which to run or, after adaptation to a personal computer, run considerably more slowly. Another partner is incorporating the results of the project into complete security systems.

In addition to the work normally going on within these projects, three computer vision workshops have been organised during 1989. These have stimulated the transfer of ideas and results between workers in the field.

Speech processing

Speech processing, is becoming an important technology. Products incorporating speech synthesisers are already on the market whilst work to develop systems which recognise and understand speech should lead to products in this decade. SAM, project 2589, was launched during 1989. This project will play a central role within the speech processing community by providing standard techniques for assessing the quality of both synthesisers and recognisers in eight different languages.

Optical computing

Most signal processing is carried out electronically. An alternative is to develop optical computing hardware. COUSTO, project 866, has been concerned with the use of acousto-optical components in which acoustic waves and light interact in a crystal. The interaction modifies not only the amplitude, frequency and phase of the light beam but also its direction. In this way, information carried by both sound and light is processed and revealed. The results of this work are already being used within a radar processing system and may be applied to high speed LAN interconnections within the next two years.

In the same vein, COOP, project 1035, has made significant progress in the development of high performance optical correlators.

Office and Business Systems

Overview

The Office and Business Systems (OBS) domain is concerned with developing the strengths of European industry in IT systems designed to support office, business and home applications. The aim is to help improve white-collar productivity, the quality of service provided and the quality of life, both at work and at home, through the provision of powerful and flexible IT support.

Work during 1989 has reflected the increasing importance of the workstation as a principal means of using IT systems for many office workers, the increasing role of multimedia information, the increasing need for distributed systems, and the continuing need to apply the technology to significant organisational and business applications.

The research has been done in an environment characterised by the need to support the integration of systems at three levels: integration of technologies and tools, integration of users' work (both for individual users and for groups), and integration of enterprise functions and sites.

During 1989, the work has made significant contributions to international standards in many areas, especially in the areas of document handling and communications. A wide range of new products announced by participating companies are benefiting from ESPRIT results, and the research has laid a firm foundation for the next phase of development which will help ensure that European industry stays in the race in this rapidly evolving domain.

System integration - a unifying concept

A specific concern of OBS is the planning, design, development and uptake of systems for the creation, storage/retrieval, processing, transfer and management of information in private and public organisations. These systems will typically be multi-vendor, heterogeneous (with respect to hardware, software and the way in which data are organised), and distributed (both geographically and over a number of processors). They will encompass traditional office bases, mobile workers, and work places at home.

Such systems need to be integrated, and this is the unifying concept of the OBS programme in ESPRIT. This covers integration at three levels:

- integration of technologies and tools so that, for example, technologies for processing information and those for transferring it to another place are not seen as separate domains but as contributing to more complete systems;
- integration of users' work activities (both for individual users, and to support cooperative working within groups of users) so that, for example, the preparation of documents and the retrieval of information from databases are seen as complementary aspects of an overall process, whether these different tasks are carried out by the same or by different users;
- integration of enterprise functions and sites so that, for example, the accounting function within an organisation and the production function are seen as interlinked aspects of the overall functioning of a single enterprise.

Progress towards effective integration at these different levels has been made. The work done has taken account of the fact that European IT companies operate in a multi-vendor environment, in which products and systems

need to be able to work with those of other vendors, and to be capable of working with existing equipment so that user organisations can upgrade and expand their systems without losing the benefits of earlier investments. To meet these needs, the work done under ESPRIT has emphasised an "open systems" approach, compliance with relevant standards where these exist, and the establishment of new international standards where necessary.

Addressing an expanding dynamic environment

Integration of greater functionality into products together with the ever-increasing availability of cheaper and more powerful communications, networking and other technologies, means that the market for Office and Business Systems is moving in the direction of more sophisticated applications running on open, and often distributed, systems.

In this highly dynamic, rapidly evolving area, the work conducted under ESPRIT has reflected the key directions of change which have been observed by the European companies involved in the Programme. These include:

- the rise of the workstation as a principal interface between the end-user office worker and the IT systems serving the enterprise
- the trend towards multimedia information and communication, including both multimedia documents and multimedia person-to-person or group communication
- the rise of networking and the increasing emphasis on the need for distributed systems which can take full advantage of the networks
- increasing demands from user organisations to apply the systems to significant applications within the enterprise, taking adequate account of the richness and complexity of organisational and business needs.

These trends have influenced the direction that work under the Office and Business Systems area of ESPRIT is taking. In particular, some new and important projects have been started on application software development and more user organisations have appeared in consortia, reinforcing a strong user-orientation to the work.

The following account highlights the main achievements in regard to each of the above trends during the first phase of ESPRIT, with special emphasis on achievements during 1989.

Workstations - increasing sophistication

During the 1980s, the personal computer has demonstrated to many organisations the value of providing office workers of various sorts with direct access to information in electronic form and the computing power necessary to work with it effectively. The personal computer is one example of a workstation which, with sophistication and greater technology potential, will become more powerful and widespread.

During the 1990s, the number of people in Europe having a workstation at their desk will rise from one in six (in 1985) to a forecast one in three (in 1995), and in the U.S. the number will rise from one in three (in 1985) to one in every two (in 1995). In terms of its combination of availability and power, the workstation will become the dominant means of providing office workers with access to electronic information. The continuing support under ESPRIT for R&D on workstations is designed to help European manufacturers to be competitive in meeting this need.

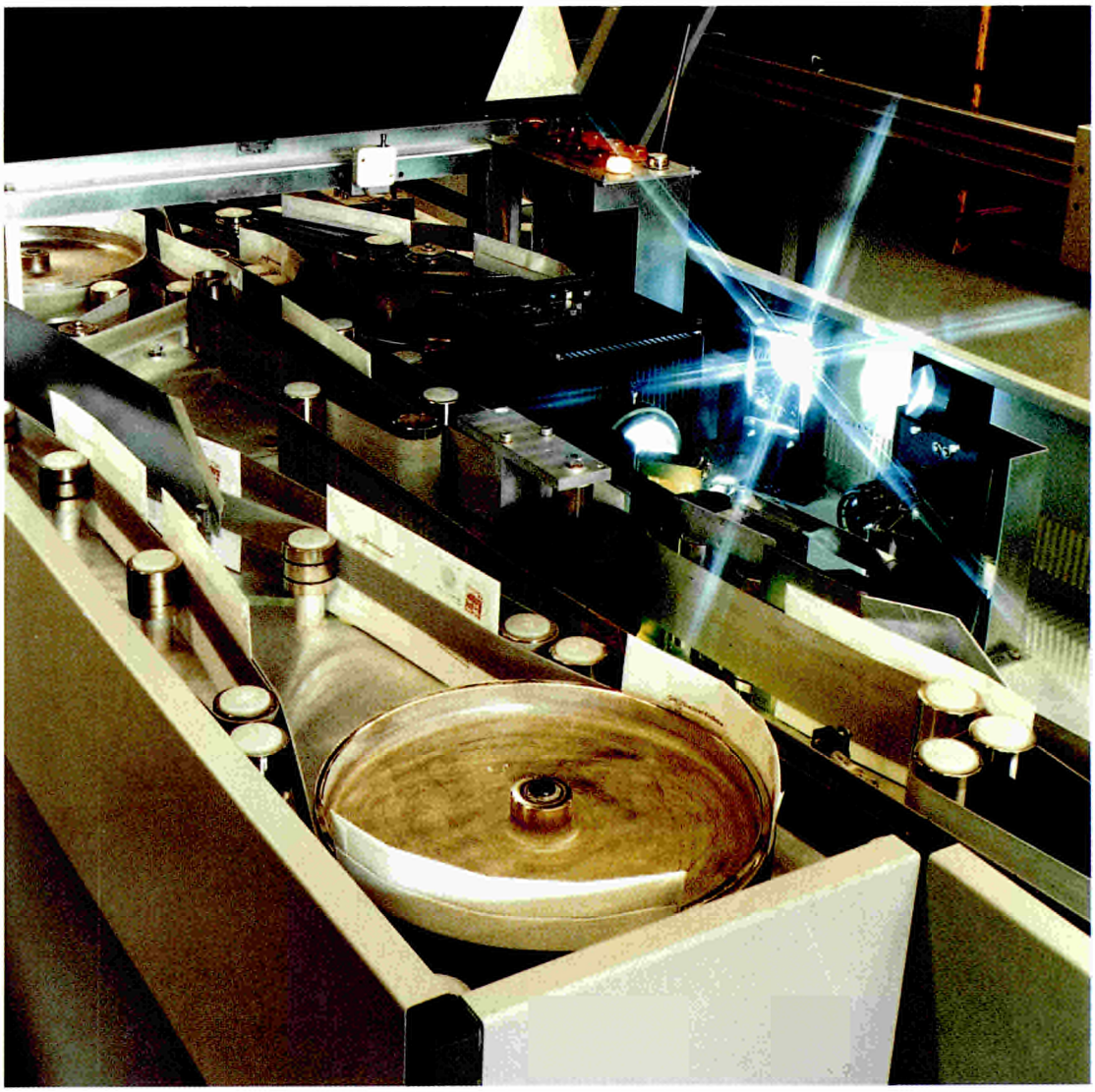
The key office and business workstation project supported under ESPRIT is MULTIWORKS, project 2105. This project builds upon the results of a number of the projects completed under the first phase of the Programme.

A key thread of ESPRIT R&D that inputs to MULTIWORKS comes from COCOS, project 956. It was from technology developed in this project that the ARM 3 RISC (Reduced Instruction Set Computing) chipset being used in MULTIWORKS was developed by Acorn and announced as a product in the second half of 1989.

One of the first products to be launched on the basis of the MULTIWORKS project is an EISA-compatible video card providing for "video in a window". This means that moving video images can be displayed in one of the MULTIWORKS windows whilst other windows show other aspects of the work being done (e.g. a document being edited, or a hypertext application being used). The video window could, for example, provide a means for different workstation users to see each other as they discuss a document, or it could display images as part of a training application.

The workstation is one of the main bridges between IT and paper, and is forecast to become the dominant form of "electronic working" for many office workers during the early 1990s. It needs to accept inputs from both the IT and paper domains, and to deliver outputs to both. The work now being done on workstations is benefiting from the research on this problem undertaken under PAPER INTERFACE, project 295. The project explored the whole gamut of document reading technologies. From it emerged a number of commercially exploitable elements. AEG Electrocom have used the recognition algorithms developed under the project in their address-reading equipment, as part of letter sorting systems, where the company is a world market leader. An example of the company's success in this field is a $300 million contract they have been awarded from US MAIL involving 346

Character recognition algorithms developed within PAPER INTERFACE are used in high speed automatic letter sorting equipment marketed worldwide.



reading systems for mail sorting. The AEG systems substantially outperformed other systems that were considered. The character-recognition algorithm was a key factor in this, being able to process more than 250 fonts (compared with the ten or so in competing products) as well as handprinted characters.

Workstation users not experienced in data processing need an advanced user-interface. HUFIT, project 385, has produced significant results in this area, including multimedia demonstrations combining text, speech, graphics and animation which have direct application in training and equipment maintenance. HUFIT has also produced software to facilitate interface building which operates within the Open Systems Foundation/Motif context.

Handling Multimedia Information

One of the early beginnings of "office automation" during the 1970s was the advent of word processing systems for the office. Word processing remains one of the most common general office applications of IT, although now typically performed on personal computers. However, new methods of document creation, such as "desktop publishing", have been evolving, which push personal computers to their limits, and point to the need for more powerful machines. This trend is continuing into the 1990s as the technology becomes increasingly available to produce documents composed of text, pictures, graphics, moving video together with voice annotation, in other words true "multimedia documents". Document creation will remain an important application of IT in the office during the 1990s, but will be much more sophisticated than anything seen during the 1970s or 80s.

Work on the SOMIW project has resulted in a powerful multimedia document editor, BALZAC, which can process text, graphics, images and mathematical formulae. It significantly exceeds the specifications of current "desktop publishing" systems. It provides users with a means of easily creating and editing documents containing information in a

HUFIT developed man machine interfaces which facilitate the simultaneous use of text, graphics animation, video and voice.

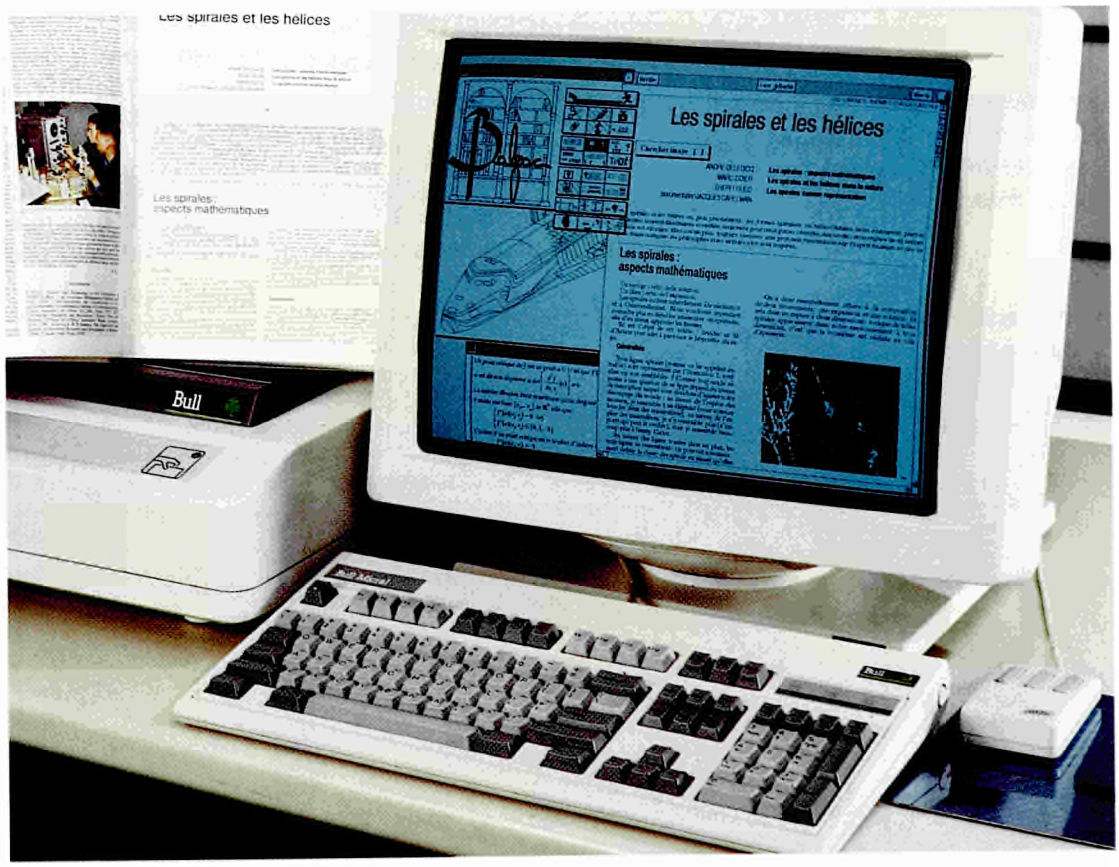
variety of different forms, including text, graphics, and images. BALZAC was launched by Bull as a commercial product in the second half of 1989, and has been exhibited running on the Bull DPX 1000 workstation.

As well as the ability to handle information in a variety of different forms, workstations of the 1990s are being designed to provide users with more support in manipulating documents according to the meanings of the elements within them, and to file and retrieve documents according to an understanding of the meaning of their contents.

The work done under MULTOS, project 28, shows how it is possible to automatically classify documents according to elements of their conceptual structure. The classification of the document can be based on the text content or on any other aspect of the document (such as its image content). The power of MULTOS has been illustrated in a demonstration which was based on real documents used by the El Pais newspaper, containing both text and images. This showed documents being brought into the system through a document scanner, manual and automatic classification, filing and retrieval.

As well as creating, editing, storing and retrieving documents, workstation users typically need to exchange documents with other users. Standard models of documents are needed when exchanging documents between machines or between software packages. The sending and receiving machines or packages must share a common view of the structure of the document, so that the sequences of bits that represent the document at the most elemental level can be interpreted in the same way when they arrive as when they were sent.

Significant progress on this problem has been achieved under the ESPRIT programme, especially in PODA, project 1024; INCA, project 395; and HERODE, project 121. This work has supported the development of the ODA (Office Document Architecture) and ODIF (Office Document Interchange Format) standards, which have now been adopted by many European companies. ODA is documented as ISO 8613 by the International Standards Organisation, as the T410 Series by the CCITT, and as ECMA 101 by the European Computer Manufacturers Association. All three are essentially the same.



The BALZAC editor is part of Bull's advanced multimedia document management system.

Bull have announced a range of ODA products and others are doing so during early 1990. One of the first products, announced during 1989, is a converter which can interpret MS-Word documents into ODA format and vice versa. The complete Bull and ICL "ODA Product Set" is intended to provide a platform of generic software to enable consistent and cost-effective development of applications based on ODA documents. It runs under MS-DOS and Unix, and takes account of the relevant ISO standards and CCITT recommendations.

It is available under licence to other software developers and system suppliers. Associated applications such as other word processor converters and page description language converters will be available in due course. In addition to these products, Bull has developed an ODA teletex system for the French PTT, and this was completed towards the end of 1989.

Siemens are releasing ODIF converters as products in 1990. These allow interchange of documents between editors on three different operating systems. They were implemented on top of SODA (Stored ODA) and ODASM (ODA Storage Manager), which were both developed within the ESPRIT projects PODA and PODA-2. A department of CENELEC has contacted Siemens with a view to being a pilot user of one of these converters.

IBM has indicated strong commitment to producing products based on the international ISO standard for ODA/ODIF (ISO 8613) which will allow the interchange of office documents between IBM systems (especially the IBM Office Vision family) and systems from other vendors.

ICL has played a leading role in ODA standardisation, including the final preparation of the ISO 8613 text, and it developed the SODA common platform for use by other PODA members, now used by ten companies. The company's corporate plan for ODA/ODIF product development and release centres around its OFFICEPOWER integrated office system.

Work on the ODA/ODIF standards is continuing in order for the standards to encompass the kinds of multimedia documents with which workstation users of the 1990s will be dealing, and to consider the requirements in regard to hypermedia systems.

In support of effective interaction between users, standards are needed for multipoint, multimedia communication. Work on this has been proceeding under MIAC, project 1057, (and the follow-on, MIAS project). These projects have been developing standards and demonstration systems for new digital services which can combine different media such as voice, pictures and data in such a way that they can be used together to provide a form of enhanced conferencing system, possibly involving several users in a "multipoint" conference. The first national demonstration based on MIAC hardware was organised in early 1988 between Turin and Rome, using leased lines. Further demonstrations are planned, and may make use of the PICA algorithms developed under ESPRIT in order to

ODA - The standard for document interchange.

support the exchange of photographic images. Starting from the MIAC results, MIAS, project 2684, is making use of ISDN (Integrated Services Digital Network) to add various enhancements to the MIAC concept, including moving TV images. The work on MIAC and MIAS has made significant contributions to standards activities, especially through the ETSI Harmonisation Project TR1/HP6, responsible for developing a CEPT standard on digital audiographic teleconferencing.

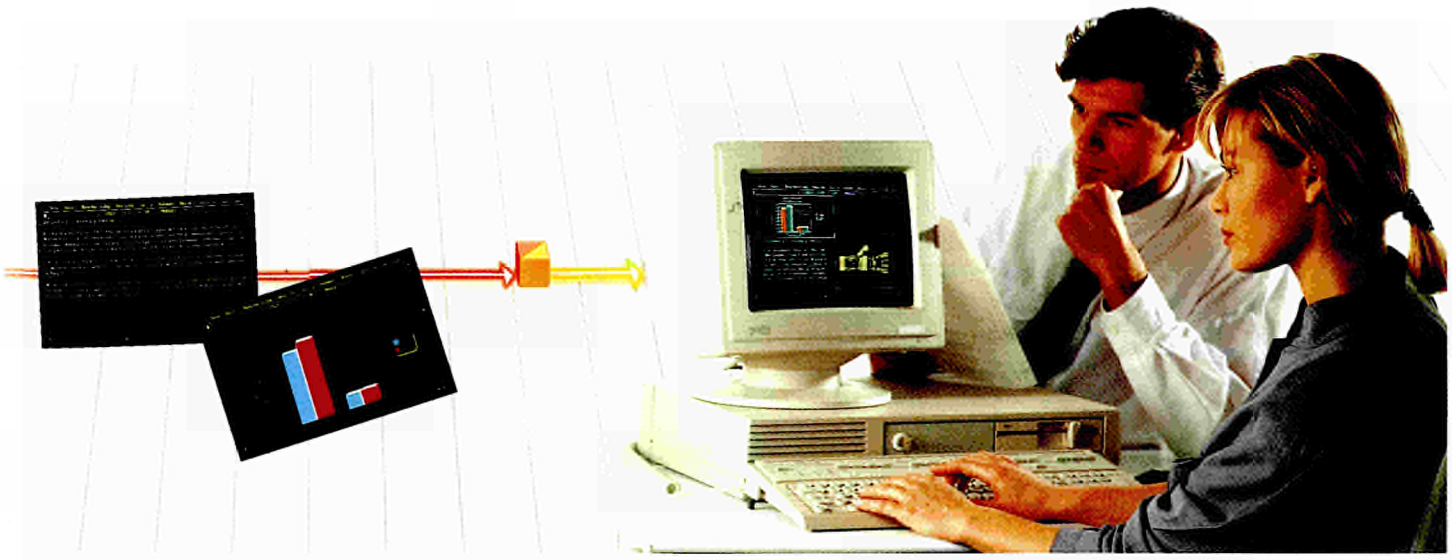
Distributed Systems - increasing enterprise efficiency

The need for interaction between workstation users is just one example of the increasing need for systems which bring together different resources within the enterprise into a common electronic environment. Stand-alone systems (such as the stand-alone, dedicated word-processing machines of the 1970s) have been steadily giving way to networks of varying sizes and complexity. As these networks have grown, it has become apparent that significant benefits in terms of efficiency and effectiveness can be achieved by distributing the work to be done over the most appropriate resources available on the networks.

In such a system, programs running under different operating systems and data organised in various different ways and spread over a number of different machines may need to be coordinated in the execution of a single, distributed application.

One important European dimension of this is that as cross-border trade within the European Community becomes easier in terms of the legal and administrative aspects, so it will become increasingly important for IT systems to be able to support applications which span different local systems in perhaps several different Member States.

Several related projects have been researching aspects of distributed systems, but notably COMANDOS, project 834/2071, with two overall goals: first, the cost of developing and maintaining such systems needs to be reduced, and secondly the user needs to be protected from the underlying complexity by perceiving a single view of the system despite the variety of its components. Achievement of these goals takes the form of a software "platform" which can be tailored to run on a variety of different hardware and operating systems and which provides a standard software base on which distributed applications can be built. Such a platform allows the development of easily portable applications while enabling coexistence with existing applications designed to run on current operating systems such as Unix. The COMANDOS results enable applications software to be developed on one machine and then distributed without change to run on a number of machines each equipped with the COMANDOS software platform. Whilst the primary stimulus for developing such a platform has been the need to develop distributed systems for office and business applications, the platform lends itself to the



development of applications in other areas as well.

The work completed under these projects has resulted in several demonstration systems and is being exploited commercially by the companies involved. Bull, for example, is now taking the results of the research on COMANDOS to a second phase of development which will result in a pre-industrial prototype in 1992. The Fraunhofer Institute and the University of Stuttgart are applying the tools and methodologies to commercial application projects. One is for a European multinational manufacturing company which needs to have a coherent distributed system covering all the various company sites in Europe and the U.S. Another is for a German public administration which needs a distributed information system.

New ventures are being built on the results of the research. For example, two European SMEs are joining with one of the partners in COMANDOS (Trinity College) in a new venture to set up a joint company to exploit the work done on that project. The first product announcements are expected during 1990.

ARG have launched a product called SINBAD based on their own implementation of the COMANDOS object-oriented data model. This product, aimed at the MS-DOS PC market, provides users with a uniform way of accessing remote databases.

Communications - the vital infrastructure for future systems

Below the level of the individual operating systems within each computer, distributed systems geographically spread, depend upon efficient communications. As the number of items of information needing to be exchanged through the emerging networks has increased, and as the items concerned have themselves become more demanding of bandwidth (by incorporating graphics, voice and images as well as text and data), so the need for both efficient use of available bandwidth, and the availability of high-bandwidth communication systems has increased.

PICA (Photovideotex Image Compression Algorithm), project 563, set itself a target of a 16 to 1 compression ratio. This it far exceeded offering ratios of at least 20 to 1 and as much as 192 to 1 where lower quality image is acceptable. This algorithm is now a world standard and embodied in integrated circuit components produced by the participant companies. The system was used for transmitting colour photographs for the press via HF radio from the yachts taking part in the 1990 Whitbread Round the World yacht race.

DAMS, project 1059/2146, has focused on developing systems for switching business communications which can dynamically adapt in real time to the varying demands on them so as to use the available bandwidth in the most effective way. The DAMS research is contributing to improved integration of "circuit-switching" and "packet-switching" which has application to advanced voice and data PABX equipment. VLSI chips and a prototype PABX have been developed, the various elements of which are interconnected over a fibre optic LAN using the FDDI 2 standard. LION, project 169, demonstrates how optical fibre can be used effectively as a transmission medium in local area networking. The emphasis in LION is on the network as a total system, however, not just a transmission medium.

LION has demonstrated all the elements of a 140 Mb/s LAN and the possibility of speed increase to 565 Mb/s. It has achieved the adaptive use of bandwidth at the network level to cope with varying mixes of traffic, and has an ability to reconfigure itself automatically should there be a breakdown in any part of the network. Gateways to ISDN and satellite networks are provided. LION has been the first to tackle some of the technical issues involved in high-bandwidth multimedia communication, and is in many respects technically the best approach developed so far.

NKT is negotiating with possible partners for full industrialisation of the LION results. In the meantime, the results of the research will be applied to various real-world applications in connection with the IACIS project. These will include applications in sea ports, in airports and in the 1992 Olympic Games. The research results will also contribute to work on the development of metropolitan area networks being undertaken under MAX, project 2100.

Whilst DAMS, LION and MAX are examples of projects aimed at exploiting currently avail-

able fibre optic technologies, project UCOL is working on multigigabit per second fibre LANs. It is exploring both the technological possibilities and the standards implications of the use of frequency division multiplexing techniques within office based networks.

Distributed Applications- improving the administration

The ability to run distributed applications across a range of heterogeneous hardware and software is being demonstrated in ASTRA, project 831.

Aimed at key applications in public administrations, this research is demonstrating how the amount of paper flowing may be significantly reduced by managing the information in electronic form, including the use of optical disc storage. This reduced amount of paper to distribute, store and search is constituting an important benefit to large, bureaucratic organisations such as Public Adminstrations. The research has led to the building of a first prototype, in order to show the ASTRA functionalities. A pilot, derived from this prototype, will be installed initially in the Italian Ministry of Finance.

Whilst a very positive feature of this project is the emphasis on the particular user needs of the organisations in which the system is being demonstrated, the project has in addition provided the basis for more generic products. The Olivetti IBIS family has made significant use of the research results, Bull are making use of the results in connection with a filing system under development, and SOGEI is verifying with Data Centralen the possibility to develop a range of application packages derived from the research. Moreover, the consortium is publishing a manual of IT-uptake guidelines based on the ASTRA research. These guidelines are aimed at helping public administrations benefit from the ASTRA experience.

Looking at a different kind of environment, RICHE, project 2221, started during 1989, is developing a health service information and communication network for Europe. Its two main areas of focus are the management of health care services and patient file management (especially support to all medical services available to the patient). The approach being taken is to base the system on European technology and to comply with international standards.

The kind of work being done on ASTRA and RICHE is illustrative of the increasing need within Europe to develop application systems that are applicable to common needs in all the Member States, and in some cases applications which themselves may be Europe-wide. Such Europe-wide application systems are needed to support the European Community's coordinated approach to such challenges as the need to develop and maintain good environmental conditions, to combat terrorism, to tackle international transportation problems, and other applications which cut across national borders.

Home Systems

Whilst the main thrust of R&D in office and business systems has been on systems designed to support working at traditional office bases, it is recognised that an evolution has already started towards greater independence from such bases. This can be seen in the growth of mobile communications, portable computing, and other developments aimed at supporting workers on the move or away from the traditional office. This trend will continue during the 1990s, and systems will be needed to meet the increased demand.

One of the main alternatives to working at a traditional office is to work from home, at least for part of one's time. This is possible to some extent today but to be a truly effective option it requires the development of home systems which are specifically designed to support the needs of the office worker or business person working from home.

Home systems need not, however, be confined to supporting work. Once the concept of IT in the home is accepted, it becomes possible to think in terms of integrated systems supporting all aspects of home life, including both work, leisure, safety, security, privacy, energy control, voice and document communications and the IT upgrade of white goods. Early indications of a trend in this direction can already be discerned. Analysis of the product replacement patterns of consumer electronic equipment suggests that during the next decade the market share of established stand-alone products will de-

Information management as developed in ASTRA reduces significantly the use of paper within public administrations.

crease and a vast new market will open for value-added new products with an increasing emphasis on systems that incorporate the functions of what were previously many separate products.

Home systems in turn are not restricted to private houses. The difference between domestic and corporate or multi-tenant building applications is seen as a matter of scale and of the degree of sophistication of the user interface. Intelligent buildings include hospitals, plants, hotels and business locations.

The market for integrated home systems is potentially huge, covering both new construction and retrofitting to existing ones : entertainment, personal security, energy management, lighting, waste control, remote and programmable control of household appliances, and so forth.

Such developments will evolve gradually, in Europe as in the US and Japan. In Japan, the government, electronics industries, home builders, and other relevant groups have been active in organising themselves into interest groups in order to promote their standards.

In Europe, work on the definition of appropriate architectures for such systems, progress towards relevant interconnection standards, and other aspects of the necessary R&D has also begun. After initial work by the Eureka 84 Integrated Home Systems Group, the ESPRIT IT Home Systems Consortium has been set up to develop the work further. This consortium represents a broad European forum which can define a Home Systems Architecture and the necessary standards. The consortium extends the work also into the direction of business premises where the same standards are equally relevant. A close connection has been established with the relevant standardisation bodies, including CENELEC, and ISO/IEC.

The work so far has resulted in the specification of user requirements, applications definitions, media and interface definitions, and the first draft of an installation philosophy. A European Conference on Integrated Home Applications will be held in Amsterdam in January 1991 to report on the results of achievements during the previous year, including the draft protocol language specification, the installation guide and recommended practices. The research includes the validation of proposals for standards and a multi-vendor, multi-application demonstration.

Computer Integrated Manufacturing

Overview

Manufacturing and engineering industries are key sectors of the Community economy and represent a large marketplace for IT products in which Europe can excel. The CIM area of ESPRIT is developing the key technologies to access this market based on an Open Systems Interconnection (OSI) approach which allows the development of industrial environments in which multi-vendor systems can be implemented easily and progressively to meet the needs of manufacturing companies of all sizes. By bringing together the major CIM vendors, leading edge users, and the small and medium sized companies (SMEs) which both use and sell Information Technology, a base is being created for promoting the competitiveness of European manufacturing industry.

In selected domains, the results from CIM projects have significantly influenced the international standardisation process, facilitated numerous implementations of advanced CIM technology in real production environments, provided new and improved products and services in the marketplace and enhanced the education and training facilities offered by research institutes and universities. The work aims at ensuring the availability of reliable, affordable and customisable CIM systems suitable for use by companies of all sizes.

The 76 ESPRIT CIM projects, 28 of which are now completed, are strongly influencing manufacturing technology in the Community. CIM has a strong user orientation and accordingly the new and emerging products of Community vendors arising from CIM projects are highly attuned to user needs. In particular, CIM work seeks to address the needs of SMEs who provide a vital component of Community manufacturing industry.

Work in CIM proceeds along four main lines:

Opening up the manufacturing environment - Architectures and Communications

The incompatibility of equipment and subsystems supplied by vendors remains a serious obstacle to the implementation of CIM, and its integration with the total enterprise. This can lead to high costs when a user has to implement an integrated manufacturing system which necessarily requires a variety of hardware and software components from different suppliers. In working towards solving this problem, CIM projects in the areas of generic systems architectures and factory communications involve major Community equipment vendors and users. Projects are exerting a strong influence on international standardisation which is leading towards the provision of economical and customised multi-vendor systems which may be progressively implemented by enterprises of all sizes.

Accelerating design to production - CAD/CAE systems

It is critical to competitivity that new design concepts can be turned into products with the minimum of delay. This is facilitated by the use of Computer Aided Design and Computer Aided Engineering (CAD/CAE) systems. Advanced IT tools developed within CIM are enhancing the creativity of the designer and allowing faster product design and substantial reductions in the time to bring products to the market. It is becoming possible to predict the future behaviour and performance of products at the design stage thus avoiding time wasting and costly iteration cycles between design and production and facilitating the drive towards the "total quality" concept. Additionally, the ability to freely exchange data between design systems is being realised. The work in this area also covers the design and validation

of complete manufacturing systems in the discrete parts, batch and process industries.

Effective control of resources - Manufacturing planning and control

To meet the changes in market demands and customer requirements, a manufacturing enterprise, be it small or large, must be able to respond and adapt quickly. Production planning, control and scheduling systems under development within ESPRIT allow the necessary flexibility by predicting manufacturing system throughput and highlighting potential problems. Effective use of these tools is also reducing production lead-times thus improving the economies of manufacture by reducing capital bound up in stocks and work in progress, and allowing accurate prediction of delivery dates. Many manufacturing plants are already using early project results and show the power of advances in this area, such as decentralisation, improved flexibility of control structures, and developments in Just In Time (JIT) manufacture and Optimised Production Technology (OPT) techniques.

Improved manufacturing equipment and systems - Robotics and shop floor systems

Efficiency and reliability of manufacturing equipment and ensuring high product quality are key elements in raising productivity. Success in this area provides a large potential market for Community vendors in the discrete parts manufacturing and process industries, as well as in the sectors of agriculture, forestry and construction. On-line quality control techniques for a wide range of manufacturing processes have either been implemented or are under development. Work on the next generation of industrial robots which are faster, lighter and less expensive than traditional robots is continuing in the CIM programme. Such advances in manufacturing equipment and process control leads not only to higher productivity and quality, but also to improved energy efficiency and reduced environmental pollution.

The CIM work areas and achievements are considered in detail in the following sections.

CAD modelling software is a key building block for CIM systems.

Architectures and Communications

In selected areas, 1989 has seen substantial ESPRIT led advances in international standardisation efforts and an enhanced ability of European vendors to supply standards conformant products to the world market. The conformance testing tools developed within the first phase of CNMA have facilitated the setting up of test services by several European test houses. New work has commenced which will lead to major advances in factory communications and will cover the area of mobile terminals for industrial environments.

CIM-OSA gathers strength

The 21 partner AMICE consortium, project 688, working on the development of Open Systems Architectures for the manufacturing enterprise, has enabled the establishment of a new ISO TC184 work item based on the CIM-OSA modelling structure developed within the project. CEN/CENELEC has drafted a European pre-standard using the same basis. This, taken together with the publicly stated commitment of all partners to the CIM-OSA architecture, has the potential to put Europe into the driving seat of international standards work in systems architecture development. CIM-OSA concepts have also been used by major companies in the aerospace, automotive and electronics sectors to model key areas of manufacturing environments so as to identify and implement improvements paths in enterprise structure functions. Major aspects of CIM-OSA development were demonstrated at the ESPRIT Conference and a book detailing the reference architecture and integrating infrastructure is now available.

CNMA leads the standardisation drive

In the vital area of factory communications, previously dominated by the US MAP and TOP initiatives, the first phases of CNMA, project 955, which completed work at the end of 1988, continues to exert a strong influence on emerging standards, particularly in the areas of functional specifications for industrial LANs, and companion standards for manufacturing messages.

The industrial pilots using CNMA technology, at Aeritalia, BMW and British Aerospace are fully functional and have been widely demonstrated to experts and leading interested parties in the factory communications field. Vendor members of the 955 consortium are now marketing products based on project results which are fully compatible with new and evolving standards. Examples include CNMA and MAP 3.0 equipment for broadband LANs, gateways between broadband and ethernet LANs and file transfer software.

The conformance testing tools developed in the project have allowed ACERLI, IITB, SPAG and TNC to set up conformance testing services within the framework of ECIT and MAP/TOP world federation schemes. In late 1989 SPAG sold a non-exclusive licence to TOYO of Japan for a complete integrated tool set for conformance testing tools for CNMA/MAP conformant products.

1989 saw the successful start-up of two projects involving subsets of the original CNMA team. Project 2617 follows on from the mainstream work of CNMA and continues to influence standards development. Four new industrial pilots are being set up to implement and demonstrate advanced CNMA features such as network administration and directory services. A new implementation guide covering all aspects of CNMA was made available during the year. With its advanced features and facilities, CNMA now represents a superset of MAP which has strong appeal to users and places European vendors in a strong position in the world factory communications market.

Additionally, TT-CNMA, project 2292, builds on the earlier conformance testing work of CNMA and is placing Europe in a pre-eminent position in this field by developing and supplying the test tools to meet the requirements imposed by emerging standards. The work is carried out in cooperation with the major US and Japanese organisations concerned with factory communications to ensure early international agreement.

FCPN, project 2198 complements CNMA work by developing mobile communications facilities for factory environments. The project also works towards the integration of voice and video data in manufacturing plants.

This British Aerospace factory, which fabricates Airbus wings, uses CNMA results to permit computing systems from several vendors to interwork.

CIM for multi-supplier environments

Coping with the needs of multi-supplier manufacturing chains such as those found in the automotive industry, and which frequently include SMEs, is becoming increasingly important. CMSO, project 2277, contributes to this need by optimising information flows between different and geographically separated companies by integrating commercial and engineering information via neutral file (ie vendor independent) application interfaces. Benefits to the user will include lower stocks, shorter lead times which may be accurately predicted, increased service levels and a reduction in overall production costs.

CAD/CAE Systems

Although the CAD/CAE hardware market is still dominated by non-European vendors who supply proprietary systems, the drawbacks which this entails can be overcome by the provision of appropriate software. CIM projects have developed standardised interfaces which allow information flow between CAD/CAE systems from different suppliers. This allows users to realise integrated multi-vendor CAD/CAE systems. Another important ESPRIT advance has been the integration of more functions within the CIM design-to-product chain such as graphics systems to improve man machine interaction in design and production environments, and tools for incorporating life cycle reliability analysis at the design stage. New work on product modelling has been launched which will allow the full range of manufacturing, materials and cost data to be incorporated at the product design stage.

Advances in CAD interfaces

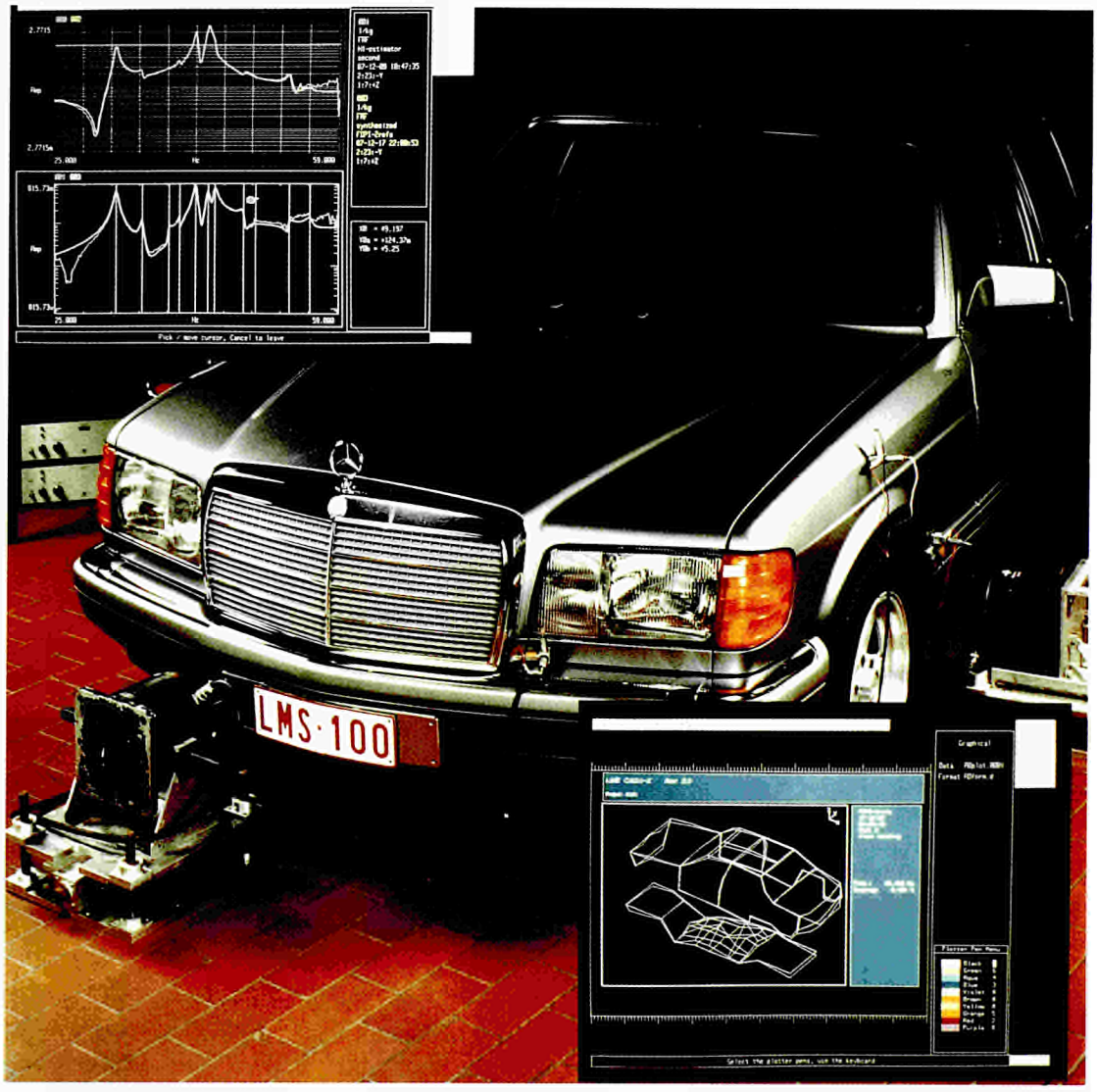
CAD*I, project 322, has defined interface specifications for CAD and CAE data exchange between many of the currently available proprietary systems. This has been achieved in conjunction with the project's strong influence on the emerging ISO STEP standard. ESPRIT inputs to the development of this standard include neutral file formats which allow free exchange of CAD data of many types, eg. solid and wireframe models, and powerful interfaces between CAD systems and CAE tools such as finite element analysis.

Several of the partners including LMS (B) and GFS (D), both SMEs, are now marketing products which have emerged from the project work. These have widespread applicability for, and are being used in, the manufacture of aircraft, cars and machine tools. BMW has made extensive use of the technology for the design and development of its product range and has granted a licence to a German SME, GTWD, to market and maintain the software.

The results from CAD*I have been provided to a number of European SME CAD vendors who are participating in the recently launched CADEX project (no. 2195). The project aims to continue influencing emerging ISO standards and to develop and test further prototype systems based on CAD*I results.

New design and engineering tools available

To facilitate rapid product realisation, it is important to be able to take account of as many aspects of overall product performance as possible at the design stage. ACCORD, project 1062 led by Bertin (F), has developed CAD/CAE software packages for long term product reliability modelling, life cycle costing and thermal analysis of mechnical and electronic systems. The techniques developed use parallel computing technology and have been shown to be fast and effective. GEC have used the facilities for reliability prediction of radar systems and for bid preparation. Bertin now uses the techniques widely in their industrial technology services and, based on



Computer aided engineering techniques developed in Project 322 are being used for the analysis and improvement of vibration within the automotive industry.

the parallel architectures work, Vector Fields is marketing a library of high speed CAE software.

The design and implementation of user interfaces and graphics subsystems in manufacturing industry strongly influences man machine interaction at both design and physical production stages which, in turn, impacts on the efficient use of manufacturing resources. VITAMIN, project 1556, led by Syseca (F), has developed, implemented and evaluated two key subsystems. One of these aids is for the control and management of production systems with a low level of automation, such as those typically found in SMEs; the other allows the supervisor of a production system to carry out remote control system management tasks. Use of these subsystems has allowed the partners to re-design the user interfaces of their products and Mannesmann is now marketing a spin-off product, an X-Window implementation. Further commercialisation of results will commence when the project finishes in early 1990.

The way forward in CAD/CAE

Product modelling allows factors such as cost parameters, optimum use of new materials, manufacturing requirements, manufacturing and quality data information to be included at the design stage of a part or engineering system. This vastly extends the power of present generation CAD/CAE techniques. The integration of all essential information in a single accessible model allows "right first time" design, improved product quality, rapid changes in specifications to meet market needs, and full cost monitoring. ESPRIT II has seen the launch of two CIM projects in this field, IMPPACT, project 2165 and IPDES, project 2590. Both consortia have powerful combinations of vendor and user partners, and are demonstrating the technology in real design and production environments.

Manufacturing planning and control

Principal indicators of success in this area include the large number of applications of project technology in live production and the wide availability of spin-off products. These implementations are proving the value of this technology in a wide range of manufacturing environments and enabling the provision of high quality products from European vendors which meet the needs of all types of user. Additionally, aided by the strong participation of universities and research organisations, training and skill development in this important field has been greatly enhanced.

Controlling integrated manufacture

The effective control of small batch manufacturing in terms of optimising plant utilisation, producing the right product at the right time and reducing tedious human tasks, is a goal that has been sought for many years.
COSIMA, project 477, under the leadership of COMAU, has used the concept of Production Activity Control (PAC) to close the loop between production planning and manufacture. PAC relies on automatic data capture from the shop floor and substantially reduces manufacturing system reaction time to changes in product requirements.

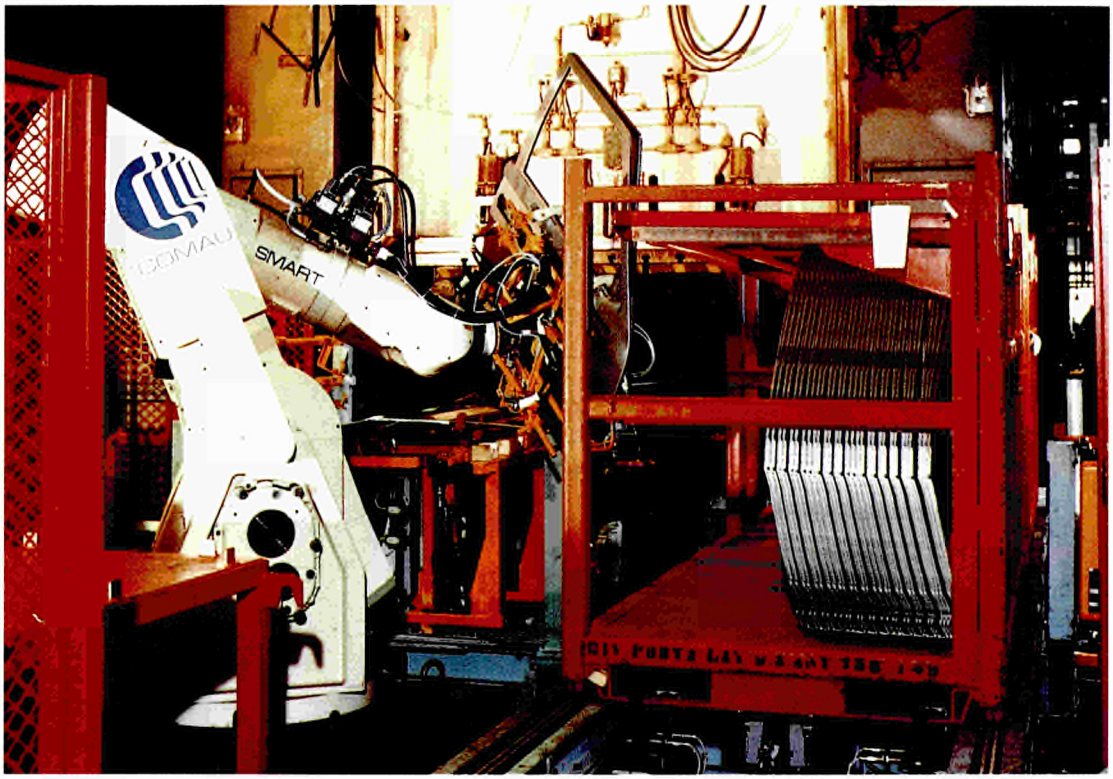
Three implementations of the PAC software products are now successfully operating. These cover the diverse areas of printed circuit board manufacture - Digital, automotive engine assembly - Renault, and machine tool manufacture - COMAU. European companies have been invited to evaluate PAC software on a free of charge basis.

Realising the potential of industrial robots

For full realisation of the benefits to manufacturing industry offered by robots it is essential that they are fully integrated with other elements of manufacturing technology, such as CAD and production planning and control systems. Project 623 has two main themes - off-line programming and robot system planning.

Until now, it has been necessary to programme a robot by taking it out of production while the programmer works at the robot controller and "teaches" it to perform its new task. This is a time-consuming process, during which the programmer is in real danger of being injured by the robot while experimenting in its proximity, and parts and material are often wasted.

The project, led by IPK, has developed methods which allow robots to be programmed



Comau robot with car doors - production planning is essential to efficient manufacturing..

"off-line". This means that the programmer can work in the safety and comfort of an office away from the robot system and generate proven sets of instructions for the manufacture of new parts. A principal benefit of off-line programming is that the robot does not have to be taken out of service during programming, this allows substantial improvements in production cycle times ranging from 30-80%.

The off-line programming techniques developed in the project have had significant influence on the work of an International Standards Organisation (ISO) technical committee, and a related DIN standard will be published in 1989.

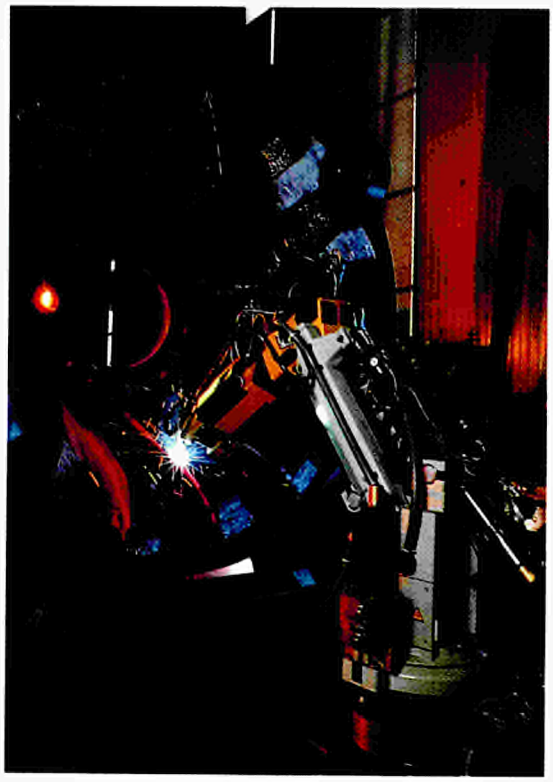
The market for robotic systems is highly competitive and it is of great advantage to a vendor to be able to design a system quickly and cost-effectively so as to win an order. Within the project, tools have been developed which facilitate system design. These are used by both KUKA and Renault who report time and cost savings of up to 50% when tendering for system supply.

Off-line programming, and the advanced design systems developed in the project, allow a wide range of applications for robots, including work in hostile environments such as radioactive and chemically polluted zones. Early spin-offs from the project have allowed KUKA and Renault Automation to provide advanced robot systems to the automotive, nuclear, ship-building, offshore and space industries. In their last project report, the partners estimated that between them the total value of industrial work conducted using project results had reached 64 million ECU by mid-1989.

Knowledge based systems improve plant supervision

In order to improve throughput and profitability, factories require dynamic scheduling in order to bridge the time gap between long-term logistics planning and real-time conditions on the shop floor. The partners of project 932 set out to develop such a capability using knowledge-based system (KBS) techniques. The terms of reference were to build and implement knowledge acquisition and user-interface modules and expert systems for diagnosis, preventive maintenance and quality control and to test a generic system embracing these facilities in real manufacturing environments.

The project, now in its final stages has achieved the major objectives. KBS's are now



Offline programming allows dangerous tasks in hostile environments to be programmed in safety as illustrated in this application by Renault Automation.

in use in the Turin tyre manufacturing plant of Pirelli, the Philips Wetzlar car accessory plant and BICC wire and cable manufacturing plants in the UK. Operational systems include those for plant fault diagnosis, planning, simulation and factory layout. ARS and FIAR are already marketing products which have been derived from early project results and five other partners are developing products based on the project results.

New initiatives in manufacturing control

During 1989 several new projects in the subarea were successfully launched. Some of these build on the success of earlier projects with a strong feedthrough of ESPRIT I results to ESPRIT II work. One example here is CIMPLATO, project 2202, which is extending the work of project 623 on robot systems to the design, planning and control of wider manufacturing systems. The work is increasing the effectiveness of the planning process to further improve the efficiency of manufacturing systems control. CIDAM, project 2527, led by Mannesmann Kienzle developing a range of IT tools to facilitate transfer of data between different CIM subsystems and enable their rapid integration in the manufacturing enterprise.

BIPMS, project 2189 is of particular interest as it aims to use the concepts and tools developed for the discrete parts manufacturing environment for realising an effective project management system for the construction industry. ROCOCO, project 2439, is working in the analagous area of shipbuilding and marine construction where effective management and control in the production of large one-off structures are vital factors for the industry's competitivity.

Robotics and Shop Floor Systems

Several ESPRIT I projects completed their work during 1989 and have resulted in many successful products in the market-place and have demonstrated advances in machine and robot control, fault diagnosis and advanced sensor systems. Continuing and new projects are developing the technology for the next generation of robots for manufacturing and mobile robots for unstructured and hazardous environments, such as forestry, mining and nuclear industries. A principal feature of work in this subarea is the development of mechatronics technology, ie the embedding of IT in electro-mechanical subsystems.

Improving machine tool efficiency

Inadequate control of machine tools results in the manufacture of a high proportion of parts which do not meet their specifications and have to be scrapped. This results in wastage of materials and valuable machining time, and in some cases may also lead to damage of the production equipment itself. These problems were addressed successfully in PAQO, project 504, with a demonstration of new techniques for ensuring the optimum operation of an advanced manufacturing system at the Ikerlan Centre in Spain.

The project was led by Stewart Hughes, a small UK engineering company. The project results have been commercialised and several systems have already been sold. These now contribute to increased quality and cost-effectiveness in aerospace, automobile and other industries.

The success of project 504 attracted the well-known automotive manufacturers, PSA and

The shipbuilding industry is adopting state of the art planning and scheduling tools in order to increase competitivity.

PEGASO, and the machine tool vendor MANDELLI to join forces with members of the original consortium in order to build on the work of project 504. The impact of project 2349 on European industry lies in enabling the provision of manufacturing systems better able to cope with fault conditions in real time, thus improving plant availability, product quality and operational safety.

Developments in advanced sensors and smart drives

Projects 118 and 278, now completed, have led to several new products. MARI, an SME, and Joyce Loebl now manufacture and market tactile sensors and vision systems respectively. During the past year, over 40 vision systems have been installed throughout the Community in a wide range of engineering industries. Substantially increased markets for the systems are being pursued with potential clients in areas as diverse as razor blade and artificial limb manufacture. Also as a result of project 278, Bosch has improved its range of robot controllers which can now incorporate information from vision systems in the control process. Another form of vision system resulted from Project 118 and is being used internally and externally by Siemens for a range of de-palletising operations and car wheel inspection.

High speed drives and their effective on-board control systems are typical of advanced mechatronic subsystems which form essential components of production systems. These are important for ensuring the further develop-

ment of robots, machine tools and materials handling devices. Project 179 has successfully incorporated in VLSI the latest technology for the control of DC drives and for high speed processing of control commands for robots and machine tools. During 1989 IDRIS, project 2656, was launched which is developing the technology for intelligent high speed drives and the means for integrating their advanced capabilities with system control architectures.

and can be quickly switched from one task to another. Hitherto, this has presented serious problems due to vibration and lack of positioning accuracy. SACODY solves these problems by using new IT techniques to improve the control of robots by providing fast active feedback to the robot controller from various sensors. This ensures the high accuracy and vibration-free performance required for the future exploitation of robot technology. Key market areas for lightweight high-speed robots include automated assembly, metal-cutting operations, and large flexible structures in building and construction industries.

European automotive companies take up ESPRIT technology.

Towards the next generation of robots

Improving the performance of industrial robots is a prime target area for developing the strengths of European manufacturing systems vendors and users. Existing robots have massive, stiff structures which are expensive to build, slow in operation and often exhibit problems of accuracy and repeatability of positioning.

SACODY, project 1561, led by Bertin (F), aims to overcome these problems by facilitating the design of light flexible robot structures which will allow fast operation during complex tasks

Bertin, KUL and LMS have already integrated early spin-offs from SACODY into commercial mechatronics based products. AEG and KUKA are providing challenging industrial testbeds to further develop the technology, which is being incorporated in emerging products.

The SACODY project marks a significant advance in robotics technology. New projects launched in 1989 will lead to further major developments. LAMA, project 2280, will de-

velop long-reach, high-speed manipulators which will enable new concepts in shop floor layouts to be realised. The technology will also have important spin-offs to other industries such as, construction, off-shore activities, mining and extraction. ARMS, project 2637, is developing high speed robots for flexible automated assembly. The robots developed will incorporate the latest developments in smart drives, mechatronics and control technologies developed within ESPRIT.

Mobile robots have a potentially wide range of application areas in many industries, including hazardous environments. MARIE, project 2043, and PANORAMA, project 2483, are tackling the problems of autonomous navigation and operation in poorly structured environments, such as those found in mining, extraction, agriculture and forestry industries. The prototype mobile robot systems are being developed for real working environments.

Humans factors in CIM

It is widely accepted that people, particularly skilled personnel, are a key factor in efficient manufacturing. Considerable effort has been devoted to improving the richness and flexibility of the interaction between IT equipment and operators, planners and engineers as a way of gaining the maximum benefits from an enterprise's human resources. As a result of EP 1199, real-time shop floor monitoring and control systems for SME's and CNC controllers with improved interface capabilities have been developed for the market. The technology is already operating successfully in live industrial plants at Rolls Royce and BICC.

Energy efficiency and environmental quality

Many key industries rely on fuel burning installations such as furnaces and boilers. Fuel efficiency, pollution control and operational cost-effectiveness are critical to production efficiency and profitability. AIMBURN, project 2192, led by ADIST of Portugal, aims to improve the performance of combustion systems by the application of information technology. The target applications for the project work include glass manufacture and power generation plants of the industrial partners.

The breakthrough achieved by AIMBURN is to use the latest advances in information technology for the real-time control of combustion processes. This has been done by employing advanced sensor systems for visual analysis of furnace flames, and integrated measurement of pressure, temperature and gas composition. The techniques were successfully demonstrated at the ESPRIT Conference.

Other new projects are addressing the control and management of process plants which can be intensive energy users and potential sources of pollution. DIAS, project 2172, and KB-MUSICA, project 2671, deal with the integration of data from large numbers of sensors, and intelligent sensor-actvator integration, to ensure optimal and safe process plant performance.

As well as improving the economic performance of large market sectors, the work of these projects also contributes strongly to energy conservation and protection of the environment.

ESPRIT Basic Research Actions

Overview

The ESPRIT Basic Research Actions (BR), a new element of the ESPRIT programme, represent an effort to maintain and increase the reservoir of scientific knowledge and skills needed for the vitality of European industrial R&D. The Actions, launched in 1989, have as their main objectives :

- to support collaborative fundamental research in selected IT areas;
- to increase the involvement of leading research teams in ESPRIT.

The dual role of providing new knowledge and helping to ensure the future availability of high-calibre scientists and engineers are key elements in the long-term ability of Europe to compete in global markets. The BR actions recognise that fundamental research, even when it does not have visible immediate applications often leads to technological developments with major industrial, economic and social impact.

The main criteria for the selection of work areas have been :

- potential to produce future breakthroughs or important advances;
- added value of collaborative research on a European scale;
- work clearly upstream of main ESPRIT pre-competitive R&D.

As a result of the first call for proposals, 61 actions involving 285 different organizations have started during 1989. In addition, partners from 24 proposals are being supported to collaborate in 13 working groups. Working groups fund mobility and interchange of information between teams sharing common or complementary goals in advanced areas of research. It is expected that well defined focused research actions will be spawned by some of these groups in the future. Community funding of 63 MECU is expected to cover work over a 30-month period for the 74 actions and working groups. About 75% of the researchers working in BR are newcomers to ESPRIT and the involvement of leading research teams has quite clearly been secured.

There is already evidence of significant catalytic effects from the BR Actions, even though it is still early to talk about actual scientific results. These effects are mostly felt through greater mobility of researchers and new collaborating patterns emerging in the form of closely knit networks of research teams.

- Synergies are rapidly developing between actions resulting in scientific interchange, common workshops, coordination of work programmes, etc. Such developments can be seen, for instance, in the three Actions investigating III - V microstructures, (NANOFET, NANSDEV, LATMIC), in the three Actions developing a framework for human-computer interaction, (AMODEUS, MOHAWC, KAUDYTE), and in the formation of an algorithms group including the top European experts with close cooperation links.
- Many new communication and cooperation channels are opening up between academia and industry and between ESPRIT industrial Projects and BR Actions. Examples are the close cooperation evolving in the area of databases (FIDE, ITHACA), and the collaboration between Actions and Projects investigating neural networks (NERVES,ANNIE,PYGMALION).

- Workshops organised in the context of BR Actions are seen more and more as major scientific events attracting many researchers both from within and outside Europe.
- Even though each Action has well focused research goals, there are evolving networks of institutions with close cooperation between them which address much broader and interdisciplinary areas than those of any individual Action. This invaluable trend should be nurtured and reinforced; the emergence of networks of cooperating research centers enhances mobility achieves critical mass though expertise , achieves critical mass, promotes interdisciplinary links and makes access to scarce human resources easier for all.

The closer cooperation and information exchange generated also enhances knowledge transfer between organisations. To further promote such transfer, a new approach has been adopted for the reviewing of Actions which is seen not only as a process of assessment but also as an opportunity for concrete interaction of the research team being reviewed with a broader community of peers and relevant industry. Most Action reviews are therefore accompanied by a workshop open to selected researchers from both academia and industry who are asked to contribute their views and ideas, as well as criticism.

The ESPRIT Basic Research Actions have taken off and constitute, as the ESPRIT Review Board put it, an "essential part of the continuation of ESPRIT". The first results of progress will be seen in 1990 but all indications so far show that this is an exciting and promising collective venture.

Highlights from the four main areas of activity follow.

Microelectronics

In the area of microelectronics, 26 actions and 2 working groups have been launched. Many different disciplines come together in these actions, such as physics, optoelectronics, organic, inorganic and physical chemistry, electronic engineering, materials science, and metallurgy. The main work in these actions includes:

- Low-noise and high-speed devices deriving from the use of low temperature electronics and high temperature superconductivity technology;
- Fundamental in-depth studies of structures based on new silicon III-V and II-VI compounds and other advanced substrates, and exploring quantum effects and tailoring of electrical properties;
- Nanometre-scaling of circuits including fabrication techniques based on realisation of organic molecule assemblages. Investigation of the electrical properties of organics, carrier transport control and electronic switching capabilities;
- Development of optoelectronic elements and devices to facilitate preparation of superfast parallel computing systems;
- Next generation design systems; development of formal methods and algorithms, for formal verification, behavioural synthesis, real-time VLSI architecture optimisation, and power timing optimisation.

Computer Science

15 actions and 6 working groups are under way. The actions provide a coherent coverage of basic research in computer science and will provide results of wide applicability. They include:

- Formal systems; the two main foundation components of computer science, logic and algebra, are addressed with a view to broadening and combining existing formalisms to create a basis for the development of industrially applicable systems.
- Concurrent systems; the work aims to unify competing theories (logics, languages, models) to provide an adequate framework for the description and analysis of concurrent systems.
- Specification and verification ; work covers the design of a specification language with the necessary system support, the use of logics as a foundation for specification techniques in concurrent systems, and ultimately a complex system which is amenable to automatic verification and deals with

multiprogramming and real-time requirements.

- Algorithms and integration of programming styles; efforts are focused on defining high level declarative programming languages, integrating aspects of functional, logic and object-oriented programming and strengthening research on the design and analysis of efficient algorithms.

- Dependability, data bases and distributed computing; actions cover the prototyping of an integrated systems architecture, and the software technology needed to provide integrated data base services and programming language capabilities. Concepts underlying design decisions and development techniques for assessing, predicting and validating dependability are dealt with in a unified manner.

Artificial Intelligence and Cognitive Science

20 actions and 5 working groups are in hand. Although the actions are classified into subareas below, individual actions often cover more than one area and also have close connections with computer science and microelectronics.

- Robotics and Vision: the issues of uncertainty, concerning the representation of space and movement, and of adequate functioning in real-world domains, are addressed by developing an understanding of the characteristics of systems that deal with natural environments.

- Neural networks: the emphasis is on the development of suitable hardware (VLSI) implementations of neural networks. A deeper understanding of the relationship between classical AI techniques and neural network techniques is also sought.

- Knowledge Representation: Actions deal with uncertain reasoning, automated deduction in non-standard reasoning, computer-aided tutorial environments, and the building of a framework for a reflective system able to reason about its own competence and to apply its knowledge flexibly.

- Speech and Natural Language Processing: The ultimate goal of robust, speaker-independent recognition of continuous speech, exploring neural network techniques and natural speech production is addressed. Other actions deal with large multi-lingual knowledge bases, the integration of speech and natural language, and the handling of discourse.

- Formal Theories of Automated Manufacture: The major need for a unification of the field's fragmented theoretical foundations is addressed, aimed at formalising a conceptual model of product design, production and production management.

- Human-Computer Interaction: Actions cover modelling of human-computer interaction in complex work domains, cognitive modelling, and investigation of user behaviour in the laboratory.

The VLSI Design Training Action

In addition to research Actions and working groups, 1989 saw the launching of the VLSI Design Training Action, prompted by the shortage within the Community of trained VLSI designers. This shortage is now limiting the use of advanced microelectronics in a number of industrial sectors which are critically dependent on skilled people, including small and medium sized enterprises.

The Community's existing VLSI training capacity can accomodate about 1500 students per year. Given current estimates of the immediate need for highly skilled VLSI design manpower, training places will have to be increased by at least 3000 per year. The VLSI Design Training Action aims to achieve this additional capacity.

The main obstacle to training which this Action addresses is access to silicon, and to the infrastructure necessary to make good use of that access (workstations, CAD software, testers, skilled trainers etc). The enormous overhead to which a single university would be subjected if it were to access such facilities on its own is reduced dramatically by providing a central service organisation for 118 universities participating in the Action which also acts as the focal point in negotiations with

providers of industrial fabrication facilities (foundries) and with suppliers of design tools.

There are five organisations participating in the central service organisation - Circuits Multi Projects , Danmarks Tekniske Hoejskole , Gesellschaft für Mathematik und Datenverarbeitung GmbH, Interuniversitair MicroElectronica Centrum vzw and Rutherford Appleton Laboratory .

The 118 universities and Polytechnics participating, include experienced institutions already active in VLSI design training, as well as institutions proposing to enter the field for the first time and which are not yet fully equipped to do so. To enhance their training capabilities, they will be provided with access to a range of industrial fabrication facilities and to high-quality CAD software. Their design hardware will be supplemented where necessary by dedicated workstations and dedicated IC testers. Most importantly, when needed, they will receive support for an additional dedicated lectureship for the period of the Action. Additional institutions can join the Action on a "pay as you use" basis.

Some 50 fabrication runs will be launched over a limited period of two to three years. Each run will include multi-project chips and wafers from academic institutions in several countries.

As a further step to be taken during the Action, the fabrication service will be extended to all academic institutions of the Community which may wish to take part at their own expense and avail themselves of such reduced prices as may be negotiated centrally.

The Information Exchange System

Overview

The international cooperation which characterises ESPRIT projects requires that the project participants communicate with each other not only by the traditional methods such as conferences, seminars, workshops and special interest groups, but also that they should be able to make immediate contact with their partners in other organisations or countries in an easy and cost effective way. Furthermore, in order to encourage cross fertilisation between new ideas and developments, the involved scientists and engineers should be able to contact readily those who participate in other ESPRIT projects, and have access to the Commission's Scientific databases which are hosted on the DG XIII sponsored "ECHO" host in Luxembourg. It is also desirable that participants in other Community programmes, and indeed European scientists generally, should have access to this type of information and have available high quality, cost effective communications tools and network facilities.

To this end, three lines of activities are pursued within ESPRIT:

- The provision of communication services to ESPRITparticipants;
- R&D projects aiming to accelerate the availability of OSI conformant computer communications software;
- Harmonisation of the implementation of inter computer communication protocols, by providing strong encouragement for the adoption of the ISO-OSI model. Particular support is given to European-wide researchers networking activities such as the EUREKA COSINE project in order to enable interworking between researchers and their computers across all participating countries.

These three types of activity are closely related: the communications services are gradually improved as new developments take place, and users point to the need for yet more developments, which again causes further need for harmonisation activities.

To disseminate information about activities, the IES Newsletter is published every two months and contains information of specific interest to specialists in researchers networking. The Newsletter has now reached its silver jubilee, with the 25th edition being published at the end of 1989. This newsletter, with specific sections being provided by CEN-CENELEC , IT standards, and COSINE Project Groups, is now distributed to over 10,000 people throughout Europe who are active in this field.

Communication Services

The main objective in providing services to the participants is to satisfy the users requirements for readily available and cost effective electronic mail. Through the provision of EuroKom, electronic mail and conferencing service facilities have been made available to the programme participants throughout all Member States, via the public packet switched networks.

The conferencing function is a useful addition to the electronic mail service, and allows users to easily group their messages by subject, and to selectively receive just those messages that are required at a particular moment.

1989 saw a significant increase in the use of EuroKom, and the user base grew by 40% over the period to 2,100 registered users. A corresponding increase in the number of messages generated was also recorded, which now stands at an average of 600 per working day.

Improvements have been implemented for the handling of traffic, and so the performance of the system, as perceived by the user, has been maintained.

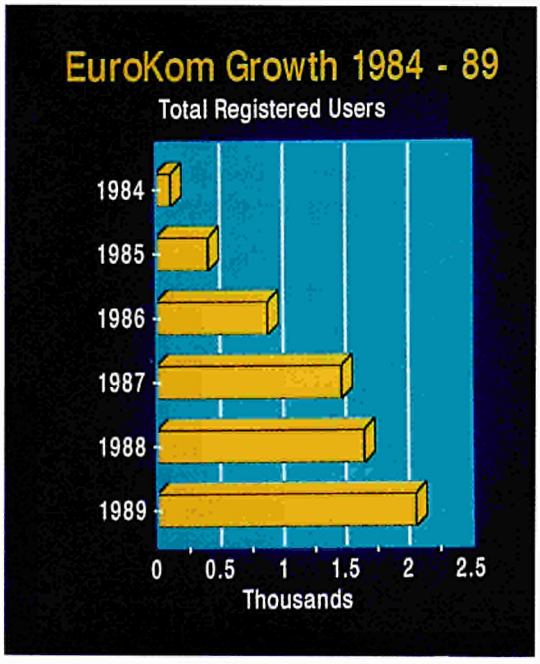
Many people in the ESPRIT environment are now accessible via telefax, and so a further mechanism was implemented enabling messages to be sent directly for facsimile transmission. This has proved to be a very popular feature, and over 1,200 messages were transmitted via this method during the first month of operation. This feature is proving particularly useful when a message is required to be sent to a large number of people.

Demand is now growing for project participants to exchange and subsequently edit formatted documents. During 1989, some projects implemented the procedures necessary for document handling, so all their participants are now capable of re-editing formatted documents which were generated by their colleagues and transmitted to them via EuroKom.

Considerable work has been expended in improving the user interface for EuroKom. Additional software has been developed that the user may load locally into his own PC, which gives further simplification and user friendliness.

Other IES services, such as Eurocontact, are described in the following section concerning Awareness Activities.

The number of users of Eurokom continues to grow and reached 2100 during 1989.



It is the Commission's policy to support the introduction of international standards, and therefore ESPRIT encourages the adoption of OSI conformant communications applications wherever possible. Standards conformant products for X.400 electronic mail are now becoming available in the marketplace, and an X.400 gateway has been implemented which will enable EuroKom subscribers to communicate with their colleagues who have already implemented these new products. Additionally, in 1989 further action was undertaken in conjunction with leading industrial companies under the title of "Y-NET". This project is aimed at providing X.400 services to community researchers in all Member States. Particular emphasis is placed on the needs of SMEs who have historically experienced difficulties in accessing open European-wide communications systems. The key to the success of Y-NET is the provision of a reliable and professional management and coordination activity. Therefore, while the collaborating IT manufacturers are contributing the necessary hardware and software to support the implementation of the service points in each country, the Commission is ensuring that the necessary operating infrastructure is put in place so that a high grade of service can be provided.

RARE Message Handling System

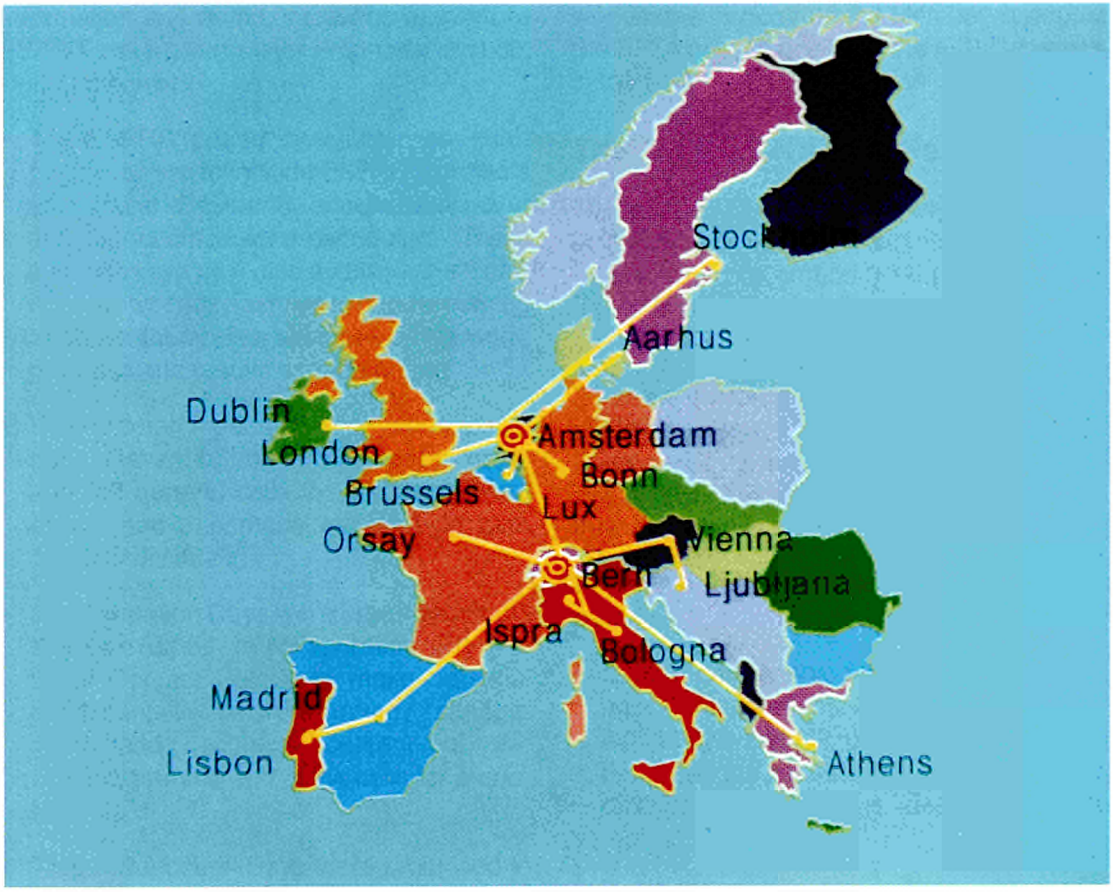
The Réseaux Associés pour la Recherche Européenne (RARE) represents those people responsible for the national research networks throughout Europe. The RARE members are operating on their own behalf an electronic mail system which is X.400 conformant and has a world-wide coverage of over 530 intercommunicating sites, each one supporting the costs of operating their own system. However, certain activities such as routing charges and the release of new facilities need coordination at the international level and ESPRIT has provided support to achieve this. It is estimated that during 1989 12,000 researchers were regular users of this system. This ability to extend communications to the international level has been made possible by ESPRIT.

International X-25 Infrastructure (I X I)

The EUREKA COSINE project is dedicated to ensuring that the European researcher is provided with good quality, standards conformant

data communications services. As part of the significant encouragement given by the Commission to this EUREKA project, a supporting project was launched in 1989 within the framework of ESPRIT with the objective of putting in place a European-wide backbone network. This network assures communications integrity which would otherwise not be available from the public service providers. Community funding also allows for more unified and equitable tarifs which encourages wider use of international communications services.

The I X I network will provide a standards conformant, pan European network over which research workers can intercommunicate.



IES Development Projects

Special steps have been taken within ESPRIT to encourage European manufacturers to develop OSI conformant communications. Several projects were successfully completed in 1989, culminating in demonstrations at the ESPRIT conference.

In order that electronic mail may be sent to subscribers of systems other than the senders own, directory services are needed which provide the sender with the necessary addressing information. THORN, project 719, targeted the study and development of such directory services, and in 1989 an X.500 conformant pilot was implemented across the participants sites and demonstrated at the ESPRIT conference. Directories implemented on several different manufacturers computers and serving local electronic mail systems in France, Germany, Italy and UK were interrogated at the demonstration during the ESPRIT conference, in a manner independent of the locally implemented interface style.

CARLOS, project 718, was dedicated to investigating the most effective means for allowing the large existing set of personal computers to have OSI conformant communication possibilities. This had already resulted in a device named the OSI-PAD enabling PC's to be directly connected to the public packet switch network, and in 1989 work continued on two further extensions of the projects:

- CACTUS, which has developed X.400 conformant message-handling software for a cluster of PC's around a local server. By

using formal description techniques and automatic code generation, the CACTUS implementation is easily adaptable to the evolving standards. A prototype was shown at the 1989 ESPRIT Conference. The success and potential of the work was such that within the framework of the Spanish Research networking organisation (IRIS) two of the project partners (the Universities of Madrid and Barcelona) are continuing their work without further Community funding.

- SESTA built upon the code developed in CARLOS and implemented a revised version on a plug-in card for personal computers. This provides an X.25 interface at speeds up to 64 K b/s and a V24 interface up to 19,200 b/s. The prototype was successfully demonstrated in Dec 1989, showing both File Transfer Access and Management (FTAM) as well as Virtual Terminal (VT) applications.

Awareness Activities

Providing access to ESPRIT results and information

Information and communications relevant to ESPRIT were given major emphasis in 1989. During the year:

- The ESPRIT project synopses were completely revised to include ESPRIT II projects and Basic Research actions and over 100,000 volumes were distributed. These synopses are now also available via Euro-Kom, as an added service to people wishing to obtain thumb-nail sketches of the work, progress and results of each project.;
- Workprogrammes and information packages relevant to both the Microelectronics and the general calls for proposals were established and made available to over 14,000individuals;
- 15 Information Days were organised in the Member States, in collaboration with National Contact Points, to make potential participants aware of the strategy, management and technical content of the workprogramme and of the calls for proposals;
- Three Proposers' Days were organised in Brussels, with a total attendance of over 1,300 participants. Potential project participants were provided with detailed information on each work area and given the opportunity to identify potential partners;
- With strong support from national organisersinMemberStates,a"EUROCONTACT" service was operated, giving help to prospective ESPRIT participants to form consortia.

In addition, ESPRIT projects were demonstrated at numerous exhibitions and results were presented at conferences, symposia and workshops throughout the Member States, in the EFTA countries and at the IFIP Congress in the USA.

The 1989 ESPRIT Conference

The annual ESPRIT Conference, organised during the last week of November in Brussels was attended by around 3000 persons which represents an increase of approximately 50% compared to 1988.

It was the opportunity for people representing political, industrial and scientific interests of European Information Technology to meet and discuss the results and achievements of their work within the ESPRIT programme.

During the week, the different events that took place were:

- a three day technical conference, with 87 paper presentations, complemented by 79 workshops and 22 panels where participants had the possiblity to exchange and to discuss, in small groups, ideas on different topics;
- the IT Forum Day, giving distinguished European IT personalities the opportunity to discuss broad strategic issues of importance to the future of high technology in Europe. Mr F.M. Pandolfi, Vice President of the Commission of the European Communities chaired the event, which featured the following speakers:

  Mr H. Curien - Minister of Research and Technology in France and Chairman of the Council of Research Ministers;

  Mr A. La Pergola - Chairman of the European Parliament Commission on Energy, Research and Technology;

Viscount E. Davignon - Chairman of the Société Générale de Belgique;

Dr U. Agnelli - Vice-Chairman of Fiat;

Dr H. Nasko - Executive Board Spokesman of NIXDORF and Chairman of the ESPRIT Advisory Board.

The IT Forum Day proceedings were retransmitted via satellite to more than 40 sites by Europace;

- a press conference by Mr Pandolfi for over 70 journalists;
- a discussion session on the recommendations of prominent members of the European IT community as to future directions of ESPRIT;
- a special session on Technology Transfer within the ESPRIT programme with presentation of case studies and commentary by a panel of outside experts:

  Dr Jos B. Peeters - Chairman European Venture Capital Association;

  Mr J. Aris - Director, National Computing Centre;

  Dr J. Lambrecht - Director, Industrieberatung Lambrecht;

  Mr M-H. Menard - Director, Innovation 128;

- a special session on SME participation in the ESPRIT programme;
- an exhibition, covering 2000 sqm, with 130 projects participating in more than 100 exhibits. Some of the most imaginative and innovative products at the exhibition have been produced by the many small companies involved in ESPRIT.

The Conference was also visited by Members of the European Parliament who attended the IT Forum and were given a special presentation as well as a guided tour of the exhibition.

Increasing knowledge transfer between researchers - Technical Interest Groups

As in previous years, the ESPRIT Technical Interest Groups and associated activities provided an important communication platform between projects with common interests and wider audiences. Information on individual TIGs including contact points, follows:

CIM-Europe

CIM-Europe, now in its fifth year, continued to expand its role in disseminating information and encouraging reaction, discussion and application to ensure that the results of ESPRIT-CIM and the general benefits of CIM are better known and used.

CIM-Europe is based on a number of Special Interest Groups which are open to all parties, and cover following subjects:

- Architectures and Communications
- Fieldbus
- Advanced Information Processing
- Human Factors in CIM
- CAD Interface
- Control and Management for Production Systems
- Production Systems Design and Engineering
- Advanced Robotics and Intelligent Sensors
- Model based predictive control.
- In 1989 there were 21 technical and discussion meetings of CIM-Europe's Special Interest and Advisory groups.
- Public events included six workshops, four of which covered the results of ESPRIT-CIM projects, these were attended by some 700 persons from industry and academia.
- The highlight of the CIM-Europe year was the Annual Conference which was hosted by the Athens Chamber of Commerce. More than 300 delegates attended to exchange experiences and to hear over 40 quality presentations.

Contact Point:

CIM-Europe Secretariat - CEC
DGXIII/A/6
Tel: + 32 2 236 30 97
Fax: + 32 2 236 30 23

CAD for VLSI in Europe (CAVE)

The first CAVE workshop was held in May 1983. During 1989 workshops were held in May and in December.

- disseminating the results of ESPRIT CAD projects
- ensuring rapid and consistent exploitation of new research ideas by means of selected tutorials
- maintaining the strong sense of identity of the existing community of CAD researchers in Europe
- encouraging strategic thinking and debate on critical issues, leading, for example, to recommendations for future actions.

Contact Point:

M. J Newman - CEC
DGXIII/A3
Tel: + 32.2.235.70.63

Graphics and Interaction in ESPRIT

The objective is to encourage information exchange in the computer graphics field. In 1989 two workshops were held in Brussels.

Contact Point:

D. A. Duce
Rutherford Appleton Laboratory
Chilton, Didcot
OXON OX11 OQX, UK
Tel: + 44.235.44.55.11
Fax: + 44.235.44.58.31

LISP

The objective of this group is the preparation of an international standard for the programming language Lisp. This group is open to all European parties interested in the definition and the use of a standardized Lisp.

In 1989 six meetings were held to prepare "The EULISP Definition".

Contact Point:

Jérôme Chailloux and Greg Nuyens,
ILOG
2, avenue Galliéni
94253 Gentilly, France
Tel: + 33.1.46.63.66.66
Fax: + 33.1.46.63.15.82

Lithography

This group has the following objectives:

- exchanging views in the field of optical, E-beam and X-ray lithography
- promoting the standardisation of metrology procedures.

The group meets once or twice a year. The core participants of the group are partners in ESPRIT and EUREKA projects, but in certain events others may also participate. A workshop was held in Brussels in November 1989 during the annual ESPRIT Conference.

Contact Point:

Leo Karapiperis
DGXIII/A3
Tel: + 32 2 236.07.20

VDM-Europe

VDM-Europe was formed in 1985 with the objective of increasing the awareness, use, development and standardisation of the Vienna Development Method (VDM).

The group is open to all European parties interested in the use, propagation, and further development of VDM.

Principal Activities in 1989

- three meetings were held in 1989 on VDM standardisation and the presentation of VDM-related projects

Contact Point:

Karel De Vriendt - CEC
DGXIII/A2
Tel: + 32.2.235.77.69

Technical Interest Group on VLSI Manufacturing Automation

This group has the following objectives:

- exchanging views and experience in the implementation of standards, and recommending changes and additions to standards
- promoting future industrial cooperative actions for tackling VLSI automation-related problems

- collating semiconductor manufacturing requirements for automation and reliability in order to provide informal recommendations to manufacturers and users
- promoting the use of, and disseminating information on, a uniform set of standards.

The group meets at least twice a year. The core participants are partners in ESPRIT and EUREKA projects; others may participate by invitation. Two workshop were held in Brussels in 1989.

Contact Point:

Leo Karapiperis
DGXIII/A3
Tel: + 32 2 236.07.20

Industrial Developments in IT

ESPRIT is an industrial programme. For that reason alone it is relevant to consider the IT scene in Europe and to note the situation in the various market segments (microelectronics, industrial automation, software, business systems) which relate directly to the programme.

The output from the Information Technology industry represents almost 5% of Europe's gross domestic product and is one of the largest sectors, indeed larger than the automotive sector. Furthermore, many other industries and services depend for their efficiency and competitiveness on IT. Information Technology has a key role to play in ensuring high prosperity and quality of life through the coming decades. Europe's IT industry is an important engine driving the European economy towards success in the world marketplace and therefore continued attention must be paid to its well being.

The traditional handicaps of fragmentation can only be overcome through collaboration, here ESPRIT is having an important catalytic role through industrial restructuring on a European and global scale. Mergers and acquisitions have been noteworthy within IT related industries in recent years and for the most part these must be expected and welcomed as contributory factors in increasing the competitiveness of Europe's overall industrial base. Important examples include:- Bull/Zenith, Siemens/Nixdorf, Sema/CAP, SGS-Thomson/Inmos. ESPRIT, which represents some 5% of the total R&D in Europe in IT, and a much larger share of the precompetitive work, has stimulated the growth of investment to new levels which are already working their way through to break the vicious circle of decline.

Preliminary data on 1989 company performance indicate that in 1989 the world market for information systems grew by 14% and the European market grew by 16% to a total value of nearly $133 billion. The world-wide growth rate was lower than the 16% experienced one year before, but still sufficient to confirm the expectations (Fig. 1) for a world market reaching $650 billion in 1992, the European market representing at that time 33% of the world-wide market, compared with 30% in 1988. It is also a confirmation of the increasing importance of the European market: higher growth rates and the foreseen effects of the single European market will certainly attract increased marketing efforts on the European scene.

The largest contribution to growth in 1989 came from the software and services sectors, compensating for a much lower growth in hardware sales. The largest companies suffered more than others from this imbalance: at least four companies out of the top ten had a growth rate of less than 5%. The market slowed down significantly in the USA and this will have an important impact on the European market which has become the major source of sales and profits for the big international players. Some of the largest US companies would not have shown growth at all without the contribution of European sales. European companies performed well in this harsh competitive environment and for the first time, three European companies are firmly positioned amongst the top ten in the world-wide information system market.

When more accurate data are available, it is likely they will confirm the common opinion of analysts indicating that in 1989 the profits of IT companies did not grow at the same rate as revenues and in many cases were lower than in 1988. The opinion of analysts is that the IT industry in the future will not generally show the profitability experienced in recent years: this is because IT companies need increasing

Present market and forecasted market growth in key sectors of IT.

	1988 Market			1988-1992 Annual Growth Rate	
	World $ billion	Europe $ billion	Eur/World %	World %	Europe %
Minis and mainframes	70	24	34%	6%	9%
PC and workstations	57	18	32%	22%	26%
Peripherals	91	25	27%	13%	12%
Software and services	161	48	30%	15%	18%
Total - Information systems	379	115	30%	14%	16%
Semiconductors	55	9.1	13%	17%	14%
Industrial automation	98	26	27%	10%	11%

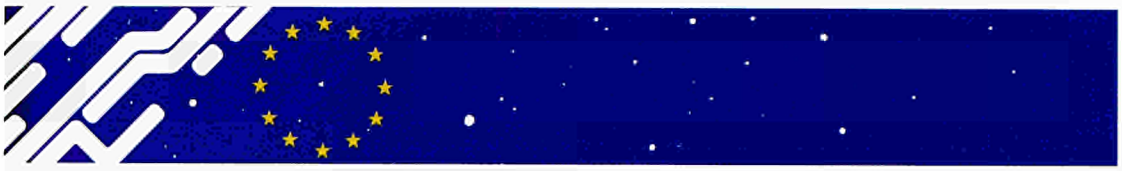
Sources: Price Waterhouse, Dataquest, EIC.

investments in R&D, the hardware share of IT expenditure by the users is decreasing and the constraints linking the supplier to its customer base are less effective.

Several other factors will contribute to enhance the competition and to provide new opportunities, but at the same time will also represent major threats for those not able to adapt to the changing environment. These changes include the trend from proprietary to open systems; the tendency towards higher performance at lower price, which will extend the use of currently high-cost workstations, and the demand for more sophisticated services, eg. systems integration or comprehensive packages which is replacing the present fragmented demand for software. Major R&D investments are essential conditions for taking advantage of these opportunities.

The growth in the industrial automation sector was lower in 1989 than that of the information systems sector. However this does not reflect the much higher and continuing increase in the IT content of industrial automation. The same factors influencing the information systems market hold valid for the IT applications in the field of industrial automation, with the additional element represented by a more stable path of the demand, aligned to the capital investment plans of the manufacturing industry.

In semiconductors the market growth in 1989 was also higher in Europe than in the other regions: 14%, against a world-wide growth of 10%. The results of European semiconductor companies are particularly worthy of consideration: the combined increase in sales of the three largest European companies was significantly higher than the average market growth. This is an important indication of the future possibilities for obtaining a better position in the production of semiconductors which matches the high level of European consumption.



The ESPRIT Review (1984-88)

The ESPRIT Review Board was set up in October 1988 under the chairmanship of Dr A.E. Pannenborg and presented its findings in May 1989. Its objectives were to assess the extent to which ESPRIT I was meeting its objectives, to determine the effects of the programme, and to assess the need for changes affecting ESPRIT or future IT-related programmes. It was the first full review of a Community R&D programme in the industrial sphere at its five year mark.

The Board's overall perception of ESPRIT I, after a large number of interviews and considerable research, was positive. They found that in the vast majority of projects, trans-European cooperation has been a success and that the European technology base has improved as a result of ESPRIT. Moreover, ESPRIT has helped European companies to move from followers to leaders in the evolution of standards. However, they concluded that it would be hazardous to underestimate the problems which remain, including dependencies on overseas supply in key technology areas.

The Commission has accepted the principal recommendations of the Board.

In particular the Commission:

- Accepts that Information Technology remains of strategic importance to the European economy, and is a key to the competitiveness of a large proportion of European industry as well as the means to support improvements in the quality of life of the European citizen.
- Will ensure that users of Information Technology products and services, and in particular, software houses, are involved more directly in the formulation of the annual workprogramme.
- Intends to firmly enforce the recommendation of the Board to limit the number of partners in consortia (except for projects which are mainly standardization-oriented).
- Undertook, as a result of the Board's analysis of aspects of project administration, to set up a small task force composed of experienced project managers, including ESPRIT project partners, which worked in a concentrated manner and identified concrete operational measures to implement the Board's recommendations.

ESPRIT Projects and Partners

Microelectronics

10
High Level CAD for Interactive Layout and Design
AEG, Bull, General Electric Company, Plessey Company

14
Advanced Interconnect for VLSI
General Electric Company, Plessey Company, Telefunken Electronic, Thomson-CSF-DTE

42
Description Languages for VLSI
Nederlandse Philips Bedrijven, Siemens

71
A Compiler for Advanced Signal Processor
Bell Telephone Mfg Co., Katholieke Universiteit Leuven, Thomson-CSF

97
Advanced Algorithms, Architecture and Layout Techniques for VLSI Dedicated Digital Signal Processing Chips
Bell Telephone Mfg. Co., Imec VZW, Philips Gloeilampenfabrieken, Ruhr Universität Bochum, Siemens, Silvar-Lisco

232
Compound Semiconductor Materials & Integrated Circuits - I
Laboratoire de Physique Appliquee, Plessey Company, Siemens, Thomson-CSF-DCI

243
Submicron Bipolar Technology - I
Cemota, Plessey Company, Technische Universität Berlin, Telefunken Electronic, Thomson-CSF-DTE, Thomson-CSF-Laboratoire Central de Recherche

244 HYETI
High Yield High Reliability Ultra-large Scale Integration System through Reconfigurability
British Telecom, Brunel University, Bull, CEA-LETI, Cirrus Computer, IMAG, Institut National Polytechnique de Grenoble, SGS-Thomson Microelectronics, Technische Hochschule Darmstadt

245
SOI Materials and Processing Towards 3-D Integration
CEA-LETI, CNET, General Electric Company, National Microelectronics Research Centre, SGS-Thomson Microelectronics, University of Camondge

255
CAD Methods for Analog GAAS Monolithic IC's
CISE, Politecnico di Torino, Siemens, Telettra

263
Integrated Opto-Electronics on INP
CGE-Laboratoires de Marcoussis, CNET CSELT, GEC Marconi Research Centre, Heinrich Hertz Institut, Standard Elektrik Lorenz, STC Technology, Thomson-CSF-Laboratoire Central de Recherche

271
Automatic Design Validation of Integrated Circuits Using E-Beam
British Telecom, CNET, CSELT, IMAG-LGI-Laboratoire, GENIE Informatique, Trinity College, Dublin

281
Submicron Bipolar Technology - I
RTC Radiotechnique Compelectr., Siemens

305
Assessment of Silicon MBE Layers
AEG, General Electric Company, ISA Riber

334
Plasma Deposition Technology for Magnetic Recording Thin Film Media
Basf, Leybold Heraeus, Sagem

369
Physical Chemical Characterization of Silicon Oxynitrides in Relation to their Electronic Properties
Aere-Atomic Energy Research, Imec VZW, Matra Harris Semiconducteurs (MHS), Philips Gloeilampenfabrieken, Universiteit Van Utrecht

370
Silicon-on-Insulator Systems Combined with Low Temperature Silicon Epitaxy
General Electric Company, Imec VZW, Mietec

380
Optical Interconnect for VLSI and High Bit Rate IC's
GEC Marconi Research Centre, Telettra, University of Southampton

412 BiCMOS
A High Performance CMOS-Bipolar Process For VLSI Circuits
Philips Gloeilampenfabrieken, Siemens

443
Molecular Engineering for Optoelectronics
CNET, Faculte Universitaire Notre-Dame de la Paix, Imperial Chemical Industries, Thomson-CSF-Laboratoire Central de Recherche

456
Improvement of Yield & Performance of ICS by Design Centering
AEG, SGS-Thomson Microelectronics, Telefunken Electronic, Universität Stuttgart

491
Materials and Technologies for High Mobility TFTS for LC Display Bus Drivers
AEG, CETIA, CNET, CSEE

509
Substrates for CMOS VLSI Technology
Imec VZW, Matra Harris Semiconducteurs, SGS-Thomson Microelectronics

514
Quantum Semiconductor Devices
General Electric Company, Thomson-CSF-Laboratoire Central de Recherche

519
Dopant Profiling for Submicron Structures
AEG, General Electric Company, Imec VZW

522
Compound Semiconductor Materials & Integrated Circuits - I
Bell Telephone Mfg. Co., CNET, Farran Technology, General Electric Company, STC Technology Ltd, Telefunken Electronic

544
Investigation of all Aspects of the Interconnection of High Pincount Integrated Circuits
BPA Techn. & Management, British Aerospace, Lucas Stability Electron, National Microelectronics Research Centre

554 SPECTRE
Submicron CMOS Technology
Aarhus Universitet, Aere-Atomic Energy Research, British Telecom, Bull, CNET, CNR-Istituto Lamel, VZW, Matra Harris Semiconducteurs (MHS), SGS-Thomson Microelectronics, Telettra, Universite Catholique Louvain

574
High Resolution Plasma Etching in Semiconductor Technology-Fundamentals, Processing and Equipment
Atomic Energy Research, Fraunhofer IM, Johnson Matthey Chemical, Leybold Heraeus, Mono Light Instruments

802 CVS
CAD for VLSI Systems
AEG, British Telecom, CIT-Alcatel, CNET, CSELT, GMD, Italtel Telematica, Matra Harris Semiconducteurs, SGS-Thomson Microelectronics

824
Wafer Scale Integration
British Telecom, CEA-LETI, Institut National Polytechnique de Grenoble, National Microelectronics Research Centre, SGS-Thomson Microelectronics, Technische Hochschule Darmstadt

830
Packages for High Speed Digital GAAS Integrated Circuits
Mo Valve Company, Thomson-CSF-Laboratoire Central de Recherche

833
Large Area Complex Liquid Crystal Display Addressed by Thin Film Silicon Transistors
AEG, Aristotle University of Thessaloniki, CNET, General Electric Company, Modulex, Thomson-CSF-Laboratoire Central de Recherche, Universita di Bologna

843
Compound Semiconductor Integrated Circuits
Farran Technology, General Electric Company, Laboratoire de Physique Appliquee, Plessey Company, Siemens, STC Technology, Thomson-CSF-DCI

887 ECIP
European Cad Integration Project
Bull, CIT-Alcatel, ICL, Nederlandse Philips Bedrijven, SGS-Thomson Microelectronics, Siemens

888 AIDA
Advanced Integrated-Circuit Design Aids
ICL, SGS-Thomson Microelectronics, Siemens

927
Basic Technologies for Gainas Misfets
Aixtron, Laboratoire de Physique Appliquee, RWTH Aachen, Wacker Chemitronic

958
High Performance VLSI Packaging for Complex Electronic Systems
British Telecom, Bull, GEC Research Laboratories

962 EVEREST
Three Dimensional Algorithms for Robust and Efficient Semiconductor Simulator
Analog Devices, General Electric Company, Imec VZW, National Microelectronics Research Centre, Nederlandse Philips Bedrijven, Rutherford Appleton Laboratory, GS-Thomson Microelectronics, STC Technology, Trinity College Dublin, Universita di Bologna, University College of Swansea

971
Technology of GaAs Bipolar Integrated Circuits
CNET, Farran Technology, General Electric Company, Plasma Technology, Plessey Company

986
Optical Interconnect for VLSI and High Bit Rate ICS
GEC Marconi Research Centre, Telettra, University of Southampton

991
Multiview VLSI - Design System ICD
British Telecom, ICS, INESC, Peripheral Computer Systems, Technische Universiteit Delft, Technische Universiteit Eindhoven, University of Essex

1007
0,5 Micron X-Ray Lithography:Sources,Masks,Resist and Transferred Image
CNR-IESS, CNRS, King's College London, SGS-Thomson Microelectronics, Thomson-CSF-Laboratoire Central de Recherche

1043
Advanced Mask and Reticle Technology for VLSI Submicron Microelectronics Devices
BMP Plasmatechnologie, British Telecom, Imec VZW, Plessey Semiconductors, Siemens, Valvo Bauelemente Philips

1056
Ultrasensitive Impurity Analysis for Semiconductor Structures and Materials
CAMECA, Imec VZW, Philips Research Laboratories, Siemens

1058
Knowledge Based Design Assistant for Modular VLSI Design
Imec VZW, INESC, Philips Gloeilampenfabrieken, Silvar-Lisco

1128
Large Diameter Semiinsulating GAAS Substrates Suitable for LSI Circuits
Laboratoire de Physique Appliquee, Universite Catholique Louvain, Wacker Chemitronic

1270
Advanced Processing Technology for GAAS Modulation Doped Transistors and Lasers
CNET, Elltec, Plessey Company, Research Center of Crete - Cretan Computer, University of Wales I.S.T.

1551 AMS
Advanced Manufacturing System
Marconi Electronic Devices, SGS-Thomson Microelectronics

1563 ACAFS
Automatic Control of an Asic Fabrication Sequence as Demonstrated in the Plasma ETCH Area
Bertin & Cie, European Silicon Structures, Leybold Heraeus, Mietec, Plasma Technology

2013
Development of European Magneto-Optical Drives
Sagem, CEA-Leti, Coventry Polytechnic, Hoechst, Lexikon

2016 VHS BIPOL TECH
Very High Speed Bipolar Technology and Circuits
Siemens, Philips Gloeilampenfabrieken, Plessey Company, SGS-Thomson Microelectronics, Telefunken Electronic

2035
Advanced GAINAS Based Transistors for High Speed Integrated Circuits
Plessey Company, Philips-Lep, Picogiga, STC Technology, Thomson-Csf

2039 APBB
Advanced PROM Building Blocks
Plessey Company, SGS-Thomson Microelectronics, STM-SGS-Thomson Microelectronics

2048
Deep UV-Lithography
ASM-Lithography, Carl Zeiss, Commissariat a l'Energie Atomique, Fraunhofer, Hoechst, Nederlandse Philips Bedrijven, Siemens

2072
European CAD Integration Project
Bull, ICL, Nederlandse Philips Bedrijven, Nixdorf Computer, SGS-Thomson Microelectronics, Siemens, Thomson-Csf

2075 APACHIP
Advanced packaging for High Performance
Bull, GEC Research Laboratories, Hoechst Ceramtec, Institut National Polytechnique de Grenoble, Micro-Connectique Technologies, National Microelectronics Research Centre, Siemens, Souriau & Cie

2125 ETR
Electrothermal Ribbon
Baltea, AEG Olympia, Ing. C. Olivetti & C., Manchester Polytechnic

2193 ADCIS
Analog-CMOS ICS
Matra Harris Semiconducteurs, Anacad-Computer Systems, Centro Nacional de Microelectronica, CNET, Instituto Superior Tecnico, Mietec, National Microelectronics Research Centre, Universidad de Sevilla

2197 STORM
Process Modelling and Device Optimization for Submicron Technologies
CNET, CNR-Istituto Lamel, Fraunhofer IM, IMEC, National Microelectronics Research Centre, Plessey Company, SGS-Thomson Microelectronics, Universita di Bologna

2260 SPRITE
Interactive Silicon Compilation for High-Performance Integrated Systems
IMEC, Nederlandse Philips Bedrijven, Racal Research, Siemens

2265 DRYDEL
Dry Develop Optical Lithography for ULSI
IMEC, CEA-Leti, Farran Technology, Nederlandse Philips Bedrijven, Plessey Company, Siemens, UCB Electronics

2268 CANDI
Combined Analogue Digital Integration
SGS-Thomson Microelectronics, Telefunken Electronic

2270 IDPS
Integrated Design and Production System
SGS-Thomson Microelectronics, ICL, Nixdorf Computer, Plessey Company, Siemens

2272 SMILE
Technical Feasibility of High Volt Smart Power IC's for Lighting Applics
SGS-Thomson Microelectronics, Philips Gloeilampenfabrieken

2281 UNITED
High-T Superconducting Thin Films and Tunnel Junction Devices
Thomson-Csf, CNRS, Nederlandse Philips Bedrijven, Universite de Paris VII, University of Cambridge

2283
Active Matrix LCD for TV and Office Systems
Eurodisplay, AEG, GEC Research Laboratories, IMEC, Thomson Consumer Electronics

2284
Optoelectronics with Active Organic Molecules
Thomson-Csf, Commissariat a l'Energie Atomique, CNET, Facultes Universitaires Notre-Dame de la Paix, ICI Imagedata

2289 OLIVES
Optical Interconnections for VLSI and Electronic Systems
STC Technology, Centro Nacional de Microelectronica, Forth Research Center of Crete, IMEC, Plessey Company, Siemens, Swiss Federal Institute of Technology, Thomson-Csf, University College London

2318 EVEREST
EVEREST
Elektronik Centralen, Bull, Nederlandse Philips Bedrijven, Siemens, Telefonica Investigacion y Desarrollo

2319
ASIC Multichamber Rapid Thermal Processing with Microwave Enhancement
Sitesa Addax, CEA-Leti, CNRS-Laas, SGS-Thomson Microelectronics, STC Technology, University of Edinburgh

2360 FELICITA
Development of Ferroelectric Liquid Crystal Devices for Information Technology Applications
GEC Research Laboratories, E. Merck, Oce-Nederland, Robert Bosch, Seleco, Thomslagerwall, Thomson-Csf, Thorn Emi, Universidad de Madrid-Etsi, Universita di Bari

2394 ASAC
Application Specific Architecture Compilation
ICL, Bull, Ing. C. Olivetti & C., SGS-Thomson Microelectronics, Siemens

2403 MCBRIDE
Development of a Multi Chamber Batch Reactor for the Production of Multilayer Interpoly Dielectrics
Advanced Semiconductor Materials International, CEA-Leti, STM-SGS-Thomson

2426 IDPS
Very Fast Implementation of Complex Systems on Silicon
Philips International, Bull, European Silicon Structures, Marconi Electronic Devices, Robert Bosch

2430 BICMOS
Analog - Digital Integrated Circuits
Nederlandse Philips Bedrijven, Siemens

2437 ICARE
Industrial Characterization of an Advanced Resonant Etcher
Cit-Alcatel, CEA-Leti, Centro Nacional de Microelectronica, CNET, Nederlandse Philips Bedrijven, STC Technology, Trinity College Dublin

2478
Research into Boundary Scan Implementation
Nederlandse Philips Bedrijven, Elektronik Centralen, SGS-Thomson Microelectronics, Siemens, Silicon & Software Systems, Thomson Sintra-Asm, Thomson-Csf

2518
Wafer and Epilayer Improvement Correlated with Device Performances
Laboratoire de Physique Appliquee, Aixtron, ICI Wafer Technology, RWTH Aachen

2633
Magnetic Media for Future Ultra High Density Information Storage
Agfa Gevaert, Basf, Du Pont de Nemours Luxembourg

5002
New DUV Stepper Optics - Study of Feasibility
Carl Zeiss, ASM-Lithography, Heraeus Quarzschmelze 5003 PLANET Multiwafer Planet MOVPE Reactor Philips, Aixtron, Telefonica, Polyflow

5004 SEDESES
Selective Deposition of Silicides and Epitaxial Silicon
Advanced Semiconductor Materials International, Alcatel, CNET, Siemens, National Microelectronic Research Centre, IMEC

5005 ESD
Protection for Submicron Technologies
Siemens, IMEC, Philips, Technische Universitaet Muenchen

5011 JEPS
Bootstrap Project for Joint European Printer Server
Bull, OCE-Nederland, Siemens

5012 PREJEEMI
Bootstrap Project for a Multiple Device File Server
Bull, Philips, Siemens

5014
Mask & Reticle Technology for Advanced High Density and ASIC Devices
Compugraphics International, Balzers, Polymer Laboratories, BMP Plasmatechnologie, IMEC, Wild Leitz Instruments, Valvo Unternehmensbereich, Siemens, Semisystems

5018 SPRINT
Signal Processor using Innovative III/V Technologies
Forth-Research Center of Crete, CNET, Royal Signals & Radar Establishment, Siemens, Argumens, Plessey Company, Ingenieurbuero fuer IMHT, Universita di Roma - La Sapienza, Telefonica, Picgiga, Philips, Forth-Research Center of Crete

5020 PATRICIA
Proving and Testability for Realiability Improvement of Complex Integrated Architectures
Abstract Hardware, GEC, Politecnico di Milano, Italtel Telematica, University of Bristol

5026 METR-ICS
High Precision
Automated CD Metrology Station Philips, Integrated Circuit Testing, Rutherford Appeltor Laboratory

5029 SUBSOITEC
High Performance Submicron SOI-CMOS Technologies
Thomson-CSF, Fraunhofer, Commissariat a l'Energie Atomique, University of Sheffield National Microelctronic Research Centre, Marconi

5031 MOSDT
MOMBE for III-V Semiconductor Devices and Technology
Thomson-CSF, Forth-Research Centre of Crete, RWTH Aachen, Royal Signals & Rada Establishment

5032 AIMS
Advanced Integrated Millimeter Wave Subassemblies
Thomson-CSF, Alcatel, Universite de Lille, Telefunken Electronic, Elektronik Centralen

5033 PLASIC
Performance and Reliability of Plastic Encapsulated CMOS
ASIC's Mietec, Elektronik Centralen, Standard Elektrik Lorenz, SGS-Thomsor Microelectronics

5041 PROMIMPS
Process Module Integration in a Multichamber Production System
Alcatel, AST Elektronik, SCIC, Commissariat a l'Energie Atomique, Blazers Fraunhofer-IFT, Siemens, SGS-Thomson Micorelectronics, Plasmos, Philips

5048 ASIC 0.5 UM CMOS
European Silicon Structures,
British Telecommunications, Matra-MHS, Mietec, IMEC, CNET, Plessey Company STC-ICL, Telefunken Electronic, Telefonica, Standard Elektrik Lorenz

5052 MONOFAST
Monolithic Integration beyond 26.5 GHZ
University of Glasgow, Alcatel, Gaas Code, University of Cambridge, Nationa Microelectronic Research Centre, Farran Technology

Information Processing Systems

26
Advanced Algorithms and Architectures for Speech and Image Processing
AEG, CSELT, Hitec, Politecnico di Torino, Thomson-CSF, Universita di Torino, Universite de Strasbourg

32 PCTE
A Basis for a Portable Common Tool Environment
Bull, General Electric Company, ICL, Ing. C. Olivetti & C., Nixdorf Computer, Siemens

96
Expert System Builder
CIMSA Sintra, CSELT, Plessey Company, Soren T.Lyngsoe

107 LOKI
A Logic-oriented Approach to Knowledge and Data Bases Supporting Natural User Interaction
BIM, BP-Research Center, Cranfield Institute of Technology, Cretan Computer Institute, Fraunhofer IAO, INCA, Scicon, Scientific Control Systems, Technische Universität München, Universität Stuttgart

112
Knowledge Integration and Management Systems
Bull, CGE-Laboratoires de Marcoussis, INRIA, Prologia, Siemens, Universite de Paris Nord

125 GRASPIN
Personal Workstation for Incremental Graphical Specification and Formal Implementation of Non-Sequential SY
Epsilon, Etnoteam, GMD, Ing. C. Olivetti & C. Siemens, Tecsiel, Universitet Kaiserslautern, University of Patras

256
Time Dependency and System Modeling in kbs Design for Industrial Process Applications
CISE, Framentec

266 PEACOCK
Software Development Using Concurrently Executable Modules
Eurosoft Systems, Plessey Company, Polytechnic of Hatfield, Universität Dortmund, Universität Karlsruhe

267 ASSET
Automated Support for Software Engineering Technology Feasability Study
Gesellschaft für Prozessrechnerprogrammi, Plessey Office Systems

280
Intelligent Help for Information System Users
Courseware Europe, CRI, Dansk Datamatik Center, ICL, Universiteit van Amsterdam, University of Leeds

282 SPMMS
Software Production & Maintenance Management Support
GSI Tecsi CIT-Alcatel-SESA, Data Management, Sema Metra, Sofemasa

283 FOR-ME-TOO
Formalisms, Methods and Tools
CSELT, Siemens, Syseca Logiciel

300 REQUEST
Reliability and Quality of European Software
AEG, CISI-Informatique Internationale, Elektronik Centralen, Esacontrol, Gesellschaft für Reaktorsicherheit, STC IDEC, STC Technology, Thomson-CSF, UKAEA

302
Investigation of Performance Achievable with Highly Concurrent Interpretations of Functional Programs
CAP SESA Innovation, ICL, INRIA, University of Stirling

304
Design of Techniques and Tools to Aid in the Analysis and Design of Knowledge Based Systems
ICL, Network Systems, Polytechnic of the South Bank, Scientific Control Systems, Universiteit van Amsterdam

311 ADKMS
Advanced Data & Knowledge Management Systems
Bull, Hildesheim Hochschule, Ing. C. Olivetti & C., Nixdorf Computer, Technische Universität Berlin, Universita di Bologna, Universita di Torino

315 RAISE
Rigorous Approach to Industrial Software Engineering
Brown Boveri & CIE., CRI, ICL, STC Technology

316
An Architecture for Interactive Problem Solving by Cooperating Data and Knowledge Bases
CAP SESA Innovation, CSELT, ONERA-Centre d'Etudes Recherches Toulouse, Philips & Mble. Associated

348 GIPE
Generation of Interactive Programming Environments
Bureau voor Systeemontwikkeling, Centrum voor Wiskunde & Informatica, INRIA, Sema Metra

387
Knowledge Representation and Inference Techniques in Industrial Control
British Telecom, Framentec, Krupp Atlas Elektronik, Queen Mary College

390 PROSPECTRA
Program Development by Specification and Transformation
Alcatel Standard Electrica, CRI, Syseca Logiciel, Universität Bremen, Universität Dortmund, Universität Passau, Universität Saarbruecken, University of Strathclyde

393 ACORD
Construction and Interrogation of Knowledge Bases Using Natural Language Text and Graphics
Bull, CGE-Laboratoires de Marcoussis, Fraunhofer IM, Triumph-Adler, Universität Stuttgart, University of Edinburgh

401 ASPIS
Application Software Prototype Implementation System
CAP SESA Innovation, General Electric Company, Ing. C. Olivetti & C., Tecsiel, Universite de Grenoble

410 SEDOS
Software Environment for the Design of Open Distributed Systems
Bull, CNRS, ICL-International Computers, University of Twente

415
Parallel Architectures & Languages for AIP-A VLSI Directed Approach
AEG, Bull, CSELT, Centrum voor Wiskunde & Informatica, Ecole Sup. d'Ingenieurs Electr./Electrot, General Electric Company, INPG-IMAG, Nixdorf Computer, Philips Gloeilampenfabrieken, Stollmann & Co., Technische Universität Berlin, Technische Universität München

419
Image and Movement Understanding
Computer Appl.Technics, Katholieke Universiteit Nijmegen, Trinity College Dublin, Universita di Genova, Video Display Systems

432 METEOR
An Integrated Formal Approach to Industrial Software Development
ATT & Philips Telecommunication, CGE-Laboratoires de Marcoussis, COPS (Europe), Centrum voor Wiskunde & Informatica, Philips & Mble. Associated, Philips Gloeilampenfabrieken, Txt-Tech.Soft e Telematica, Universität Passau, Universite de Paris Sud

440 MADS
Message Passing Architectures & Description Systems
CGE-Laboratoires de Marcoussis, Delphi, Vrije Universiteit Brussel

510 TOOL USE
An Advanced Support Environment for Method Driven Development and Evolution of Packaged Software
CISI-Informatique Internationale, Generics Software, GMD, Onera-Centre d'Etudes Recherches Toulouse, Universite Catholique Louvain

527
Communication Failure in Dialogue: Techniques for Detection and Repair
ITT Industries, Linguistics Institute of Ireland, Memory Computer, St. Patrick's College, Universita di Pisa, University of Leeds

530 EPSILON
Advanced Knowledge Base Management System
Bense, Criss, Systems and Management, Universita di Pisa, Universität Dortmund, Universite de Lyon 3

532 GENEDIS
Real Time Generation and Display of the 2.5D Sketch for Moving Scenes
Barr & Stroud, Ing. C. Olivetti & C., University of Strathclyde, Zeltron

599
Knowledge Based Assistant for Electromyography"
CRI, Judex Datasystemer, Logica UL, National Hospital for Nervous Diseases, Nordjysk Udviklingscenter

814 PIMS
Project Integrated Management Systems
Bureau voor Systeemontwikkeling, CAP SESA Innovation, London School of Economics, Pactel, The Turing Institute, Universiteit van Amsterdam, University College of London

818 DELTA 4
Definition and Design of an Open Dependable Distributed Computer System Architecture
Basf, Bull, CNR, CNR-IEI, CNRS-Laas, Ferranti Electronics, Fraunhofer Gesellschaft, GMD, GSO Informatica SpA, IMAG-LGI-Laboratoire Genie Informatique, INESC, Jeumont-Schneider Telecommunications, Mari Advanced Microelectronics, Plessey Semiconductors, Telettra, Universita di Bologna

820
Design,Experimentation of a KBS Architecture and Tool Kit for Real Time Process Control Applications
Ansaldo Impianti, CAP Sesa Innovation, CISE, Framentec, Heriot-Watt University, NEA-Lindberg, SNIAS

835 PROSPECTRADEMO
Demonstration of Prospectra Methodology and System
Alcatel Standard Electrica, Syseca Logiciel

857 GRADIENT
Graphics & Knowledge Based Dialogue for Dynamic Systems
CRI, Gesamthochschule Kassel, Katholieke Universiteit Leuven, Nordisk Brown Boveri, University of Strathclyde

865
Non-Monotonic Reasoning Techniques for Industrial Planning Applications
Aeritalia, Battelle Institut, Elsag, Italcad

866 COUSTO
Integrated Optic Technologies for Real Time Wideband Optical Signal Processing
General Electric Company, Selenia, University College of London

867 ARTS-IP
Adaptive Real-Time Strategies for Image Processing A Case for Satellite Data
Chambre Commerce & Industrie Paris, Dornier, Ecole Sup. d'Ingenieurs Electr./Electrot, General Electric Company, Hunting Technical Services, Politecnico di Milano, Polytechnic of Central London, Selenia, Thomson-CSF-Laboratoire Central de Recherche

874
Integrated Environment for Reliable Systems
Jeumont-Schneider Telecommunications, Mari Advanced Microelectronics, Telettra, Universita di Bologna

881 FORFUN
Formal Description of Arbitrary Systems by Means of Functional Languages
Bell Telephone Mfg. Co., Katholieke Universiteit Nijmegen, Sagantec, Technische Universiteit Delft

891
Development of an Efficient Functional Programming System for the Support of Prototyping
ICL, Non Standard Logics, University of St. Andrews, University of Twente

892 DAIDA
Advanced Interactive Development of Data-Intensive Applications
BIM, Cretan Computer Institute, GFI, SCS Scientific Control Systems, Universität Frankfurt

898
External Interface for Processing of 3-D Holographic and X-Ray Image for Analysis and Control
BIAS, General Electric Company, IRAM, Scanray, Universität Dortmund

928 RUBRIC
"A Rule Based Approach to Information Systems Development"
BIM, James Martin Associates, Micro Focus, University of Manchester Institute of Science and Technology

937 DESCARTES
"Debugging and Specification of ADA Real-Time Embedded Systems"
Electronique Serge Dassault, Foxboro Nederland, GSI Tecsi Software, Systeam, Technische Universiteit Eindhoven, University of Stirling

938 IMPW
Integrated Management Process Workbench
CETE Mediterannee, ICL, National Institute for Higher Education, Imperial College, Verilog

940 DMA
Depth and Motion Analysis
CGS-ITMI, ELSAG , General Electric Company, INPG-IMAG, INRIA, Matra Datavision, Noesis, Universita di Genova, University of Cambridge

951 PACT
PCTE-Added Common Tools
Bull, Eurosoft Systems, GEC Software, ICL, Ing. C. Olivetti & C., Syseca Logiciel, Systems and Management

957
High Density Mass Storage Memories for Knowledge and Information Storage
Basf, Bogen Electronic, Bull, CEA-Leti, Glaverbel, Simulog, Thomson-CSF-Laboratoire Central de Recherche

967
Parallel Associative Development Machine as a Vehicle for Artificial Intelligence
CIMSA Sintra, CSELT, General Electric Company, Non-Standard Logics, Thomson-CSF

973 ALPES
Advanced Logical Programming Environments Support
Bull, CRIL, Enidata, Technische Universität München, Universidade Nova de Lisboa, Universite de Paris Sud

974 KNOSOS
A Knowledge-base Environment for Software System Configuration Reusing Components
CIT-Alcatel, CNET, Dornier System, ESI, Matra Datavision (Espace), Yard Software Systems

1005 MUST
Next Generation Data Base Management System
ABSY, Syseca Logiciel, Universität Kaiserslautern

1015 PALABRE
Integration of Artificial Intelligence, Vocal I/O and Natural Language Dialogue - Application to Directory
British Telecom, CNET, CNRS, ERLI, Politecnico di Torino, Sarin, SESA

1033 FORMAST
Formal Methods for Asynchronous System Technology
Advanced System Architectures, ERNO Raumfahrttechnik, Loughborough University Technology, Imperial College, Universität Kaiserslautern

1035
2-D Coherent Optical Dynamic Processor
General Electric Company, Thomson-CSF, Thomson-CSF-Laboratoire Central de Recherche, Vrije Universiteit Brussel

1041
A General Environment for Formal Systems Development-Genesis
Imperial Software Technology, Philips Gloeilampenfabrieken, Imperial College

1063 INSTIL
Integration of Symbolic and Numeric Learning Techniques
Cognitech, GEC Research Laboratories, Universite de Paris Sud

1072 DIAMOND
Development and Integration of Accurate Operations in Numerical Data Processing
Centrum voor Wiskunde & Informatica, Numerical Algorithms Group, Siemens AG, Universität Karlsruhe, University of Bath

1074
Shipboard Installation of Knowledge Based Systems Conceptual Design
Danish Maritime Institute, East Asiatic Company, Krupp Atlas Elektronik, Lloyd's Register of Shipping, National Technical University Athens, Soft International, Soren T. Lyngsoe

1085 SUPERNODE
Development and Application of a Low-Cost High Performance Multi-Processor Machine
APSIS, Inmos, Royal Signals and Radar Establishment, Telmat, Thorn EMI, Universite de Grenoble, University of Southampton

1094 PRACTITIONER
Support System for Pragmatic Reuse of Software Concepts
Brunel University, CRI, Nordisk Brown Boveri, Peripheral Computer Systems

1098 KADS
A Methodology for the Development of Knowledge Based Systems
CAP Sesa Innovation, Polytechnic of the South Bank, Scicon, Scientific Control Systems, STC Technology, Universiteit van Amsterdam

1106
Further Development of Prolog and its Validation by KBS in Technical Areas
Daimler-Benz, GIA-Universite d'Aix-Marseille I, Gesellschaft für Ingenieurtechniken, Prologia, Robert Bosch

1117 KIWI
Knowledge Based User Friendly System for the Utilisation of Information Bases
Consorzio per le Ricerche e le Applicazioni d, Dansk Datamatik Center, Enidata, INRIA, Philips Gloeilampenfabrieken, Universita di Roma La Sapienza, Universitaire Instelling Antwerpen

1133 ISIDE
Advanced Model for Integration of DB and KB Management Systems
Agusta, Ars, CRIL, INRIA, Sagem, Simulog

1158 ATES
Advanced Techniques Integration into Efficient Scientific Application Software
CISI Ingenierie, Philips & Mble. Associated, UFR-Universite Paris 7, Universite de Liege, Universiteit van Twente

1252 AMADEUS
A Multi-Method Approach for Developing Universal Specifications
BIM, HITEC, Interprogram, Telefonica CTNE, University of Manchester Institute of Science and Technology

1256 CHAMELEON
Dynamic Software Migration between Cooperating Environments
Delphi, Harlequin Non-Standard Logics, Universite de Paris Sud

1257 MUSE
Software Quality and Reliability Metrics for Selected Domains : Safety Management & Clerical Systems
Brameur, CRIL, EBO, TUEV

1258 TRUST
Testing & Consequent Reliability Estimation for Real-Time Embedded Software
City University of London, John Bell Systems, Liverpool Data Research Assoc., SES Software Engineering Services, University of Liverpool

1261 HTDS
Host Target Development System
Logica, Marconi Defence Systems, SESA, SFGL-Societe Francaise de Genie Logiciel, Softlab

1262 SFINX
Software Factory Integration and Experimentation
CAP Industry, CRI, ERIA, Societe Francaise de Genie Logiciel, Tecnopolis Csata Novus Ortus

1265 SEDOS DEMO
Sedos Estelle Demonstrator
Agence de l'Informatique, Bull, CNET, CNRS-Laas, Expert Software Systems, ENTEL, Marben, Universidad Politecnica de Madrid, Verilog

1271 SED
SETL Experimentation and Demonstrator
Centre National des Arts et Metiers, Enidata, Hildesheim Hochschule, Thomson-CSF-DSE, University of Patras

1277 SAPPHIRE
PCTE Portability
CAP Industry, GIE Emeraude, Software Sciences, University College of Wales

1282 PAVE
PCTE and VMS Environment
GEC Software, Syseca Logiciel

1283 VIP
VDM Interfaces for PCTE
CWI-Centrum voor Wiskunde & Informatica, Oce-Nederland, Praxis Systems, PTT Nederland, University of Leicester

1520 ACCUEIL DE LOGICIEL FUTUR,ALF
Advanced Software Engineering Environment Logistics Framework
Cerilor, CIG Industry, Computer Technologies Co., Crin/Adilor, GIE Emeraude, Grupo de Mecanica del Vuelo, ICL, Universität Dortmund, Universite Catholique Louvain

1527 SPEM
Software Productivity Evaluation Model
CERCI, Fuigi Italiana, O Dati Espanola, Sofemasa, UK Atomic Energy Authority, Verilog

1532
A Preliminary Study of a Vector Processing-Oriented Parallel Architecture
Bull, Siemens

1535 APHRODITE
A PCTE Host-Target Distributed Testing Environment
Bull, Chorus Systemes, Delphi, Ferranti Computer Systems, Philips-Trt., Universite de Liege

1542
Intelligent Documents Production Demonstrator
Applied Research Group, INESC, Mnemonica Computer Services

1550 DRAGON
Distribution and Reusability of ADA Real-Time Applications through Graceful and On-line Operations
Dornier System, GSI TECSI Software, Politecnico di Milano, Tech.Soft e Telematica, Universita di Genova, Universität Passau, University College of Wales, University of Lancaster

1558 EQUUS
Efficient Qualitative and Quantitative use of Knowledge-Based Systems in Financial Management
Citymax Integr. Inf. Systems, Dataid, Riada & Co., University College of London

1560 SKIDS
Signal and Knowledge Integration with Decisional Control for Multi-Sensory Systems
British Aerospace, C.F.R., CNRS-Laas, Krupp Atlas Elektronik, Maps Informatica Industrial, Matsra Datavision, Mediprint, Universitat Politecnica de Catalunya, University of Oxford, University of Patras

1570
Application of Expert Systems to Industrial Chemical Analysis
Katholieke Universiteit Nijmegen, Organon International, Pye Unicam, Vrije Universiteit Brussel

1588 SPAN
Parallel Computer Systems for Integrated Numeric and Symbolic Processing
Cimsa Sintra, Computer Technology Institute, INEC, Peripheral Computer Systems, Thorn EMI, University College of London

1592
Therapy Adviser for Oncology
CITSA, Medimatica, Sanofi, University of Leeds

1598 REPLAY
Replay and Evaluation of Software Development Plans Using High-order Meta Systems
Alpha S.A.I., CISI-Informatique Internationale, CRI, Expert Software Systems, ONERA-Centre d'Etudes Recherches Toulouse, Universite Catholique Louvain

1609 SMART
System Measurement and Architectures Techniques
Bull, CCS/SCYT, Commissariat a l'Energie Atomique, CISI Ingenierie, CRI, Matra Datavision (Espace), Paisley College Of Technology, Universitat Politecnica de Catalunya

1613 ITS
Evaluation of an Intelligent Tutoring System Shell for Industrial/Office Training
Datamat, Education Technology Institut., ITT Industries

2025 EDS
European Declarative System
ICL, Bull, European Computer Industry Research Centre, Siemens

2046 MERMAID

Metrication and Resource Modelling Aid

Volmac, Data Management, National Computing Centre, Imperial College, University College Cork

2059 PYGMALION

PYGMALION

Thomson-Csf-Dse, Computer Technology Institute, CSELT, Ecole Normale Superieure, INESC, Iriac, Philips-Lep, Standard Elektrik Lorenz, Universidad Politecnica de Madrid, University College London

2080 REX

Reconfigurable and Extensible Parallel and Distributed Systems

Industrial Informatics, Stollmann & Co, GMD, GSI Tecsi Software, Intracom, Siemens, Technische Universitaet Berlin, Imperial College, Universitaet Karlsruhe

2092 ANNIE

Application of Neural Networks for Industry in Europe UK Atomic Energy Authority

Alpha SAI, Artificial Intelligence, British Aerospace, Cetim-Etablissement de Senlis, IBP Pietzsch, Siemens

2094 SUNSTAR

Integration and Design of Speech Understanding Interfaces

AEG Olympia, Fraunhofer, Industrie Face Standard, Jysk Telefon, Telefonica Investigacion y Desarrollo

2101 ARS

Adverse Environment Recognition of Speech

CSELT, Ecole Norm Superieure des Telecommunications, Logica Sds, Logica UK, Matra Communication, Page Iberica, Universidad Politecnica de Madrid, University of Cambridge, University of Keele

2104 POLYGLOT-1

Multi-Language Speech-to-Text and Text-to-Speech System

Ing. C. Olivetti & C., Bull, CNRS-Limsi, Katholieke Universiteit Nijmegen, Nederlandse Philips Bedrijven, Philips Kommunikations Industrie, Ruhr Universitaet Bochum, Triumph-Adler, Universidad Politecnica de Madrid, University of Edinburgh, University of Patras

2143 IMSE

An Integrated Modelling Support Environment

STC Technology, Fraunhofer Gesellschaft, Inria, Sintef, Thomson-Csf, Universita Degli Studi di Pavia, Universitaet Dortmund, University of Edinburgh

2148 VALID

Validation Methods and Tools for Knowledge-Based Systems

Cognitech, Centre d'Estudis Avancats de Blanes, Computer Resources Intl., Universidad Politecnica de Madrid

2151 SCOPE

Software Certification on Program in Europe

Verilog, City University, Elektronik Centralen, Eria, Etnoteam, Glasgow College, GMD, Gesellschaft Fuer Reaktorsicherheit, National Institute for Higher Education, UK Atomic Energy Authority, University of Strathclyde

2152 VIEWS

Visual Inspection and Evaluation of Wide-Area Scenes

Marconi Command & Control Systems, Framentec, Fraunhofer IITB, Fried. Krupp, Queen Mary College, University of Reading

2154 MLT

Machine Learning Toolbox

Nixdorf Computer, British Aerospace, CGE-Laboratoires de Marcoussis, Foundation for Research and Technology - Hellas, GMD, Inria, Intellisoft Sarl, Universite de Paris-Sud, University of Aberdeen

2163 KBS-SHIP

Shipboard Installation of Knowledge-Based Systems : Design and Installation

Danish Maritime Institute, Fried. Krupp, Instituto Superior Tecnico, Lloyd's Register of Shipping, National Technical University Athens, Soren T.Lyngsoe, The East Asiatic Company

2167 AITRAS

An Intelligent Real-Time Coupled System for Signal Understanding

Cognitech, Artificial Intelligence Systems, Crin/Adilor, Laborelec, Tecnaton

2177 GIPE II

Generation of Interactive Programming Environments II

Sema Metra, Adv/Orga F.A. Meyer, Bull, Centrum voor Wiskunde & Informatica, Gipsi, Inria, Planet, PTT Research Telematica Laboratorium

2218 SUNDIAL

Speech Understanding and Dialogue

Logica UK, AEG Aktiengesellschaft, Cap Sesa Innovation, CNET, Irisa-Rennes, Politecnico di Torino, Sarin, Siemens, Universitaet Erlangen-Nuernberg

2252 DELTA-4

Definition and Design of an Open Dependable Distributed System Architecture

Ferranti Electronics, Bull, CNR-Iei, CNRS-Laas, Fraunhofer IITB, INESC, Renault Automation, Sema Metra, The Microelectronics Applications Research Institute, UK Atomic Energy Authority, Unibanque - Credit Agricole, Universite Joseph Fourier-Grenoble I, University of Newcastle

2255 TOPMUSS

Tools for Processing of Multi-Sensorial Signals for Plant Monitoring and Control

Krupp Atlas Elektronik,Alcatel Isr, Audi, Brunel University, Danmarks Tekniske Hojskole, Enginyeria de Robotica I Visio, Esacontrol, Fraunhofer IITB, GEC Electrical Projects, The English Electric Company, Stewart Hughes, Thomson Informatique Services, Universitaet Hannover

2256 ARCHON

Architecture for Co-operative Heterogenous on-line Systems

Fried. Krupp, Amber, CERN, Electricity Council, Framentec, Iberduero, Queen Mary College, Universidade do Porto, Universiteit van Amsterdam, Volmac

2288 NAOPIA

New Architectures for Optical Processing in Industrial Applications

Thomson-Csf, Krupp Forschungsinstitut, Riso National Laboratory, Universitaet Erlangen-Nuernberg

2301 ORDIT

The Development of a Methodology for Specifying Non-Functional Requirements

Husat Research Centre,Algotech, The Microelectronics Applications Research Institute, University of Newcastle, Work Research Centre

2304 LOTOSPHERE

LOTOSPHERE

Universiteit Twente, Standard Electrica, Ascom Holding, British Telecommunication, CNRS-Laas, Consorzio Pisa Ricerche, GMD, Nederland, PTT Nederland, Syseca Logiciel, Technische Universitaet Berlin, Universidad Politecnica de Madrid, University of Stirling

2316 MUSIP

Multisensor Image Processor

Marconi Space Systems, GEC Research Laboratories, Hunting Technical Services, Marconi Command & Control Systems, Environment Research Council, Thomson-Csf-Laboratoire Electronique de Rennes, Universita di Genova

2354 DARTS

Demonstration of Advanced Reliability Techniques

UK Atomic Energy Authority, CEGB, Ceselsa, Gesellschaft Fuer Reaktorsicherheit

2384 METKIT

Metrics Education Tool Kit

Brameur, British Telecommunication, Cap Scientific, Dida*el Srl, GMD, Software Engineering Services, South Bank Polytechnic, Verilog

2397 PROMISE

Process Operator's Multi-Media Intelligent Support Environment

Tecsiel, Dow Chemical Nederland, Intelligent Decision Systems, Katholieke Universiteit Leuven, South Scotland Electricity Board, University College Dublin, University of Strathclyde, Work Research Centre

2409 EQUATOR

Environment for Qualitative Temporal Reasoning

Eria, Cise, Ecole Polytechnique Federale de Lausanne, Electronic Traffic, Ferranti Computer Systems, Laben Industrie per lo Spazio e le Telecomunicazioni, Swift, Syseca Logiciel, University College London

2424 KIWIS
Advanced Knowledge-Based Environments for Large Data Base Systems
Philips International, Enidata

2427 TROPICS
Transparent Object-Oriented Parallel Information Computing System
Cap Sesa Innovation, Nederlandse Philips Bedrijven, Ing. C. Olivetti & C., Nixdorf Computer, Thomson-Csf-Cimsa-Sintra

2443 STRETCH
Extensible KBMS for Large Knowledge Base Application
CGE-Laboratoires de Marcoussis, Agusta, Fernuniversitaet Gesamthochschule Hagen, Inria, Mbp Software & Systems, Politecnico di Milano, Sagem, Tech.Soft e Telematica

2447 GENESIS
A European Distributed Memory Parallel Supercomputer for Numerical Applications
Bull, Fried. Krupp, GMD, Inmos Limited, Siemens, Stollmann & Co, Suprenum

2469 TEMPORA
Integrating Database Technology, Temporal Reasoning for Effective Software
BIM, Hitec, Logic Programming Associates, Sintef, Swedish Institute for Systems Development, Imperial College, Universite de Liege, University of Manchester

2471 PEPMA
Parallel Execution of Prolog on Multiprocessor Architectures
BIM, Katholieke Universiteit Leuven, Meiko, Swedish Institute of Computer Science, Universidad Politecnica de Madrid, University of Bristol

2474 MMI2
A Multi-Modal Interface for Man-Machine Interaction with Knowledge-Based Systems
BIM, Adr-Criss, Ecole des Mines de Saint-Etienne, Intelligent Software Solutions, Rutherford Appleton Laboratory, University of Leeds

2487 REDO
Maintenance, Reliability, Reusability, and Documentation of Software Systems
Lloyd's Register of Shipping, Centrisa-Centro de Tratamiento de Informacion, Computer Technologies Co, Delft Hydraulics, Electricite de France, Grumann Daten-Kommunikation, Ingenieria y Tecnologia de Sistemas, Marconi Command & Control Systems, National Institute for Higher Education, University of Durham, University of Oxford

2502 VOILA
Variable Object Identification, Location and Acquisition
GEC Research Laboratories, Elsag, Inria, Matra, Plessey Company, Universita di Genova, University of Oxford, University of Sheffield

2528 SUPERNODE-II
Operating Systems and Programming Environments for Parallel Computers
Thorn-Emi, Aptor, Danish Parsim Consortium, Grupo Apd, Institut National Polytechnique de Grenoble, Numerical Algorithms Group, Royal Signals and Radar Establishment, Syseca Logiciel, System Software Factors, Telmat Informatique

2537 ICARUS
Incremental Construction and Reuse of Requirements Specifications
Philips, Alcatel Standard Electrica, CGE-Laboratoires de Marcoussis, Facultes Universitaires Notre-Dame de la Paix, Inria, Sema Metra, Universitat Politecnica de Catalunya

2565 ATMOSPHERE
Advanced Techniques and Models of System Production in a Heterogeneous, Extensible and Rigorous Environment
Siemens, Bull, ESF, GEC Marconi, Nederlandse Philips Bedrijven, Nixdorf Computer, Societe Francaise de Genie Logiciel

2570 MACS
Maintenance Assistance Capability for Software Systems Automation
Societe Etudes Systems Automations, Centro de Calculo de Sabadell, Cisi Ingenierie, Software Sciences, Tecnopolis Csata Novus Ortus, Universitaetsitaet Bremen, Universiteit van Limburg

2576 ACKNOWLEDGE
Acquisition of Knowledge
Cap Sesa Innovation, Computas Expert Systems, Marconi Command & Control Systems, Sintef, Telefonica Investigacion y Desarrollo, Universiteit van Amsterdam, University of Nottingham

2589 SAM
Multi-Lingual Speech Input/Output Assessment, Methodology and Standardisation,
University College London, AEG, Crin /Adilor, CSELT, Elab, Jysk Telefon, Televerket, TNO

2592 VIDIMUS
A Generic Vision System for Industrial Applications
British Aerospace, AEG, CEA-Leti, Ibermatica, Philips Gloeilampenfabrieken, Thomson-Csf-Laboratoire Electronique de Rennes, University of Strathclyde, Valvo

2615 ITSIE
Intelligent Training Systems in Industrial Environments
Marconi Simulation, Axion, CGE-Laboratoires de Marcoussis, CISE, Heriot-Watt University, Iberduero

2620 FOCUS
Front-Ends for Open and Closed User Systems
Numerical Algorithms Group, Lutchi Research Centre, Metek, Philips International, Solvay, Imperial College, Universitat Politecnica de Catalunya, Westfaelische Wilhelms-Universitaet

2686 COSMOS
Cost Management with Metrics of Specification
Techforce, Alcatel Austria, British Telecommunication, Nijenrode Universiteit voor Bedrijfskunde, Telefonica Sistemas, University of London Goldsmith's College

2701 PUMA
PUMA
Inmos, Bull, Chorus Systemes, GMD, Royal Signals and Radar Establishment, Siemens, Syseca Logiciel, University of Liverpool, University of Southampton

2702 SUPRENUM
SUPRENUM
Krupp Atlas Elektronik, Siemens, Stollmann & Co, The Numerical Algorithms Group, University of Liverpool, University of Southampton

Office & Business Systems

28 MULTOS
A Multimedia Filing System
Battelle Institut, CNR-IEI, Cretan Computer Institute, ERIA, Ing. C. Olivetti & C., Mnemonica Computer Services, Philips Datasystems, Triumph-Adler

43
Standardisation of Integrated Lan Services and Service Access Protocols
British Telecom, Bull, CSELT, GEC Marconi Research Centre, Nixdorf Computer, OCE-Nederland, Philips International, Plessey Office Systems, Reseaux Communication Entreprise, SESA, TITN, University of Twente

56 FAOR
Functional Analysis of Office Requirements
East Asiatic Company, GMD, STC Technology, Universität Koeln

59 MINSTREL
New Information Models for Office Filing and Retrieval
Dansk Datamatik Center, GN Data, National Software Centre, University College Dublin

64 SPIN
Speech Interface at Office Workstation
AEG, CEA, CGE-Laboratoires de Marcoussis, CSELT, National Technical University Athens, Nixdorf Computer, Oros, Sesa, SNS Pisa, Universiteit van Amsterdam

73
Broad Site Local Wideband Communication System
ACEC, Bell Telephone Mfg Co., CISI-Informatique Internationale, FCR/SI - ING RN, National Technical University Athens, Stollmann & Co. GmbH, Universite de Liege

82 IWS
Intelligent Workstation
Bull, Cretan Computer Institute, INRIA, Katholieke Universiteit Nijmegen, OCE-Nederland, Vrije Universiteit Brussel

121 HERODE
Handling of Mixed Text/Image/Voice Documents Based on a Standardised Office Document Architecture
CRIN/ADILOR, Siemens, TITN

169 LION
Local Integrated Optical Network
British Telecom, CSELT, Nordiske Kabel Og Traadvaerker, Politecnico di Milano, TITN, Universite de Paris, Universite de Toulouse-Paul Sabatier, University of Patras

231 DOEOIS
Design and Operational Evaluation of Office Information Servers
Bull, ICL, Trinity College Dublin, Universität Stuttgart

234
Cognitive Simulator for User Interface Design
Alcatel ESC, General Electric Company, Logos Progetti, Medical Research Council

237 CSA
Communications Systems Architecture
Mari Advanced Microelectronics, Philips Kommunikations Ind., Plessey Company, Synergie Informatique & Developpement

249 UCOL
Ultra Wideband Optical Coherent Lan
GEC Marconi Research Centre, Industrie Face Standard, Politecnico di Milano

285 OSSAD
Office Support Systems Analysis and Design
Centre d'Etudes du Management, Institut für Organisationsforschung & Techno, Istituto per l'Automazione delle Cass, Universita di Milano

291
Linguistic Analysis of the European Languages
Acorn Computers, Ing. C. Olivetti & C., Katholieke Universiteit Nijmegen, LIMSI-CNRS, Ruhr Universität Bochum, Tecnopolis Csata Novus Ortus, UNED, University of Patras

295
The Paper Interface
AEG Olympia, Ing. C. Olivetti & C., Philips Gloeilampenfabrieken, Philips Kommunikations Ind., Plessey Office Systems, Trent Polytechnic

367 SOMIW
Secure, Open, Multimedia, Integrated Workstation
AEG Olympia, Bull, CSELT, INESC, INRIA, Iselqui, Italtel Telematica, Prodata, S.C.K. - C.E.N., Sarin, Sobemap

385 HUFIT
Human Factors Laboratories In Information Technologies
Bull, Fraunhofer IAO, Husat Research Centre, ICL, Ing. C. Olivetti & C., Philips Gloeilampenfabrieken, Siemens, The Piraeus Graduate School, Universidade do Minho, University College Cork, Wilhelms Universität Westfalen

395 INCA
An Integrated Network Architecture for Office Communications
General Electric Company, Ing. C. Olivetti & C., Modcomp, Nixdorf Computer, Systems Wizards, University College of London

449
Investigation into the Effective Use of Speech at the Human-Machine Interface
British Maritime Technology, Fincantieri, ICL, Voice Systems International

563
A High Compression Picture Coding Algorithm for Photographic Videotex
British Telecom, CLETT, CSELT, Independent Broadcasting Auth., KTAS, Nixdorf Computer, PTT Nederland

612
Modeling and Simulation of the Visual Characteristics of Modern Display Technologies under Office Work Conditions
Barco Industries, Cimsa Sintra, General Electric Company, MYFRA SA, OCE-Nederland, Universite de Paris, University of Twente

813 TODOS
Tools for Designing Office Systems
CNR-IEI, Dornier, Italtel Telematica, OCE-Nederland, Politecnico di Milano, Sema Metra, Systems and Management, Thomson Informatique Services, Universität Koeln, Universite de Paris 1 Sorbonne

831 ASTRA
Advanced and Integreted Office Systems Prototypes for European Public Administrations
Arcos Conseil, Bull, Consorzio Campano di Ricerca per l'Inf, CESIA, Datenzentrale Schleswigholstein, GSI Tecsi Software, I/S Datacentralen Af 1959, Ing. C. Olivetti & C., MC2, Sogei - Societa Generale d'Informatica

834 COMANDOS
Construction and Management of Distributed Office Systems
ARG-Applied Research Group, Bull, CNR-IEI, Fraunhofer IM, ICL, Imag-LGI-Laboratoire Genie Informatique, INESC, Ing. C. Olivetti & C., Nixdorf Computer, Trinity College Dublin, Universität Stuttgart

853
Acquisition, Compression & Reproduction of True-Colour Image Documents
Ing. C. Olivetti & C., Intersys Graphic, Katholieke Universiteit Leuven

855
European Typewriters and Other Workstation Integration
Ing. C. Olivetti & C., Olympia, Politecnico di Torino, TA Triumph-Adler

870 TALON
Testing and Analysis of Local Area Optical Networks
Cossor Electronics, NKT-Nordiske Kabel Og Traadvaerker

878 PROMINAND
Extended Office Process Migration with Interactive Panel Displays
IAB, Modulex, Riso National Laboratory, Scaitech, Technische Universität München

890 PANGLOSS
Parallel Architecture for Networking Gateways Linking OSI Systems
7-Technologies APS, CAP Scientific, PCS Peripheral Computer Systems, Universite de Liege, University of Reading, University of Twente

901
An Intelligent General Public Data, Voice and Picture Storage Retrieval System
BBC Interactive Television Unit, Bureau Marcel van Dijk, CRIN/ADILOR, Logica UK, Philips Gloeilampenfabrieken NV, SEP

925
Coding for Moving Picture & Still Picture at 256 Kbits/S and 64 Kbits/S
CIT-Alcatel, General Electric Company, SAT-Societe Anonyme Telecommunications, STA Elettronica Automazione, TE.KA.DE., Telefonica CTNE

954 IKAROS
Intelligence and Knowledge Aided Recognition of Speech
CGE-Laboratoires de Marcoussis, Fraunhofer IAO, General Electric Company, Universität Stuttgart

956 COCOS
Components for Future Computing Systems
Bull, ICL, Ing. C. Olivetti & C., INRIA, Nixdorf Computer, SGS-Microelectronics

998 MARS
Highly Secure Office Information Systems-Definition Phase
BBN Communication, Bertin & Cie, COPS (Europe), Protexarms, Universität Koeln, University of East Anglia

1024 PODA
Piloting of the Office Document Architecture
Bull, ICL, Ing. C. Olivetti & C., Nixdorf Computer, OCE-Nederland, Queen Mary College, Service Etudes Communications Postes Tel, Siemens, Software Sistemi, TITN, University College of London

1030 IT-UPTAKE
Human and Economic Factors in IT Uptake Processes
Empirica, Memory Computer, STC Technology, Work Research Centre

1032 ERW
An Office Systems Research Workstation for Europe
Ing. C. Olivetti & C., Queen Mary College, Siemens, University of Sussex, Vrije Universiteit Amsterdam, Whitechapel Computer Works

1051
Amorphous Silicon Contact Imager for Office and Graphic Applications
Agfa Gevaert, CNRS, Imec VZW, MBB

1057 MIAC
Multipoint Interactive Audiovisual Communication
British Telecom, CNET, CSELT, Industrie Face Standard, PTT Nederland, STC Technology, Telefonica CTNE, TRT-Telecommunications Radioelec. & Teleph.

1059 DAMS
Dynamically Adaptable Multi-Service Switch
Jeumont-Schneider Telecommunications, Plessey Company, TN Telenorma

1533 MIS
Multilingual Information System
Bull SA, ICL, Ing. C. Olivetti & C., Nixdorf Computer

1541
Multi-Lingual Speech Input-Output Assessment, Methodology & Standardisation
CNET, CSELT, JYSK Telefon, Universiteit van Amsterdam, University College London, University College of London

1573 IBASS
Intelligent Business Application Support System
Bull, Datamont, Langton, Nixdorf Computer, Polytechnic of the South Bank

2001 SPRITE
Storage Processing and Retrieval of Information in a Technical Environment
Oce-Nederland, Adv/Orga F.A. Meyer, Olympia, College Dublin, Universiteit van Tilburg

2054 UCOL
Ultra Wideband Coherent Optical LAN
Industrie Face Standard, AEG, CGE-Laboratoires de Marcoussis, Consorzio per l'Osi in Italia, GEC Research Laboratories, Idate, INESC, PTT Nederland, Standard Elektrik Lorenz, Telettra Espanola, University of Southampton

2058 ICI
Intelligent Communication Interface
Sait Electronics, British Telecommunication, Universitat Politecnica de Catalunya

2071 COMANDOS
Construction and Management of Distributed Open Systems
Bull, INESC, Nixdorf Computer, Siemens, Trinity College Dublin

2082 HECTOR
Harmonised European Concept and Tools for Organisational Information Systems
Fraunhofer IPA, Cap Sesa Innovation, Consorzio per le Ricerche e le Applicazioni di Informatica, Delga International, Dornier System, PA Consulting Group, Peat Marwick Mclintock

2083 SIMPR
Structured Information Management : Processing and Retrieval
Computer Resources Intl., Nokia Corporation, Pandat, Research Unit for Computational Linguistics, Universidade Catolica Portugesa, University College Dublin, University of Strathclyde

2100 MAX
Metropolitan Area Communication System
CSELT, British Telecom, KTAS, NKT Elektronik, Sirti, TITN

2102 COMIS
Standard for Coding of Moving Images on Digital Storage Media
CSELT, British Telecommunication, CNET, Deutsche Thomson-Brandt, Inmos, Intermetall, Halbleiterwerk Der Deutsche, ITT Industries, Philips Research Laboratories, Thomson-Csf-Laboratoire Electronique de Rennes, TN Telnorma

2103 MASCOT
Multienvironment Advanced System for Colour Treatment
Ing. C. Olivetti & C., Computer Logic R & D, Imperial Chemical Industries, Thomson-Csf-Dci

2105 MULTIWORKS
MULTIWORKS
Ing. C. Olivetti & C., AEG Olympia, Bull, ICL

2109 TOOTSI
Telematic Object Oriented Tools for Services Interfaces
Sarin, Desarrollo de Software, Infotap, Telesystemes

2111 PONTIFEX
Planning of non Specific Transporations by an Intelligent Fleet Expert
Nixdorf Computer, Alitalia, O Dati Espanola S.L., Pandata

2114 LSVI
Large Size Visual Interface Design for Multimedia Workstation Terminals
Standard Elektrik Lorenz, Pilkington, Thomson-Csf-Dte

2121 ITHACA
Integrated Toolkit for Highly Advanced Computer Applications
Nixdorf Computer, Bull, Cap Sesa Innovation, Datamont, Foundation for Research and Technology - Hellas, Siemens, Tecnics en Automatizacio d'Oficines, Universite de Geneve

2144 IT-USE
Information Technology Uptake Support Environment
Irish Medical Systems, Futuremedia, Handelshojskolen I Kobenhavn, RIOM/ Groningen University, Work Research Centre

2146 DAMS
Dynamically Adaptable Multi-Service System
TN Telenorma, Jeumont-Schneider Telecommunications, STC Technology

2170 SUPERDOC
A Set of Software Tools for a Document Workstation
Applied Research Group, Epsilon Software, INESC

2221 RICHE
Health Services Information and Communication Network for Europe
Conseil de Filiere Staf, Bull, ICL, Irish Medical Systems, Sig Services, Universita Cattolica del Sacro Cuore

2239 SESEFA
Self Service Facilities Architecture
Prisma Informatica, Arcos Conseil, ERIA, Iko Software Service, Universita di Firenze

2267 ISA
Integrated Systems Architecture
STC Technology, AEG, Service Etudes Communications Postes, Siemens

2294 TOBIASI
Tools for Object-Based Integrated Administration of Systems
Intecs International, GIE Emeraude, Intrasoft, Planet, University of Newcastle

2315 TWB
Translator's Workbench
Triumph-Adler, Daimler-Benz, L-Cube Information Systems, Siemens

2322 ISEM
IT Support for Emergency Management
RISO National Laboratory, Adv/Orga F.a. Meyer, Creon Application Development, Scaitech, Technical Research Centre of Finland, Tecnatom,Tecnicas Reunidas

2374 PODA
Piloting of the Office Document Architecture
ICL, British Telecom, Bull, IBM Deutschland, Ing. C. Olivetti & C., Nixdorf Computer, Oce-Nederland, Siemens, TITN

2382 ELO
Elusive Office
Empirica, Computer Lernsysteme, Fraunhofer IITB, Rutherford Appleton Laboratory, Standard Elektrik Lorenz

2404 PROOF
Primary Rate ISDN OSI Office Facilities
3 Net Limited, Nixdorf Computer, Systems Wizards, University College London

2431 HOME
Home Systems
Philips International, ABB-BBC, AEG, British Telecom, GEC Research Laboratories, Legrand, Philips Scientific, Siemens, Thomson Grand Public, Zeltron

2455
Large Image Terminals
Thorn Emi, Heriot-Watt University, Nokia Graetz, Standard Elektrik Lorenz

2463 ARGOSI
Applications Related Graphics and OSI Standards Integration
Thomson-Csf-Cimsa-Sintra, Consorzio per l'Osi in Italia, GMD, Inria, Tecsiel

2466 KWICK
Knowledge Workers Intelligently Collecting/Coordinating/Consulting Knowledge
Bull,Adv/Orga F.a. Meyer, Institut International de Robotique et d'Intelligence Artificielle, Tecograf Software

Computer-integrated Manufacturing

9
Exploitation of Real-Time Imaging for Arc Welding
Babcock Power, Messer Griesheim, RWTH Aachen Rheinisch-Westfaelische Technisc, Welding Institute of Cambridge

34
Design Rules for Computer Integrated Manufacturing Systems
ISTEL, SMC

75
Design Rules for the Integration of Industrial Robots into CIM Systems
Fraunhofer IPK, Renault Automation, Universität Karlsruhe, University College Galway

92
A Computer Integrated Production Insula;Design Rules and Standards
Logica Uk, IFAO

2476 BANK 92
BANK 92
Bull Espana, Arcos Conseil, Cap Gemini Sogeti, Computer Logic R & D , Entel, Iko Software Service, Istituto per l'Automazione delle di Risparmio, Casse di Risparmio, Prisma Informatica

2484 SPIRIT
High Performance Technical Workstation
Kontron Elektronik, Associated Computer Experts, British Aerospace, Caption, Queen Mary College, Universitaet Tuebingen, University of Sussex

2499 CDR
An Application Editors and Software Developers Workbench for Publishing Multi-Media Information using Optical Read-Only Storage Devices
Elektroson, ACT Systemes, Clarinet Systems, Katholieke Universiteit Nijmegen, Textware

2512 IACIS
Intelligent Area Communication and Information System
Telefonica de Espana, Bull, CSELT, INESC, Synergie Informatique & Developpement, Synergia, Tecno T&G

2563 GAUCHO
General Distributed Architecture for Unified Communication in Heterogeneous OSI-Environments
Adv/Orga F.a. Meyer, Dannet, Fisher and Lorenz, Project Management Consultants, RC Computer, Telefonica Sistemas, Universidad Politecnica de Madrid

2569 EWS
Euroworkstations
Siemens, Fraunhofer Arbeitsgruppe für Graphische Datenverarbeitung, Gipsi, Grupo Apd, Rutherford Appleton Laboratory

2638 ADOT
Advanced Display Optimisation Tools
British Aerospace, City University, Oce-Nederland, Sogitec, TNO Netherlands Organisation for Applied Scientific Research

2649 VASARI
Visual Arts System for Archiving and Retrieval of Images
Brameur, Doerner Institute, Ecole Norm Superieure des Telecommunications, National Gallery of London, Thomson Informatique Services, Technischer Ueberwachungs-Verein,University of London Birkbeck College

2684 MIAS
Multipoint Interactive Audiovisual System
British Telecommunication, Amper, Cit-Alcatel, CNET, Centro Studi e Laboratori Telecomunicazioni, PTT Nederland, Telefonica Investigacion y Desarrollo

2704 CRYPTOIC-CARD
CRYPTOIC-CARD
Bull, Siemens

118
General Purpose Sensory Controlled Systems for Parts Production
Comau Fraunhofer IPA, OCN-PPL, Siemens, Sincon

179
Integrated Electronic Subsystems for Plant Automation
AEG, GEC Marconi Research Centre

197
Computer Aided Thermal Image Technique for Real Time Inspection of Composite Material
Barr & Stroud, CNR-IROE, University of Strathclyde

278
Integrated Sensor-Based Robot System
Fraunhofer IPA, Joyce-Loebl, MARI Advanced Microelectronics, National Technical University Athens, Robert Bosch, Universidade Nova de Lisboa, University of Newcastle

293

Knowledge & Decision Support for Material Handling Systems

CGE-Laboratoires de Marcoussis, Compagnie Generale de Productique, Fraunhofer IPK, IBM Deutschland, Instituto Superior Tecnico

319

Data Transfer between CIM Systems & Management Information Systems

Computer Systems Development, Mentec International, Trinity College Dublin

322 CAD-I

Cad Interfaces

BMW Bayerische Motorenwerke, Cisigraph, Cranfield Institute of Technology, Danmarks Tekniske Hojskole, Erdisa, Gesellschaft für Strukturanalyse, Katholieke Universiteit Leuven, Kernforschungszentrum Karlsruhe, Leuven Measurement & Systems, NEH Engineering, Rutherford Appleton Laboratory, Universität Karlsruhe

338

Product Design for Automated Manufacture & Assembly

CIMAF, COMAU, Cranfield Institute of Technology, Dunaiturria y Estanconia, Renault Automation

384

Integrated Information Processing for Design Planning and Control of Assembly

AEG, Fraunhofer IPK, GEC Research Laboratories, Induyco Investronica, Telemecanique, TNO Netherlands Organisation for Applied Scie.

409

Development of an Integrated Process and Operations Planning System with the Use of Interactive 3-D Modelli

Exapt-Verein zur Foerderung des Exapt-Systems, Matra, Volkswagen

418

Open CAM System Allowing Modular Integration into Factory Management of a Workshop Structure in Functional

Centre d'Informatique Generale, Fabrique Nationale Herstal, Ing. C. Olivetti & C., Logica Uk, Matra Datavision, Procos, RTM, RWTH Aachen , Universite de Bordeaux 1

477 COSIMA

Control Systems for Integrated Manufacturing: The CAM Solution

Comau, Digital Equipment, Renault Automation

496

Design and Specification of Configurable Graphics Subsystem for CIM

Generics Software, GTS, Trinity College Dublin

504 PAQO

Plant Availability and Quality Optimisation

ADERSA, AMTRI, Battelle Institut., Danobat S. Coop, Gesellschaft für Reaktorsicherheit, Ikerlan, Stewart Hughes, Technische Hochschule Darmstadt

534

Development of a Flexible Automated Assembly Cell and Associated Human Factors Study

Dantec Elektronik, Medical Research Council, RISO National Laboratory, Vrije Universiteit Brussel, Westland

595

The Application of CIM to Welded Fabrication

Aalborg Shipyard, Danish Welding Institute, Italsiel, Odense Steel Shipyard, Universita di Genova, Welding Institute of Cambridge

623

Operational Control for Robot System Integration into CIM

Fiar, Fraunhofer IPK, Kuka Schweissanlagen + Roboter, Ladseb-CNRP, Politecnico di Milano, PSI, Renault Automation, Seram, Universidad Politecnica de Madrid, Universidade Nova de Lisboa, Universität Karlsruhe, Universite de Valenciennes, Universiteit van Amsterdam, University College Galway

688 AMICE

AMICE, An European Computer Integrated Manufacturing Architecture

AEG, AT & T en Philips Telecommunicatie Bedrijven, British Aerospace, Bull, CAP Sesa Innovation, CIT-Alcatel, CRI, Digital Equipment, Dornier, Fiat, GEC Electrical Projects, Hewlett-Packard-France, IBM Deutschland, ICL, Network Sys., Italsiel, Philips & Mble Associated, Procos, RWTH Aachen (Seiaf, Selenia, Siemens, SNIAS, Volkswagen

809

Advanced Control Real-Time CIM Systems and Concepts for Flexible Automation

ICL, Krupp Atlas Datensysteme, TDS Dextralog, Technische Universiteit Delft, Universiteit van Twente

812

Experimental Centre for System Integration in CIM

Aeritalia GVC, ELSAG, Philips & Mble Associated, Politecnico di Milano, RWTH Aachen, Sesa

850

Predesign of FMS for Small Batch Production of Electronic Cards

CSEA, ERIA, Eurosoft Systems

909

Development of Tools for Economic Evaluation of CIM in Smaller Manufacturing Companies

AMTRI, BIBA, CIMAF, Danmarks Tekniske Hojskole, Mentec International, WTCM/CRIF

932

Knowledge Based Real Time Supervision in CIM

AEG, ARS, BICC Technologies, CEA, Fiar, Fraunhofer IPA, FZI Karlsruhe, Industrie Pirelli, Philips, Politecnico di Milano, SGN Graphael, SISAV, TITN, Universite de Savoie

955 CNMA

Communication Network for Manufacturing Applications

Aeritalia, BMW, British Aerospace, Bull, CGE-TITN, Elf Aquitaine, Fraunhofer Gesellschaft, General Electric Company, ICL, Nixdorf Computer, Olivetti G4S - Ricerca, PSA, Siemens

975 TRACIT

Transponders for Real-Time Activity Control of Manufacturing Links to CIM Information Technology Systems

Polydata, Redar NAH-Ortungstechnik, TM Technics Dieren

1062 ACCORD

Computer-Aided Engineering Software for Advanced Workstations in the CIM Environment

Athens School of Economics, Bertin & Cie, GEC Research Laboratories, , Philips Gloeilampenfabrieken, Societe Genrale de Techniques et d'Etudes, Trinity College Dublin, Universita di Genova, Vector Fields

1136 DASIQ

Distributed Automated System for Inspection and Quality Control

CEA-LETI, Microtecnica, Sagem, Universität Hannover, Visitec

1199

Human Centred CIM System

BICC Technologies, Danmarks Tekniske Hojskole, Greater London Enterprise, Krupp Atlas Elektronik, NEH Engineering, R & D Advisory Services, Rolls Royce, Teknologisk Inst., Universität Bremen, University of Manchester

1556 VITAMIN

Visualisation Standard Tools in Manufacturing Industry

Fraunhofer Gesellschaft, IMAG-LGI, Mannesmann Kienzle, Politecnico di Milano, Syseca Logiciel, Team, Universite de Valenciennes

1561 SACODY

A High Performance Flexible Manufacturing System Robot with Dynamic Compensation

AEG, Bertin & Cie, Katholieke Universiteit Leuven, Kuka Schweissanlagen + Roboter, Leuven Measurement & Systems, University College Dublin

1572

Basic Technologies for High Performance Solid State Image Sensors

Thomson-CSF-DCI, Valvo Bauelemente Philips

1652
Methods for Advanced Group Technology Integrated with CAD/CAM
CETIM, LVD Company, Michel van de Wiele, Microin, WTCM/CRIF

1653
Intelligent Process Control by Means of Expert Systems
Centre d'Estudis Avancats de Blanes, CNRS-LAAS, Dornier, Eltec Elecktronik, Miniwatt, Nederlandse Philips Bedrijven, RTC Compelec, Universitat Politecnica de Catalunya

2010 NEUTRABAS
Neutral Product Definition Database for Large Multifunctional Systems
Institut de Recherche de Construction Navale, Alsthom, BIBA, Bremer Vulkan, Construnaves, Decision International, Howaldtswerke - Deutsche Werft, Ingenieria de Sistemas de Informacion, MDC, Schiffko, Senermar, Technische Universitaet Berlin, Universidad Politecnica de Madrid, Universite de Toulouse-Paul Sabatier, University of Strathclyde

2017
Automated Process and Assembly Inspection by 3D-Vision
Siemens, Inisel, MBLE, Nederlandse Philips Bedrijven, Robotiker, Silicon & Software Systems, Universitaet Erlangen-Nuernberg, Zenon

2032 CIM ALIVE
Implementation Addressing Levels of Integration in Various Environments
Gec Electrical Projects, AEG, Carlo Gavazzi Impanti, Nederlandse Philips Bedrijven, SNIA BPD - Fiat Group

2043 MARIE
Mobile Autonomous Robot in an Industrial Environment
Volmac, Consejo Superior de Investigaciones Scientificas, Framatome, Framentec, Hitec, Indecon, Robert Bosch, Universiteit van Amsterdam, University of Strathclyde

2090 EPIC
Early Process Design Integrated with Controls
Intrasoft, Baan Info Systems, City University, Metek, Motor Oil, Planet, Special Analysis and Simulation Technology, TNO Netherlands Institute of Preventive Health Care

2091 VIMP
Vision Based on-line Inspection of Manufactured Parts
Universite Louis Pasteur Strasbourg, Caption, Fraunhofer IITB, Speroni, Universitaet Karlsruhe

2127 HIDCIM
Holographic Labelling Techniques for Automatic Identification in CIM Environments
Krupp Forschungsinstitut, ICI Imagedata, King's College London, Mandelli, Universidade do Porto

2165 IMPPACT
Integrated Modelling of Products and Products and Processes using Advanced Computer Technologies
Krupp Atlas Datensysteme, Games Ingenieri, Norsk Data, Pafec

2172 DIAS
Distributed Intelligent Actuators and Sensors
Sema Metra, Electricite de France, Electricidade de Portugal, ENEL, Esacontrol, Hartmann & Braun, Mentec International, Montefibre

2178 RA-IQSE
An Integrated Quality Support Environment
Computer Resources Intl, Asociacion de la Industria Navarra, Computer Technologies Co. HCS Industrial Automation, Paisley College of Technology

2189 BIPMS
Building Industry Project Management System
Centre Scientifique et Technique de la Construction, Baan Info Systems, UTI-Services

2192 AIMBURN
Advanced Intelligent Multi-sensor System for Control of Boilers and Furnaces
Associacao Para o Desenvolvimento do Instituto Superior Tecnico, ABB Industri, Fabrica de Vidros Barbosa & Almeida, Intelligent Decision Systems, Inspection y Garantia de Calidad, Mague, Servotrol, Trion Praezisionselektronik, Unisoft

2195 CADEX
CAD Geometry Data Exchange
Gesellschaft fuer Strukturanalyse, BMW, CAD-CAM Data Exchange Technical Centre, Centre for Industrial Research, Det Norske Veritas, Erdisa, Fegs, Fiat Aviazione, Hewlett-Packard, Isykon Software, Italcad, Norske Data, Procad, Siemens

2198 FCPN
Factory Customer Premises Network
Jeumont-Schneider Telecommunications, Democritus University of Thrace, Electricite de France, Polydata

2202 CIM-PLATO
CIM System Planning Toolbox
Fraunhofer IPK, Bull, FIAR, Induyco/Investronica, Kuka Schweissanlagen + Roboter, Psi, Universidad Politecnica de Madrid, Universisdade Nova de Lisboa, Universitaet Karlsruhe, Universiteit Van Amsterdam, University College Galway

2277 CMSO
CIM for Multi-Supplier Operations
Actis Zentrale Verwaltungs, Associacao Para o Desenvolvimento do Instituto Superior Tecnico, Associacao de Fabricantes Para a Industria Automovel, Alcatel Isr, BIBA, DAF, Helsinki University of Technology, Lucas Automotive, National Technical University Athens, Oy Saab-Valmet, Technische Universiteit Delft, Vegla Vereinigte Glaswerke, Wilhelm Karmann

2280 LAMA
Large Manipulators for CIM
AEG Aktiengesellschaft, Bertin & Cie, CASA, Fraunhofer IPK, Fraunhofer IPA, Moog Controls, Putzmeister-Werke, Teknologisk Institut

2292 TT-CNMA
Testing Technology for Communications Networks for Manufacturing Applications
Spag Services, Acerli, BMW, Fraunhofer IITB, Siemens, Swedish Telecom, TITN, TNC

2312 CIRCE
Application and Enhancement of an Experimental Center for System Integration in CIM
Elsag, Aeritalia, Cit-Alcatel, Pegaso/Enasa, RWTH Aachen, University of Manchester

2331 ADEPT
Advanced Distributed Environment for Production Technology
Cap Industry, Communication and Management Systems Unit, Syntax Factory Automation, Teknecomp

2338 IMPACS
Integrated Manufacturing Planning and Control System
CGE-Laboratoires de Marcoussis, Alcatel, Centunion, Comau, Digital Equipment Corporation Galway, PA Consulting Group, TITN, Universite de Bordeaux 1

2349
Fault Tolerant Control and Management of Production Systems
Stewart Hughes, Adersa, AMTRI, Ikerlan, Mandelli, Pegaso/Enasa, PSA

2415
Distributed Manufacturing Planning and Control
RD Projects, Krupp Atlas Datensysteme, Technische Universiteit Delft, Imperial College

2422
AMICE II
Cap Gemini Sogeti, AEG Aktiengesellschaft, Aerospatiale, Alcatel, APT Nederland, British Aerospace, Bull, Digital Equipment, Dornier System, Fiat Aviazione, GEC Electrical Projects, Hewlett-Packard-France, IBM Deutschland, ICL, Italsiel, Mble,Procos, RWTH Aachen, Seiaf, Siemens, Volkswagen

2428 IPCES
Intelligent Process Control by Means of Expert Systems
Nederlandse Philips Bedrijven, Centre d'Estudis Avancats de Blanes, CNRS-Laas, Dornier System, Eltec Elecktronik, Miniwatt, RTC Compelec, Universitat Politecnica de Catalunya

2434
Knowledge-Based Realtime CIM Controllers for Distributed Factory Supervision
Philips, Alcatel Austria - Elin, BICC Technologies, Commissariat a l'Energie Atomique, FIAR, Fraunhofer IPA, Games Ingenieri, Industrie Pirelli, Noratom, Osterreichische Philips Industrie, Steria, Tecnicas Reunidas

2439 ROCOCO

Real Time Monitoring and Control of Construction Site Manufacturing

Bremer Vulkan, Alsthom, BIBA, British Maritime Technology Cortec, Eleusis Shipyards, Fincantieri, Magnemag, Micrologica, Pandata, Universiteit van Amsterdam, Waertsilae Marine Industry

2457 FLEXPLAN

Knowledge Based Planning and Control in Manufacturing Environments

Adv/Orga F.A. Meyer, Artificial Intelligence Systems, Intelligent Decision Systems, Katholieke Universiteit Leuven, Lvd Company, Metek, Neutech, Universitaet Hannover

2483 PANORAMA

Perception and Navigation System for Autonomous Mobile Applications

Sagem, British Aerospace, CEA- Leti, CRIF/WTCM, Easams, Empresa de Investigacao e, Desenvolvimento de Electronica, LNETI, Rauma-Repola, Sepa, Tampelle Tamrock, Universidad Politecnica de Madrid

2486 ICTDAS

Integrated CAE Techniques for Dynamic Analysis of Structures

Leuven Measurement & Systems International, Fiat Aviazione, Ncode International, Porsche, Straco, Universitaet Karlsruhe

2527 CIDAM

System with Distributed Database and Configurable Modules

Mannesmann Kienzle, Cap Industry, Fiat Aviazione,Trinity College Dublin, Universitaet des Saarlandes

2588 DSDIC

Design Support for Distributed Industrial Control

AEG, F.L. Smidth & Co, GEC Electrical Projects, Procos

2590 IPDES

Integrated Product Design System

Cetim-Etablissement de Senlis, Charmilles Technologies, Coretech International, Deltacam Systems, Gildemeister Automation, Intellingent Decision Systems,Kade-Tech, Matra Datavision, Mecanica de la Pena, Technische Hochschule Darmstadt

2614 CAD* II

Interfaces to CIM Applications

Kernforschungszentrum Karlsruhe, Danmarks Tekniske Hojskole, Dansk Ingenior System, Erdisa, Psi, REIS & Co, Seeber

2617 CNMA

Communications Network for Manufacturing Applications

British Aerospace, Aerospatiale, Bull, Fraunhofer IITB, GEC Electrical Projects, Magnetti Marelli, Nixdorf Computer, Robotiker, Siemens, TITN, Universitaet Stuttgart

2623 MAGIC

Methods for Advanced Group Technology Integrated with CAD/CAM

CRIF/WTCM, Cap Sesa Industrie, Cetim-Etablissement de Senlis, Lvd Company, Michel Van de Wiele

2626 AUTOCODE

Intelligent System for Automatic Processing of Design Codes of Practice,

RTN Ingeciber, Analyse de Systemes et Informatique, Babcock & Wilcox Espanola, European Centre for Artificial Intelligence, Instituto e Qualidade

2637 ARMS

Advanced Robotics Manipulation System

Citroen-PSA, CEA-Ugra, CRIF/WTCM, Industrie Zanussi, Inria, Kuka Schweissanlagen + Roboter, Telemecanique

2640 ICI

Integrated Intelligent Process Control and Inspection in Robot Finishing

Zenon, Enosa, Fraunhofer IPK, Joyce-Loebl, Metalworks of Attika, Swiss Federal Institute of Technology

2656 IDRIS

Intelligent Drive for Shop Floor Systems

Mari Advanced Microelectronics, Nada Consulting Group, Robert Bosch, University of Newcastle

2658 ARTIFACTS

Advanced Robotics in Flexible automation - Components, Tools and Strategies

Mari Advanced Microelectronics, Fraunhofer IPA, Intracom, Joyce-Loebl, Robert Bosch,Siemens, Sincon, Zenon

2671 KB-MUSICA

Knowledge-Based Multi-Sensors Systems in CIM Applications

Imperial Chemical Industries, British Maritime Technology Cortec, Krupp Forschungsinstitut, Senter for Industriforskning, TITN

Basic Research Actions

3001 NSIGHT

Vision Systems for a Natural Human Environment

Katholieke Universiteit Leuven, Centre de Mathematiques de l'Ecole Polytechnique, Inria, Royal Institute of Technology, Ruhr-Universitaet Bochum, Universita di Genova, Universitaet Karlsruhe, Universiteit van Utrecht, University College London, University of Keele, University of Oxford, University of Sheffield, University of Stirling

3003 CLICS

Categorical Logic in Computer Science

Imperial College, Aarhus Universitet, CNRS-Ens, GMD, Inria, Universita Degli Studi di Parma, University of Cambridge

3006 CONCUR

Theories of Concurrency : Unification and Extension

University of Amsterdam, Centrum voor Wiskunde & Informatica, Inria, Swedish Institute of Computer Science, University of Edinburgh, University of Oxford, University of Sussex

3011 CEDISYS

Models, Languages and Logics for Concurrent Distributed Systems

Universita di Pisa, Aarhus Universitet, Inria, University of Sussex

3012 COMPULOG

Computational Logic

Imperial College, Ader, European Computer Industry Research Centre, Katholieke Universiteit Leuven, Instituto de Desenvolvimento de Novas Tecnologias, Universita Degli Studi di Roma la Sapienza, Universita di Pisa, Universitaet Kaiserslautern, Universitaet Passau, Universite d'Aix-Marseille II, University of Bristol, University of Edinburgh, University of Uppsala

3014 HIGH TC SUPERCONDUCT

High Temperature Superconductivity: Concepts, Models and Methods

Max-Planck-Gesellschaft, Rutherford Appleton Laboratory

3017 NOISE

Electrical Fluctuations and Noise in Advanced Microelectronics: Submicronic, Two Dimensional Gas and Low Temperature Devices

Institut National Polytechnique de Grenoble, CNET, IMEC, Plessey Company, Technische Universiteit Eindhoven, Universita di Modena, Universite des Sciences et Techniques de Lille-Flandres-Artois, Universiteit van Utrecht

3020 INTEGRATION

Integrating the Foundations of Functional, Logic and Object-Oriented Programming

Centrum voor Wiskunde & Informatica, CNRS-Ens, Nederlandse Philips Bedrijven, Imperial College, Universidade Nova de Lisboa, Universita di Pis

3023 IS-CORE

Information Systems : Correctness & Reusability

INESC, Technische Universitaet Braunschweig, Imperial College, Universitaet Dortmund, Universiteit van Tilburg

3026 HESSILSIL

Heterostructure of Semiconducting Silicides on Silicon-Applications to SI Compatible Optoelectronic Devices

CNRS Administration Deleguee, CNR, Universidad Autonoma de Madrid, Universita di Roma II Tor Vergata, Universite de Paris VI

3030 ACQUILEX

Acquisition of Lexical Knowledge for Natural Language Processing Systems

Universita di Pisa, CNR-Istituto di Linguistica Computazionale, Universiteit van Amsterdam, University College Dublin, University of Cambridge

3038 VAP

Vision as Process

Aalborg Universitet, Institut National Polytechnique de Grenoble, Linkoeping University, Royal Institute of Technology, University of Surrey

3041 MESH

Possible Mechanisms for High-TC Superconductivity and Phenomenological Approaches

Research Center of Crete, CNRS, Universitaet Karlsruhe, Universite de Paris-Sud, University of Oxford

3042 NANOFET

Performances and Physical Limits of HFET Transistors

IMEC, Armines, CNRS, University of Cambridge

3043 LATMIC

Lateral Microstructures : Fabrication, Low Dimensionality Effects and Applications to III-V Devices

CNRS, CNET, National Microelectronics Research Centre, Royal Signals and Radar Establishment, Universitaet Stuttgart, University of Cambridge, University of Exeter

3049 NERVES

Innovative Architectures for Neurocomputing Machines and VLSI Neuram Networks

Institut National Polytechnique Grenoble, Centre Suisse d'Electronique et Microtechnique, Ecole Polytechnique Federale de Lausanne, Institut fuer Mikroelektronik Stuttgart, Politecnico di Torino, St Patrick's College, Universitaet Dortmund, Universite Catholique de Louvain, Universite Joseph Fourier-Grenoble I, University of Edinburgh, University of Oxford

3059 ECOLES

Development of Representation in Machine Learning

University of Bradford, The Turing Institute, Universidade do Porto, Universite de Paris-Sud

3066 AMODEUS

Assimilating Models of Design, Users and Systems

Medical Research Council, Kobenhavns Universitet, Logica UK, Rank Xerox, Standard Elektrik Lorenz, Universite Joseph Fourier-Grenoble I, University of York

3070 FIDE

Formally Integrated Data Environment

Gip Altair, CNR-Iei, Universita di Pisa, Universitaet Hamburg, Universite de Paris-Sud, University of Glasgow, University of St. Andrews

3074 SEMAGRAPH

Semantics and Pragmatics of Generalised Graph Rewriting

University of East Anglia, CNRS, Centrum voor Wiskunde & Informatica, ICL, Katholieke Universiteit Nijmegen, Imperial College

3075 ALCOM

Algorithms and Complexity

Universiteit van Utrecht, Aarhus Universitet, Computer Technology Institute, Ehess-Cams, Freie Universitaet Berlin, Inria, Trinity College Dublin, Universita Degli Studi di Roma la Sapienza, Universitaet des Saarlandes, Universitat Politecnica de Catalunya, University of Warwick

3085 DRUMS

Defeasible Reasoning and Uncertainty Management Systems

Universite Libre de Bruxelles, Universite d'Aix-Marseille II, Centre of Advanced Studies of Blanes, Imperial Cancer Research Fund-London, Irisa-Rennes, Laboratoire de Recherche en Informatique, Universite Paul Sabatier Toulouse, Queen Mary College, Universidad de Granada

3086 LDS

MBE and VPE Growth of Low Dimensionality Structure For Future Quantum Semiconductor Devices

Universite Blaise Pascal-Clermont II, Ecole Centrale de Lyon-Leame, Forth Research Center of Crete, Institut National des Sciences Appliquees, Universidad de Barcelona, Universidad Politecnica de Madrid, University College Cardiff

3092 PDCS

Predictably Dependable Computing Systems

University of Newcastle, City University, CNR-Iei, CNRS, Laboratoire Recherche Informatique, Technische Universitaet Wien, Universitaet Karlsruhe, University of York

3096 SPEC

Formal Methods and Tools for the Development of Distributed and Real Time Systems

Technische Universiteit Eindhoven, Foundation for Research and Technology - Hellas, IMAG, Katholieke Universiteit Nijmegen, Swedish Institute of Computer Science, Imperial College, Universite de Liege, University of Manchester, University of Oxford

3104 PROCOS

Provably Correct Systems

Danmarks Tekniske Hojskole, Aarhus Universitet, Royal Holloway & Bedford New, College-University of London, Universitaet Kiel, University of Manchester, University of Oxford

3105 MOHAWC

Models of Human Actions in Work Context

RISO National Laboratory, Bamberg Universitaet, Roskilde Universitet Center, Universite de Liege, Universite de Paris-Nord, University of Manchester, University of Uppsala

3109 PROMPT

Programme for MOS Processing Technology

Harwell Laboratory, IMEC, University of Cambridge

3121 MOLCOM

Exploration of Electronic Properties in Conducting Organic Materials as a Function of Structural Modifications : a Basis for the Development of Microelectronics Utilizing Molecular Components

CNRS, HC Oersted Institute, Instituto Superior Tecnico, LNETI

3124 SEMANTIQUE

Semantics-Based Program Manipulation Techniques

Imperial College, Ecole Polytechnique, Kobenhavns Universitet, University of Glasgow

3125

Mechanizing Deduction in the Logics of Pratical Reasoning

Imperial College, ICL, Institut National Polytechnique de Grenoble, Universite Paul Sabatier Toulouse, ONERA-Cert, Research Insitute for Symbolic Computation, Universita di Torino, Universitaet Kaiserslautern, University of Muenchen

3133 NANSDEV

Nanostructures for Semiconductor Devices

University of Glasgow, Centro Nacional de Microelectronica, IMEC, Ludwig Maximilians Universitaet, Philips Gloeilampenfabrieken, Technische Universiteit Delft, Thomson-Csf

3143 FOF

Towards an Integrated Theory for Design, Production and Production Management of Complex, One of a Kind Products in the Factory of the Future

Technische Universiteit Eindhoven, Bremen Institute for Industrial Technologies, Danmarks Tekniske Hojskole, Helsinki University of Technology, Sintef, Universite de Bordeaux 1, University College Galway

3146 DIRTYSUPRA

Study of the Influence of Impurities on the Properties of High TC Superconductors

Universite Libre de Bruxelles, Max-Planck-Institut, Universite de Paris-Sud, Universite Libre de Bruxelles

3147 PHOENIX

Hierarchical Intergration of Logic and Functional Paradigms: Specifications, Refinement and Implemetation

GMD, Katholieke Universiteit Nijmegen, Imperial College

3148 DEMON

Design Methods Based on Nets

GMD, Leiden Universiteit, Technische Universitaet Muenchen, Universidad de Zaragoza, Universita di Milano, Universitaet Passau, Universite de Paris-Sud, Universite Libre de Bruxelles, University of Newcastle

3149 MUCOM

Multisensory Control of Movement

CNRS, CNR, Katholieke Universiteit Nijmegen, Ruhr-Universitaet Bochum, Universitaet Zuerich, Universite Catholique de Louvain, Universite de Geneve

3160 IDEAL

Interactive Dialogues for Explanation and Learning

City University, CNR, Queen Mary College, Universita di Pisa, University of the Aegean

3168 DX'S

Limiting Factors in III-V Semiconductor Devices due to Donor Related Deep States

CNRS, Universidad Politecnica de Madrid, Universitaet Paderborn, Universite de Paris VII, University of Lund, University of Sheffield

3174 SI/GE SLS

Ultrathin Silicon/Germanium Superlattices

AEG, University of Muenchen, University of Newcastle

3175 DYANA

Dynamic Interpretation of Natural Language

University of Edinburgh, Universitaet Stuttgart, Universitaet Tuebingen, Universiteit van Amsterdam

3177 EPIOPTIC

European Project : Investigation of Optical Probe Techniques for Interface Charaterisation

Trinity College Dublin, Royal Signals and Radar Establishment, Technische Universitaet Berlin, Universita di Messina, Universita di Roma II Tor Vergata, University College Cardiff, University of Liverpool

3178 REFLECT

Reflective Expertise in Knowledge Based Systmes

Universiteit van Amsterdam, BSR Consulting, GMD, Interface Concilium, Netherlands Energy Research Foundation

3180 FOCUS

Foundations of Optoelectronic Computers

University College London, IMEC, Philips, Plessey Company, Trinity College Dublin, Universidad de Madrid-Etsi, Universidad Politecnica de Madrid, Universite de Paris VII, University College London, University of Sheffield

3186 NOROS

Quantum Noise Reduction Schemes in Optical Systems

CNRS, CNET, Consorzio Interuniversitario Nazionale di Fisica Della Materia, Max Planck Institut fur Quantenoptik, Royal Signals & Radar Establishment

3200 ORGANICLOW-DIMENSIO

Structure and Transport Properties of Organic Low-Dimensional Systems for application to IT

University of London-Queen Mary College, Helmut Hund, Max Planck Institut fuer Festkoerperforschung, Trinity College Dublin, Universita di Genova, Universitaet Tuebingen, University of Edinburgh

3207 ACTS

High Resolution Speech Recognition

Medical Research Council, INESC, Institut National Polytechnique de Grenoble, Universita di Milano, University of Cambridge, University of Edinburgh

3215 CHEOPS

Higher Order Logic Supported Design for Complex Data Processing Systems

IMEC, University of Cambridge

3216 CHARME

Correct Hardware design : Towards Formal Design and Verification for Provably Correct VLSI Hardware

IMEC, VLSI Hardware, Politecnico di Torino, Technische Hochschule Darmstadt, Universite de Provence, University of Strathclyde

3219 KAUDYTE

Acquisition and Use of Knowledge in the Control of Dynamic Systems

Institut fuer Informatik Der Universitaet Bonn, University of Oxford, Universitaet Bayreuth, Universitaet der Bundeswehr, Universite Libre de Bruxelles

3228 SPRINT

Speech Processing and Recognition Using Integrated Neuro-Computing Techniques

Cap Sesa Innovation, Ecole Nationale Superieure des Telecommunications, Royal Signals and Radar Establishment, Standard Elektrik Lorenz, Universidad Politecnica de Madrid

3230

Common Foundations of Functional and Logic Programming

Universita di Roma, CNRS-Ura 752, Eidgenoessiche Technische Hochschule - Zentrum, National Technical University, Swedish Institute of Computer Science, Universitaet Kaiserslautern, University College of Swansea

3234

Self Organisation and Analogical Modelling Using Subsymbolic Computing

Vrije Universiteit Brussel, CEAB-Blanes, Rof Nevanlinne Institute, Universitaet Hamburg, Universite de Geneve, Universite Libre de Bruxelles, University of Lappeenranta

3237 PATMOS

Power and Timing Modeling, Optimization and Specification

Universitaet Kaiserslautern, Ecole Norm Superieure des Telecommunications, Universidad Politecnica de Canarias

3245

Logical Frameworks Design, Implementation and Experiment

Inria, Chalmers University of Technology, Universite Paris 7, Universita di Torino, University of Cambridge, University of Edinburgh, University of Manchester, University of Oxford

3247 DESON

Disorder and Electrical Properties in Silicon Oxynitrides

Lepes-CNRS-Grenoble, IMEC, Universidad Autonoma de Madrid, Universiteit van Utrecht, Ustl-Montpellier

3249

European Special Project on Qualitative Reasoning

University College London, Ecole Polytechnique Federale de Lausanne, Fraunhofer IITB, Heriot-Watt University, Siemens, Universita di Milano

3260 TOPP

Transverse Optical Patterns

Physikalisch-Technische, Bundesanstalt, Consorzio Interuniversitario Nazionale di Fisica della Materia

3264 COMPASS-A

Comprehensive Algebraic Approach to System Specification and Development

Universitaet Bremen, Crin/Adilor, Katholieke Universiteit Nijmegen, Technische Universitaet Berlin, Technische Universitaet Braunschweig, Universita di Genova, Universitaet Dortmund, Universitaet Passau, Universitat Politecnica de Catalunya, Universite de Paris-Sud, University of Edinburgh

3267

Use of Children's and Teacher's Explanations in the Specification of Systems of Explanation for Intelligent Learning Environments

London Mental Models Group-University of London, King's College, Kingston Polytechnic, London Institute of Education, Royal Danish School of Educational Studies, Universite de Paris-Sud

3274 FIRST

Fundamentals of Intelligent Reliable Robot Systems

University of Oxford, Institut National Polytechnique de Grenoble, Katholieke Universiteit Leuven, Universita di Genova, University of Karlsruhe

3279 ACCOR

Articulatory-Acoustic Correlations in Coarticulatory Processes

CNRS, Centro di Studio per le Ricerche di Fonetica, Ludwig Maximilians Universitaet, Siemens, Trinity College Dublin, Universidad Politecnica de Valencia, University of Reading, University of Stockholm

3280 NANA

Novel Algorithms for New Real-Time VLSI Architectures

IMEC, Institut National Polytechnique de Grenoble, Inria, Katholieke Universiteit Leuven, Technische Universiteit Delft

3281 ASCIS
Behavioral Synthesis, Partitioning and Architectural Optimisation for Complex Systems on Silicon
IMEC, Danmarks Tekniske Hojskole, Institut National Polytechnique de Grenoble, Technische Hochschule Darmstadt, Technische Universiteit Eindhoven, University of Patras

3299
Computing by Graph Transformations
Technische Universitaet Berlin, Freie Universitaet Berlin, Leiden Universiteit, Universita di Pisa, Universitaet Bremen, Universite de Bordeaux 1

3314 MOLSWITCH
Evaluation of Molecular Switch Type Devices: Theory and Experiments
Kobenhavns Universitet, Max-Planck-Gesellschaft, Universite de Strasbourg 1 Louis Pasteur, University of Uppsala

3327 SUPRADYNAMICS
Lattice Dynamics of High TC Single Crystal Superconductors
CNRS-Crpht, Kernforschungszentrum Karlsruhe

3700
VLSI Action
GMD, Danmarks Tekniske Hojskole, IMEC, Institut National Polytechnique de Grenoble, Rutherford Appleton Laboratory

Information Exchange System

33 ROSE
Research Open Systems for Europe
Bull, General Electric Company, ICL, Ing. C. Olivetti & C., Siemens630

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The Unix-United Aspects of the IES
D.G. Sg2 Genie Informatique, Mari Advanced Microelectronics

700 ELAN
ESPRIT/European Local Area Network
Bull, ICL Belgium, Olivetti, Siemens Data

706 EUROKOM
Computer Conferencing and Electronic Mail for ESPRIT
University College Dublin

710
IES Support Services
ECAT, IEGI, Infoarbed

717 HERMES
Message Handling Survey and Trends for the IES user Community
Fisher & Lorenz

718 CARLOS
Communications Architecture for Layered Open Systems
Case Group, ESTSET-M, ETS Ingenieros Telecomunication-UPM, Fisher & Lorenz, RC Computer, Sysware

719 THORN
The Obviously Required Name-Server
Bull, CERN, DFN, General Electric Company, ICL, Ing. C. Olivetti & C., INRIA, Siemens, Systems Wizards, University College of London

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Eigner ... Karlsruhe
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Metalworks of Attika	Athens
Metek	Halandri
Michel van de Wiele	Kortrijk
Microin	Barcelona
Micrologica	Bargteheide
Microtecnica	Torino
Micro-Connectique Technologies	Boulogne-Billancourt
Micro-Controle	Evry
Micro Focus	Newbury
Mietec	Oudenaarde
Milano Research Center	Milano
Ministry of Defence	London
Miniwatt	Barcelona
Modular Computer	Konstanz
Modulex	Billund
Monotype Corporation	Redhill
Mono Light Instruments	Weybridge
Montefibre	Venezia
Moog Controls	Tewkesbury
Morpho-Systemes	Avon
Motor Oil	Athens
MO Valve Company	London
Myfra	Montrouge
Nada Consulting Group	Gateshead
National Computing Centre	Manchester
National Software Centre	Dublin
NA Software	Liverpool
Ncode International	Sheffield
Nea-Lindberg	Ballerup
Nederlandse Philips Bedrijven	Eindhoven
Nederlandse Philips Bedrijven	Nijmegen
NEH Technology	Kobenhavn
Neptune Freight	Dublin
Neutech Entwicklungs-Gesellschaft	Muenchen
Nixdorf Computer	Berlin
Nixdorf Computer	Muenchen
Nixdorf Computer	Paderborn
Nixdorf Computer	Milano
NKT Elektronik	Brondby
Noesis	Versailles
Nokia Corporation	Helsinki
Nokia Graetz	Esslingen
Non Standard Logics	Paris
Noratom	Lysaker
Nordisk Brown Boveri	Heidelberg
Norske Data	Kongsberg
Norsk Data GmbH Germany	Muehlheim
Numerical Algorithms Group	Oxford
Oce-Nederland	Venlo
Ocn-Ppl	Torino
Odense Steel Shipyard	Odense
Oeva-Versicherungen	Manheim
Office Workstations	Edinburgh
Olivetti	Bruxelles
Olivetti	Ivrea
Olivetti	Milano
Olivetti	Pisa
Onera-Cert	Toulouse
Optec	Novara
Organon International	Oss
Oros	Meylan
Osai A-B	Torino
Ositel	Meudon-Bellevue
Osterreichische Philips Industrie	Wien
Otter Online	Muehlheim
Ove Arup & Partners	London
Oy Saab-Valmet	Uusikaupunki
O Dati Espanola	Barcelona
Pafec	Nottingham

Page Iberica	Madrid
Pandata	Rijswijk
PA Consulting Group	London
PCS Computersysteme	Muenchen
Peat Marwick Mclintock	London
Peat Marwick Treuhand	Frankfurt
Pegaso/Enasa	Madrid
Philips Datasystems	Apeldoorn
Philips Gloeilampenfabrieken	Eindhoven
Philips	Kassel
Philips International	Eindhoven
Philips International	Hilversum
Philips Kommunikations Industrie	Nuernberg
Philips	Limeil-Brevannes
Philips Research Laboratories	Redhill
Philips	Bruxelles
Philips Scientific	London
Philips	Le Plessis-Robinson
Picogiga	Les Ulis
Pilkington	Ormskirk
Pilkington	St Asaph
Planet	Athens
Plasma Technology	Bristol
Plasmos	Muenchen
Plessey Company	Christchurch
Plessey Company	Romsey
Plessey Company	Towcester
Plessey Research Roke Manor	Beeston
Plessey Semiconductors	Chadderton
Polydata	Athens
Polyflow	Louvain-La-Neuve
Polymer Laboratories	Church Stretton
Porsche	Weissach
Praxis Systems	Bath
Prisma Informatica	Perugia
Procad	Karlsruhe
Procos	Birkerod
Prodata	Bruxelles
Project Management Consultants	Holte
Prologia	Marseille
Pross	Madrid
Protexarms	Paris
PSA	Neuilly-Sur-Seine
PSI	Berlin
PTT Nederland	Leidschendam
PTT Service Etudes Communications	Caen
Putzmeister-Werke, Maschinenfabrik	Aichtal
R.N.U.R.	Boulogne-Billancourt
Racal Research	Reading
Rank Xerox	Cambridge
Rauma-Repola	Tampere
RC Computer	Aabyhoej
RD Projects	London
Realace	Dublin
Redar Nah-Ortungstechnik	Darmstadt
Reis GmbH & Co Maschinenfabrik	Obernburg
Renault Automation	Boulogne Bllancourt
Reseaux Communication Entreprise	Cergy-Pontoise
Riada & Co	Dublin
Robert Bosch	Darmstadt
Robert Bosch	Erbach
Robert Bosch	Gerlingen-Schillerhoehe
Robert Bosch	Reutlingen
Robert Bosch	Stuttgart
Rodime Europe	Glenrothes
Rolls Royce	Watford
RTC	Dreux
RTC	Paris
RTC	Issy Les Moulineaux
RTE	Karlsruhe
RTM	Torino
Rudolf Horner	Karlsruhe
Rutherford Appleton Laboratory	Didcot
Rytrak	Liverpool
Conseil de Filiere Staf	Le Mans
Sagantec	Eindhoven
Sagem	Nanterre
Sagem	Paris
SAIT Electronics	Bruxelles
Sarin	Roma
SCAITECH	Lyngby
Scanray	Hvidovre
Scantest System	Vaerlose
Schiffko	Hamburg
Scicon	London
Scientific Control Systems	Hamburg
Seeber	Leifers
SEIAF	Genova
Seleco	Pordenone
Selenia	Roma
Sema-Group	Bruxelles
Sema Metra	Fontenay-Sous-Bois
Sema Metra	Montrouge
Sema Metra	Paris
Semisystems	Fruthwilen
Senermar	Madrid
Sepa	Torino
SEP	Puteaux
Servicios de Gestion Tecnologica	Barcelona
Servotrol	Lisboa

Sesam ..... Torino
Sesa ..... Puteaux
Sesa ..... Rennes
Sextant Avionique ..... Velizy-Villacoublay
Sgn Graphael ..... Coudun
Sgs-Thomson Microelectronics ..... Gentilly
Sgs-Thomson Microelectronics ..... Grenoble
Sgs-Thomson Microelectronics ..... Milano
Siemens ..... Erlangen
Siemens ..... Graefing
Siemens ..... Karlsruhe
Siemens ..... Muenchen
Siemens ..... Regensburg
Siemens Data ..... Bruxelles
Siemens ..... Barcelona
Sig Services ..... Utrecht
Silicon & Software Systems ..... Dublin
Silvar-Lisco ..... Leuven
Simulog ..... St-Quentin-En-Yvelines
Sincon ..... Roma
Sinorg ..... Paris
Sipa ..... Vittorio Veneto
Sipe Optimation ..... Pratica di Mare
Sirti ..... Milano
Sismet ..... Lisboa
Sistemas Modulares Distribuidos ..... Lisboa
Sistemi e Telematica Porto di Genova ..... Genova
SIS ..... Milano
Sitesa Addax ..... Montbonnot
Smiths Industries Aerospace
& Defence Systems ..... Cheltenham
SMI Organometallic Division ..... Marseille
SNIAS ..... Les Mureaux
SNIA BPD - Fiat Group ..... Milano
Sociedad Espanola
de Lamparas Electricas ..... Barcelona
Societa Elettronica Automazione ..... Torino
Societe Anonyme Telecommunications .... Paris
Societe d'Etudes
& Realisations Electroniques ..... Paris
Societe Francaise de Genie Logiciel ..... Boulogne
Societe Generale
de Techniques et d'Etudes ..... Puteaux
Sofemasa ..... Madrid
Softlab ..... Muenchen
Software Engineering Services ..... Neubiberg
Software Sciences ..... Macclesfield
Software Sistemi ..... Bari
Soft International ..... Den Haag
Sogei ..... Roma
Sogitec ..... Boulogne
Solvay ..... Bruxelles
Sophiatec ..... Valbonne
Soren T. Lyngsoe ..... Horsholm
Souriau & Cie ..... Boulogne-Billancourt
South Scotland Electricity Board ..... Glasgow
SPAGServices ..... Bruxelles
Special Analysis
and Simulation Technology ..... Brentford
Speroni ..... Sostegno di S
SQL Databanksysteme ..... Berlin
Standard Elektrik Lorenz ..... Stuttgarts
Stc Components ..... Sidcup
Stc ..... Paignton
Stc Technology ..... Harlow
Stc Technology ..... Newcastle-Under-Lyne
Steria ..... Velizy-Villacoublay
Stewart Hughes ..... Southampton
SGS-Thomson Microelectronics ..... Agrate Brianza
Stollmann & Co ..... Hamburg
Straco ..... Compiegne
Strategic International ..... Athens
STZ Gesellschaft
fuer Software-Technologie ..... Dortmund
Suprenum ..... Bonn
Swedish Institute of Computer Science ..... Kista
S.W.I.F.T. ..... La Hulpe
Sybase ..... Bracknell
Synergia ..... Milano
Synergie Informatique &
Developpement ..... Paris
Syntax Factory Automation ..... Torino
Syseca Logiciel ..... St-Cloud
Systeam ..... Karlsruhe
Systems and Management ..... Milano
Systems and Management ..... Pisa
Systems Wizards ..... Torino
System Software Factors ..... Reading
Sysware ..... Copenhagen
Tampelle Ltd Tamrocks ..... Tampere
TAP Air Portugal ..... Lisboa
TDS Dextralog ..... Blackburn
Team ..... Varese
Techforce ..... Leiden
Tecnatom ..... Madrid
Tecnicas Reunidas ..... Madrid
Tecnics en Automatizacio d'Oficines ..... Barcelona
Tecnomatix Europe ..... Antwerpen
Tecno T&G ..... Madrid
Tecograf Software ..... Milano

Tecsiel	Pisa
Teice Control	Madrid
Teknecomp	Cavaglia
Telefonica de Espana	Madrid
Telefonica Investigacion y Desarrollo	Madrid
Telefonica Sistemas	Madrid
Telefunken Electronic	Heilbronn
Telefunken Systemtechnik	Ulm
Telemecanique	Nanterre
Telesystemes	Paris
Telettra Espanola	Madrid
Telettra	Bologna
Telettra	Cinisello Balsamo
Televas	Milano
Tele Logic	Farsta
Telmat Informatique	Soultz
Teseo	Milano
Textware	Bagsvard
The East Asiatic Company	Kobenhavn
The English Electric Company	Whetstone
The Piraeus Graduate School	Piraeus
Thomslagerwall	Bandol
Thomson Cetia	Toulon
Thomson Composants Microondes	Orsay
Thomson Composants Militaires et Spaciaux	Courbevoie
Thomson Consumer Electronics	Paris
Thomson-CSF	Boulogne-Billancourt
Thomson-CSF	St-Egreve
Thomson-CSF	Bagneux
Thomson-CSF	Boulogne-Billancourt
Thomson-CSF-Finance	Paris
Thomson-CSF-Laboratoire Electronique	Cesson-Sevigne
Thomson-CSF	Colombes
Thomson-CSF	Issy-Les-Moulineaux
Thomson-CSF	Orsay
Thomson-CSF	Paris
Thomson Grand Public	Illkirch-
Thomson Informatique Services	Paris
Thomson Sintra-Asm	Cagnes-Sur-Mer
Thomson-TRT Defence	Paris
Thorn EMI	Hayes
TITN	Aix-Les-Milles
TITN	Chilly-Mazarin
TITN	Massy
TITN	Morangis
TNC	Hemel Hempstead
TN Telenorma	Frankfurt
Trademco	Athens
Trion Praezisionselektronik	Berlin
Tritech	Dublin
Triumph-Adler	Fuerth
Triumph-Adler	Nuernberg
TUEV	Essen
TUEV	Muenchen
TXT-Tech.Soft E Telematica	Milano
UCB Electronics	Bruxelles
UITESA	Madrid
UK Atomic Energy Authority	Warrington
Unibanque - Credit Agricole	Paris
Unibanque	Paris
Unisoft	Lisboa
UTI-Services	Paris
Valvo Unternehmensbereich	Hamburg
Vector Fieldss	Oxford
Vereinigte Glaswerke	Aachen
Verilog	Toulouse
Video Display Systems	Firenze
Visitec	Seraing
Voice Systems International	Cambridge
Volkswagen	Wolfsburg
Volmac	Utrecht
Wacker Chemitronic	Burghausen
Waertsilae Marine Industry	Turku
Westland	Yeovil
Whitechapel Computer Works	London
Wild Leitz Instruments	Heidelberg
Wilhelm Karmann	Osnabrueck
Work Research Centre	Dublin
Yard Software Systems	Chippenham
Zeltron	Campoformido
Zenon	Athens

Esprit Participants - University & Research Organisation sites

3IT	Toulouse
Aalborg Universitet	Aalborg
Aarhus Universitet	Aarhus
ADERSA	Verrieres-Le-Buisson
ADR-CRISS	Grenoble
Advanced Computer Research Institute	Paris
AERE	Didcot
Akzo International Research	Arnhem
Alsthom	Paris
AMTRI	Macclesfield
Aristotle University	Thessaloniki
Armines	Palaiseau
Armines	Paris
Asociacion de la Industria Navarra	Pamplona
Athens School of Economics	Athens
Bamberg Universitaet	Bamberg
Battelle Institut	Frankfurt
BAZIS	Leiden
BIBA	Bremen
Bifoa	Koeln
Brighton Polytechnic	Brighton
Bristol Polytechnic	Bristol
British Maritime Technology	Wallsend
Brunel University	Uxbridge
Ccett	Cesson-Sevigne
CEA-Leti	Grenoble
CEA-Ugra	Fontenay-Aux-Roses
CEA	Gif-Sur-Yvette
Cemota	Vernaison
Cena	Orly-Aerogare
Center for Industrial Research	Oslo
Centre Commun de Microelectronique de l'Ouest	Rennes
Centre de Mathematiques de l'Ecole Polytechnique	Palaiseau
Centre d'Estudis Avancas de Blanes	Blanes
Centre d'Etudes du Management	Puyricard
Centre d'Etudes et de Recherches	Toulouse
Centre Regional de Technologie Electrique/Optique	Limoges
Centre Scientifique et Technique de la Construction	Bruxelles
Centre Suisse d'Electronique et Microtechnique	Neuchatel
Centro di Cultura Scientifica	Como
Centro Nacional de Microelectronica	Madrid
Centrum Voor Wiskunde & Informatica	Amsterdam
Cerics	Valbonne
CERN	Geneve
Cete Mediterannee	Les Milles
Cetim-Etablissement de Senlis	Senlis
Chalmers University of Technology	Goeteborg
CISE	Milano
City University	London
CNET	Bagneux
CNET	Issy-Les-Moulineaux
CNET	Lannion
CNET	Meylan
CNRS	Aix-En-Provence
CNRS	Orsay
CNRS	Paris
CNRS	Strasbourg
CNRS	Valbonne
CNRS	Marseille
CNRS	Mulhouse
CNRS	Orleans
CNRS	Ecully
CNRS	Bagneux
CNRS	Toulouse
CNRS	Villetaneuse
CNRS	Grenoble
CNR	Pisa
CNR	Milano
CNR	Roma
CNR	Firenze
CNR	Padova
CNR	Bologna
Communication/Management Systems Unit	Athens
Computer Technology Institute	Patras

Consejo Superior de Investigaciones Cientificas ..... Madrid
Conservatoire National des Arts et Metiers ..... Paris
Consorzio Campano di Ricerca per l'Informatica ..... Napoli
Consorzio Interuniversitario Nazionale di Fisica ..... Genova
Consorzio Per l'Osi in Italia ..... Milano
Consorzio Pisa Ricerche ..... Pisa
Copenhagen School of Economics & Business Administration ..... Kobenhavn
Coventry Polytechnic ..... Coventry
Cranfield Institute of Technology ..... Cranfield
Cretan Computer Institute ..... Iraklion
CRIF/WTCM ..... Bruxelles
CRIF/WTCM ..... Leuven
CRIN/Adilor ..... Vandoeuvre-Les-Nancy
CSELT ..... Torino
Danish Maritime Institute ..... Lyngby
Danish Welding Institute ..... Brondby
Danmarks Tekniske Hojskole ..... Lyngby
Datenzentrale Schleswigholstein ..... Kiel-Altenholz
Delft Hydraulics ..... Delft
Democritus University of Thrace ..... Xanthi
Direction des Musees de France ..... Paris
Doerner Institute ..... Muenchen
Dorset Institute ..... Dorset
Ecole Centrale de Lyon ..... Ecully
Ecole des Mines de Saint-Etienne ..... St Etienne
Ecole Nationale Superieure des Mines ..... Fontainbleau
Ecole Normale Superieure ..... Paris
Ecole Normale Superieure ..... Lyon
Ecole Normale Superieure des Telecommunications ..... Paris
Ecole Polytechnique Federale ..... Lausanne
Ecole Polytechnique ..... Palaiseau
Ecole Polytechnique ..... Paris
Ecole Superieure d'Ingenieurs ..... Noisy Le Grand
Education Technology Institute ..... Milton Keynes
Ehess-Cams ..... Paris
Eidgenoessiche Technische Hochschule .. Zuerich
Elab ..... Trondheim
Elektronik Centralen ..... Hoersholm
Empirica ..... Bonn
Ensea ..... Cergy
Enseeiht ..... Toulouse
Entwicklungszentrum fuer Mikroelektronik ..... Villach
ETS Ingenieros Telecomunication-UPM ..... Madrid
European Centre for Weather Forecasts ..... Reading
European Computer Industry Research Centre ..... Muenchen
Fachhochschule Augsburg ..... Augsburg
Fachhochschule Ulm ..... Ulm
Facultes Universitaires Notre-Dame de la Paix ..... Namur
Fernuniversitaet Gesamthochschule ..... Hagen
Fondazione Ugo Bordoni ..... Roma
Forschungszentrum Informatik ..... Karlsruhe
Forth Research Center of Crete ..... Heraklion
Foundation For Research and Technology ..... Heraklion
Fraunhofer AGD ..... Darmsdadt
Fraunhofer AIS ..... Erlangen
Fraunhofer Gesellschaft ..... Muenchen
Fraunhofer IAO ..... Stuttgart
Fraunhofer IFT ..... Muenchen
Fraunhofer IITB ..... Karlsruhe
Fraunhofer IMS ..... Duisburg
Fraunhofer IMT ..... Berlin
Fraunhofer IPA ..... Stuttgart
Fraunhofer IPK ..... Berlin
Fraunhofer ITW ..... Dortmund
Freiburg Universitaet ..... Freiburg
Freie Universitaet Berlin ..... Berlin
G4S Ricerca SPA ..... Bari
Gip Altair ..... Le Chesnay
Glasgow College ..... Glasgow
GMD ..... Berlin
GMD ..... Karlsruhe
GMD ..... St Augustin
Grail-Centre of Advanced Studies ..... Blanes
GS Ohm Fachhochschule ..... Nuernberg
Handelshojskolen I Kobenhavn ..... Frederiksberg
Harwell Laboratory ..... Didcot
Hatfield Polytechnic ..... Hatfield
HC Oersted Institute ..... Copenhagen
Heinrich Hertz Institut ..... Berlin
Helsinki University of Technology ..... Espoo
HERIE ..... Nimes
Heriot-Watt University ..... Edinburgh
Husat Research Centre ..... Loughborough
IABG ..... Ottobrunn
IASI ..... Roma
IDSIA-Fondazione Dalle Molle ..... Lugano

IIRIAM ..... Marseille
IKERLAN ..... Mondragon
IMAG-Laboratoire Genie Informatique ..... St-Martin-d'Heres
IMAG-Universite de Grenoble ..... Grenoble
IMEC VZW ..... Heverlee
Imperial Cancer Research Fund ..... London
Imperial College ..... London
INESC ..... Lisboa
INESC ..... Porto
Infratest Industria ..... Muenchen
Inria ..... Le Chesnay
Inria ..... Rennes
Inria ..... Valbonne
Institiuid Teangeolaiochta Eireann ..... Dublin
Institute for Scientific Interchange ..... Torino
Institute of Computer Science ..... Heraklion
Institute of Higher
Professional Education ..... Eindhoven
Instituto Nacional
de Investigacao Cientifica ..... Porto
Instituto Superior Tecnico ..... Lisboa
Institut de Recherche
de Construction Navale ..... Paris
Institut d'Optique
Theorique et Appliquee ..... Orsay
Institut fuer Deutsche Sprache ..... Mannheim
Institut fuer Informatik ..... Bonn
Institut fuer Mikroelektronik ..... Stuttgart
Institut Mediterraneen de Technologie ..... Marseille
Institut National
des Sciences Appliquees ..... Villeurbanne
Institut National
Polytechnique de Lorraine ..... Nancy
Institut National Polytechnique ..... Grenoble
Institut National Polytechnique ..... Grenoble
Institut Superieur d'Electronique ..... Lille
Iriac ..... Paris
Irisa ..... Rennes
Istituto Nazionale di Ottica ..... Firenze
Johann Wolfgang Goethe Universitaet ..... Frankfurt
Joint Research Centre ..... Varese
Katholieke Industriele
Hogeschool Antwerpen ..... Hoboken
Katholieke Industriele
Hogeschool West-Vlaanderen ..... Oostende
Katholieke Universiteit Leuven ..... Heverlee
Katholieke Universiteit Nijmegen ..... .Nijmegen
Kernforschungszentrum Karlsruhe ..... Karlsruhe
Kingston Polytechnic ..... Kingston
King's College ..... London
Kobenhavns Universitet ..... Kobenhavn
Labein ..... Bilbao
Laboratoire de Recherche Informatique ... Orsay
Laboratoire d'Informatique
Therique et de Programmation ..... Paris
Laboratoire Physique des
Composants Semiconducteurs ..... Grenoble
Ladseb-Cnrp ..... Padova
Lancashire Polytechnic ..... Preston
Leicester Polytechnic ..... Leicester
Leiden Universiteit ..... Leiden
Linguistics Institute of Ireland ..... Dublin
Linkoeping University ..... Linkoeping
LNETI-ICEN ..... Sacavem
London Institute of Education ..... London
London Mental Models Group ..... London
Loughborough University of Technology ... Loughborough
LSI-Universite Paul Sabatier Toulouse ..... Toulouse
Ludwig Maximilians
Universitaet ..... Muenchen
Lutchi Research Centre ..... Loughborough
Manchester Polytechnic ..... Manchester
Max-Planck-Gesellschaft ..... Stuttgart
Max-Planck-Institute
For Psycholinguistics ..... Nijmegen
Max-Planck-Institut
fuer Festkoerperforschung ..... Grenoble
Max Planck Institut fuer Quantenoptik ..... Garching
Medical Research Council ..... Cambridge
Medical Research Council ..... London
Medical Research Council ..... Sheffield
Middlesex Polytechnic ..... London
Ministry of Defence UK ..... Great Malvern
Napier Polytechnic ..... Edinburgh
National Gallery ..... London
National Institute for Higher Education ..... Dublin
National Institute for Higher Education ..... Limerick
National Microelectronics
Research Centre ..... Cork
National Nondestructive Testing Centre ... Harwell
National Physical Laboratory ..... Teddington
National Research Center ..... Athens
National Technical University ..... Athens
Natural Environment Research Council ..... Reading
Netherlands Energy
Research Foundation ..... Petten
Newcastle upon Tyne Polytechnic ..... Newcastle
Nijenrode Universiteit
voor Bedrijfskunde ..... Breukelen
Noratom ..... Lysaker

Nordjysk Udviklingscenter	Aalborg
Norwegian Institute of Technology	Trondheim
Odense Universiteit	Odense
Onera-Cert	Chatillon
Onera-Cert	Toulouse
P. Scherer Instiute	Zurich
Paisley College of Technology	Paisley
Physikalisch-Technische Bundesanstalt	Braunschweig
Plymouth Polytechnic	Plymouth
Politecnico di Milano	Milano
Politecnico di Torino	Torino
Polytechnic of Central London	London
Polytecnic of Crete	Chania
Portsmouth Polytechnic	Portsmouth
PTT Research Telematica Laboratorium	Groningen
Queen Mary College	London
Queen's University	Belfast
Research Center of Crete	Heraklion
Research Insitute for Symbolic Computation	Linz
Research Unit for Computational Linguistics	Helsinki
Rijksuniversiteit	Gent
RIOM / Groningen University	Groningen
RISO National Laboratory	Roskilde
Robotiker	Mungia
Rof Nevanlinne Institute	Helsinki
Roskilde Universitet Center	Roskilde
Royal Danish School of Educational Studies	Kobenhavn
Royal Holloway & Bedford New College	Egham
Royal Institute of Technology	Stockholm
Royal Signals & Radar Establishment	Great Malvern
Ruhr-Universitaet	Bochum
Rutherford Appleton Laboratory	Didcot
RWTH	Aachen
SCK - CEN	Mol
Second University of Rome Tor Vergata	Rome
Senter for Industriforskning	Oslo
Seram	Paris
Serc	Utrecht
Sheffield City Polytechnic	Sheffield
Sintef	Trondheim
SNS	Pisa
South Bank Polytechnic	London
St. Patrick's College	Drumcondra
Staffordshire Polytechnic	Stafford
Swedish Institute for Systems Development	Kista
Swedish Institute of Computer Science	Kista
Swiss Federal Institute of Technology	Lausanne
Swiss Federal Institute of Technology	Zuerich
Tampere University of Technology	Tampere
Technical Research Centre of Finland	Espoo
Technische Hochschule Darmstadt	Darmstadt
Technische Universitaet Berlin	Berlin
Technische Universitaet Braunschweig	Braunschweig
Technische Universitaet Darmstadt	Darmstadt
Technische Universitaet Hamburg	Hamburg
Technische Universitaet Muenchen	Muenchen
Technische Universitaet Wien	Vienna
Technische Universiteit Delft	Delft
Technische Universiteit Eindhoven	Eindhoven
Tecnopolis Csata Novus Ortus	Valenzano
Teesside Polytechnic	Cleveland
Teknologisk Institut	Taastrup
Televerket	Farsta
Thames Polytechnic	London
The Communication and Management Systems Unit	Athens
The Microelectronics Applications Research Institute	Gateshead
The Piraeus Graduate School	Piraeus
The Royal Institute of Technology	Stockholm
The Turing Institute	Glasgow
The Welding Institute	Cambridge
TNO Institute of Preventive Health Care	Leiden
TNO Organisation for Applied Research	Delft
TNO Organisation for Applied Scientific Research	Apeldoorn
TNO Organisation for Applied Scientific Research	Den Haag
TNO Organisation for Applied Scientific Research	Utrecht
TNO Physics and Electronics Laboratory	Den Haag
Trent Polytechnic	Nottingham
Trinity College	Dublin
UK Atomic Energy Authority	Didcot
UK Atomic Energy Authority	Dorchester
UK Atomic Energy Authority	London
Uninova	Monte de Caparica
Universidade Catolica Portugesa	Lisboa
Universidade de Aveiro	Aveiro
Universidade de Coimbra	Coimbra
Universidade do Minho	Braga
Universidade do Porto	Porto

Universidade Nova de Lisboa ..... Monte Da Caparica
Universidad Autonoma de Barcelona ..... Barcelona
Universidad Autonoma de Madrid ..... Madrid
Universidad del Pais Vasco ..... San Sebastian
Universidad de Barcelona ..... Barcelona
Universidad de Cantabria..... Santander
Universidad de Granada..... Granada
Universidad de Las Islas Baleares ..... Palma
Universidad de Madrid-Etsi ..... Madrid
Universidad de Sevilla ..... Sevilla
Universidad de Zaragoza ..... Zaragoza
Universidad Nacional
de Educacion a Distancia..... Madrid
Universidad Politecnica de Canarias ..... Las Palmas
Universidad Politecnica de Madrid ..... Madrid
Universidad Politecnica de Valencia..... Valencia
Universitaet Bayreuth ..... Bayreuth
Universitaet Bielefeld..... Bielefeld
Universitaet Bremen ..... Bremen
Universitaet der Bundeswehr ..... Hamburg
Universitaet des Saarlandes..... Saarbruecken
Universitaet Dortmund..... Dortmund
Universitaet Duisburg ..... Duisburg
Universitaet Erlangen-Nuernberg..... Erlangen
Universitaet Frankfurt ..... Frankfurt
Universitaet Gesamthochschule Siegen.... Siegen
Universitaet Goettingen ..... Goettingen
Universitaet Hamburg..... Hamburg
Universitaet Hannover ..... Hannover
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The Review of ESPRIT 1984-1988:
The Report of the ESPRIT Review Board
(Executive Version) May 1989
(DA, DE, EL, EN, ES, FR, IT, NL, PT)

European File - ESPRIT:
Key to the Technological Awakening
of Europe
(DA, DE, EL, EN, ES, FR, IT, NL, PT)

Official Documentation

COM (90) 153 final 23.5.1990
Proposal for a Council Decision concerning a Specific Programme of Research and Technological Development in the field of Information Technology (1990-1994)
(DA, DE, EL, EN, ES, FR, IT, NL, PT)

SEC (89) 1348 final 7.9.1989
Communication from the Commission to the Council and the Parliament concerning a review to assess the performance and results of the programme ESPRIT
(DA, DE, EL, EN, ES, FR, IT, NL, PT)

Official Journal L118 6.5.1988
Council Decision adopting the second phase of ESPRIT
(DA, DE, EL, EN, ES, FR, IT, NL, PT)

COM (88) 173 final 5.4.1988
Communication from the Commission to the Council and the Parliament concerning the final programme assessment of the Microelectronics programme
(DA, DE, EL, EN, ES, FR, IT, NL, PT)

COM (88) 102 final 29.2.1988
Revised proposal for a Council Decision concerning ESPRIT
(DA, DE, EL, EN, ES, FR, IT, NL, PT)

COM (86) 687 final 8.12.1986
ESPRIT - The First Phase: Progress and Results. Communication from the Commission to the Council
(DA, DE, EL, EN, ES, FR, IT, NL, PT)

COM (86) 269 final 21.5.1986
Communication from the Commission to the Council
The Second Phase of ESPRIT
(DA, DE, EL, EN, FR, IT, NL)

COM (85) 616 final 19.11.1985
Communication from the Commission to the Council and the Parliament concerning a review to assess the initial results of the ESPRIT programme
(DA, DE, EL, EN, FR, IT, NL)

Books

The following books containing the proceedings of the Annual ESPRIT Conference, technical papers and reports relating to ESPRIT project work are available.

BÖSSER, T., Learning in Man-Computer Interaction. A Review of the Literature, Springer-Verlag, 1987, ISBN 3-540-18291-4.

CHRISTIE, B. (Ed.), Human Factors of the User-System Interface. A Report on an ESPRIT Preparatory Study, Elsevier, 1985, ISBN 0-444-87832-7.

DIAZ, M., ANSART, J-P., COURTIAT, J-P., AZEMA, P. & CHARI, V., Results of the Esprit SEDOS Project, Elsevier, 1989, ISBN 0-444-87132-2.

ESPRIT CONSORTIUM AMICE (Ed.), Open System Architecture for CIM, Springer-Verlag, 1989, ISBN 3-540-52058-9.

ESPRIT '84, Status Report of Ongoing Work, ROUKENS, J. & RENUART J.F. (Eds.), Elsevier, 1985, ISBN 0-444-87740-1.

ESPRIT '85, Status Report of Continuing Work, The Commission of the European Communities (Eds.), Elsevier, 1986, ISBN 0-444-87915-3.

ESPRIT '86, Results and Achievements - Proc. of the 3rd ESPRIT Conference, Palais des Congrès, Brussels, 29 Sept. - 1 Oct. 1986, DG XIII, Telecommunications, Information Industries and Innovation (Eds.), Elsevier, 1987, ISBN 0-444-70160-5.

ESPRIT '87, Achievements and Impacts - Proc. of the 4th Annual ESPRIT Conf., Brussels, 28-29 Sept. 1987, DG XIII, Telecommunications, Information Industries and Innovation (Eds.), Elsevier, 1987, ISBN 0-444-70333-0.

ESPRIT '88, Putting the Technology to Use, Commission of the European Communities (Eds.), Elsevier, 1988, ISBN 0-444-87832-7.

ESPRIT '89 Conference Proceedings, Proceedings of the 6th Annual Conference, Brussels, Nov 27 - Dec 1 1989, Kluwer Academic Publishers, 1989, ISBN 0-7923-0592-2.

HALATSIS, C., TORRES, J. (Eds.), Computer Integrated Manufacturing, Proceedings of the 5th International Conference, IFS Publications/Springer Verlag, 1989, ISBN 1-854423-040-9.

HIRSCH, B., ACTIS-DATO, M. (Eds.), ESPRIT CIM. Design, Engineering, Management and Control of Production Systems Proc. of an Eur. Working Conf., Bremen, FRG 27-29 May 1986, Elsevier, 1987, ISBN 0-444-70300-4.

JÜPTNER, W., KREIS, T. (Eds.), An External Interface for Processing 3-D Holographic and X-Ray Images, Springer-Verlag, 1989, ISBN 3-540-50822-8.

PUENTE, E., MACCONAILL, P. (Eds.), Computer Integrated Manufacturing, Proceedings of the 4th International Conference, IFS Publications/Springer-Verlag, 1988, ISBN 0-948507-67-5.

RATHMILL, K., MACCONAILL, P. (Eds.), Computer Integrated Manufacturing, Proceedings of the 3rd International Conference, IFS Publications/Springer-Verlag, 1987, ISBN 0-948507-67-5.

SCHLECHTENDAHL, E.G. (Ed.), CAD Data Transfer for Solid Models, Springer-Verlag, 1989, ISBN 3-540-51826-6.

SCHLECHTENDAHL, E.G. (Ed.), Specification of a CAD*I Neutral File for CAD Geometry - Wireframes, Surfaces, Solids - Version 3.3, Springer-Verlag, 1988, ISBN-3-540-50392-7.

THOMAS, J., VAN MAANEN, J., MEAD, M. (Eds.), Specification for Exchange of Product Analysis Data - Version 3, Springer-Verlag, 1989, ISBN 3-540-51579-8.

ULLRICH, D., WOLFF VON GUDENBERG, J. (Eds.), Accurate Numerical Algorithms - A Collection of Research Papers, Springer-Verlag, 1989, ISBN 3-540-51477-5.

VAN EIJK, P.H.J., VISSERS, C.A., DIAZ, M. (Eds.), The Formal Description Technique LOTOS. Results of the ESPRIT/SEDOS Project, Elsevier, 1989, (In preparation).

YEOMANS, R.W., CHOUDRY, A., TEN HAGEN, P.J.W. (Eds.), Design Rules for a CIM System. 1985. 1st rept., Elsevier, 1987, ISBN 0-444-87812-2.

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