THE REVIEW OF ESPRIT
1984 - 1988

The Report of the ESPRIT Review Board
May 1989

Directorate-General XIII
Telecommunications, Information Industries
and Innovation

Esprit

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INTRODUCTION AND BACKGROUND

ESPRIT, the European Strategic Programme for Research and development in Information Technologies was conceived as a ten year programme. It was formally launched on January 1st, 1984, as a five year programme with total funding of 1.5 billion ECUs, of which the Community's contribution was 50%. Later the programme was extended for a further five years. This second phase, ESPRIT II, amounting to 3.2 billion ECUs, is funded on the same basis: 50% from the Community and 50% from participating industrial, academic and research bodies.

The overall strategic goal of ESPRIT was to provide European information technology (IT) industry with the technology base which it needs to become and stay competitive with the US and Japan in the 1990s. In addition to this primary objective, two others were identified, namely:

- Promotion of Europe's industrial co-operation in IT.
- Contribution to the development of internationally accepted standards.

Prior to the start of ESPRIT I there had been a one year pilot phase, during which a series of projects were started and much of the organisational structure established. A review was carried out in 1985 to obtain feedback and comment from a large sample of participant organisations. This so called Mid Term Review concluded that ESPRIT was well established and received, seemed to be highly successful in promoting trans-European cooperation and was not in conflict with national programmes. Certain changes were suggested to the modalities of the programme. The Mid Term Review recommended that for the future the emphasis should remain on precompetitive R&D, the research areas should be restructured and that focussed demonstration projects should be added to the programme. The essence of these suggestions were adopted within ESPRIT II.

This Review of ESPRIT I lasted from October 1988 until May 1989, and was undertaken by an independent Review Board. The objectives of the review were:

- To assess the extent to which ESPRIT I was achieving its objectives.
- To determine the effects of the programme.
- To assess the need for any changes affecting ESPRIT or future IT-related community programmes.

The review was carried out by means of:

- Face-to-face interviews with 210 industrial, academic and research participant organisations plus a further 39 interviews with Commission officials, with evaluators and reviewers as well as with national administrations.
- Analysis of 949 questionnaires completed by participants.
- Inputs from external consultants.

- Desk research of published information sources.

The reader may wish to refer to the Extended Report of the ESPRIT Review Board (ERB) which contains the findings and analysis in full with comprehensive supporting annexes.

The members of the ESPRIT Review Board were:

ERB Members

Dr. A.E. Pannenborg (Chairman of Review Board)	Retired Vice-Chairman of the Board of N.V. Philips
Professor H. Durand (Executive Vice-Chairman)	Professor at Paris University and former Assistant Secretary General of NATO (Scientific Affairs and Environment).
Professor U. Colombo	Chairman of the Italian National Agency for Atomic and Alternative Energy Sources (ENEA) and former chairman of the EC Committee on Science and Technology (CODEST).
Dr. J.R.Forrest	Director of Engineering, Independent Broadcasting Authority, United Kingdom.
Professor P.L. Ølgaard	Professor at the Institute of Electrophysics, Technical University of Denmark.
Professor J. Peracaula	Professor of Electronic Engineering. Technical University of Catalonia, and Director of the Barcelona High Technical School for Industrial Engineering.
Professor I. Ruge	Director of the Fraunhofer Institute for Solid State Technology, Munich

At the Review Board meeting on May 24th 1989 they collectively approved the publication of this report.

Technical secretariat

The members of the ERB were assisted by a full-time technical secretariat, consisting mainly of experienced independent consultants, and four secretaries. The technical secretariat members and their countries of residence were:

Mr. T.F. Chapman (Belgium), Mr. F. Danielsen (Denmark), Mrs. L. Henriques (Portugal), Mr. K. Kataras (Greece), Mr. R.D. Killick (UK) and Mr. P. Murtagh (Ireland).

KEY OBSERVATIONS AND CONCLUSIONS

The IT scene in Europe

ESPRIT was started against a background of decline in Europe's IT industry and a worsening balance of trade in this field. There was widespread agreement that a healthy indigenous IT industry and extensive use of IT would be of great significance in assuring future prosperity and employment prospects within the Community. Since then there has been a growing understanding that IT plays a key role in assuring quality of life as well. For the future Europe needs clean wealth producing industries. Information Technology is one such, but it also provides pivotal ingredients within the service sectors, together with socially important areas such as education and health care, besides being an enabling technology for all almost every economic activity.

Over the past five years the European IT industry has had mixed fortunes. In microelectronics, the adverse balance of trade has continued whilst the technological base has improved. In computer systems, market share has been well maintained within Europe, but not elsewhere. The position with respect to computer peripherals remains very weak. In software, European companies have performed well whilst in industrial automation, Europe has held its own.

Considerable industrial restructuring has occurred in recent years and will continue as the European "national champions" regroup to address world markets.

On the global scale Europe's IT industry is still weak but better positioned and more optimistic about its future than five years ago. Its strategic importance is undiminished. By 1993 it will represent the largest economic sector in Europe and almost two thirds of other industrial and service sectors will depend upon it for their efficiency and competitiveness.

The resources allocated to ESPRIT I are but a small fraction of the total R&D in information technology within community countries. Furthermore, the work was precompetitive and mostly of a long term nature. Therefore, it is premature to identify a direct causal relationship at this stage between ESPRIT and Europe's competitive performance vis-a-vis its major rivals, the USA and Japan.

ESPRIT I

The Review Board's overall perception of ESPRIT I, after a large number of interviews and considerable research, is positive.

The ERB found that in the vast majority of projects trans-European cooperation has been a success and resulted in significant benefits for the participants. There have been direct benefits of being able to cover a wider range of research topics more quickly by sharing results with the project partners. And there have been indirect benefits such as an improved awareness within Europe of the need to look outside national boundaries and the use of the diverse opportunities present within Europe, with respect to both research cooperation and future markets.

Europe's technological base has improved as a result of ESPRIT, in techniques and facilities and, most importantly, in human resources. Good work has been done on international standards. Links between industry and universities have been strengthened and transnationally, have often been created for the first time. Managerial awareness of the strategic importance of IT has been heightened and there is an increased confidence and optimism about the future.

All these are positive outcomes of ESPRIT. This is not to say that everything about ESPRIT and the way it is evolving is perfect but rather to set this report which necessarily dwells more extensively on criticisms than compliments into a balanced context.

Workplan pragmatically determined

Industry selected the research areas and defined the workplan for ESPRIT I. Five years ago the largest European companies viewed one another much more as competitors than collaborators. There was no united view of the strategic priorities for the industry nor, indeed, was there sufficient confidence in the efficacy of ESPRIT for them to commit their core business developments to the programme. Despite these problems at the inception of the programme the rather pragmatic work plan which resulted did address a number of technological issues of great significance in the three areas of microelectronics, software technology and advanced information processing, and their application to office systems and computer integrated manufacturing.

Technology has improved

Turning now to the results of ESPRIT, we the find that the European technology base has improved. This improvement is in all the research areas addressed. In some topics, European technology has moved ahead of its competitors; in others, the improvement has been in much needed "catch up" technology (for example, in silicon chips). Rather too much of the technological advance has been in niche areas with limited potential for future market exploitation. Given the manner in which the workplan was constructed this is, perhaps, not surprising.

Good progress in standards

A number of ESPRIT projects (15%) aimed to work on international standards. The thinking behind this was that the IT marketplace is moving more and more to the adoption of standards. Only companies with the largest market shares can afford to promote their proprietary standards. The rest must use common international standards, where competitive advantage should lie with those who lead in standards development. ESPRIT has helped European companies to move from followers to leaders in the evolution of standards across a range of different technologies.

Communications infrastructure

All the services which it was hoped to provide to ESPRIT I participants did not meet the expectations in the way originally foreseen. The goals set were overambitious. For the future, Value Added Services for collaborative R&D remain desirable. A reappraisal is needed of precisely how to obtain these and what the Commission's role in their provision should be.

Programme managed well and ...

The ERB found that the management of ESPRIT has, in general, been satisfactory and smooth and the procedures and modalities sensible.

Project Reviews effective but ...

Every project is reviewed by independent experts periodically, typically every six months. This is a feature which was pioneered by ESPRIT amongst publicly funded R&D programmes and seems to work very well. The outsiders view can help both the project and the Commission, especially when work has to be redirected.

... several areas need improving

The programme management could be improved in a number of respects. The handling of contract negotiation and the speed of payments were a source of justified criticism. The Commission was perceived not to have ensured adequate access to the results between ESPRIT projects. The number of partners in a project should not - except for standards projects - rise above six.

ESPRIT II

The ERB concentrated on reviewing ESPRIT I and, in no sense, should this report be considered a review of ESPRIT II. Nevertheless, various lessons learned and opinions formed during the review have relevance to ESPRIT II. In general, the ERB supports the changes of emphasis which are apparent in the evolution of ESPRIT. In particular, a stronger focus on the potential for economic exploitation and greater involvement of users are both welcome.

Within ESPRIT II the programme has become targeted towards major strategic themes. Nevertheless, the European approach to planning necessarily runs the risk of producing more widely based programmes than those to be found in either the USA or Japan.

The evaluation of proposals has become more systematic and the project database much more reliable. The ERB is concerned about the problems of managing projects with a large number of participants. While welcoming the Basic Research Action in ESPRIT II the ERB believes that the excellent links which have built up between industry and academia transnationally should be maintained.

Beyond ESPRIT

The IT industry together with industries and services which derive much of their competitive advantage from the application of information technology are of great importance to the Community's future. The ERB believes continued Community action beyond ESPRIT will be needed in the IT field and certain principles are important in its eventual formulation.

Cooperative research and development is a formula which is now beginning to work effectively and should be retained. Basic research must continue and even be increased. There needs to be a greater degree of concerted action by project teams and sharper strategic focus on market opportunities. The way in which ESPRIT II has evolved towards a stronger application orientation involving users to help pull technology through into the marketplace is a change in the right direction but further evolution is needed. As well as a broadly based technology push programme, room should also be made for a few ambitious, structured, goal-oriented projects. Finally, pressure must be sustained to reduce timescales of all aspects of research and development within IT in order to react to the extremely rapid changes which are occuring in the marketplace.

INFORMATION TECHNOLOGY INDUSTRY IN EUROPE

Significance of the IT sector

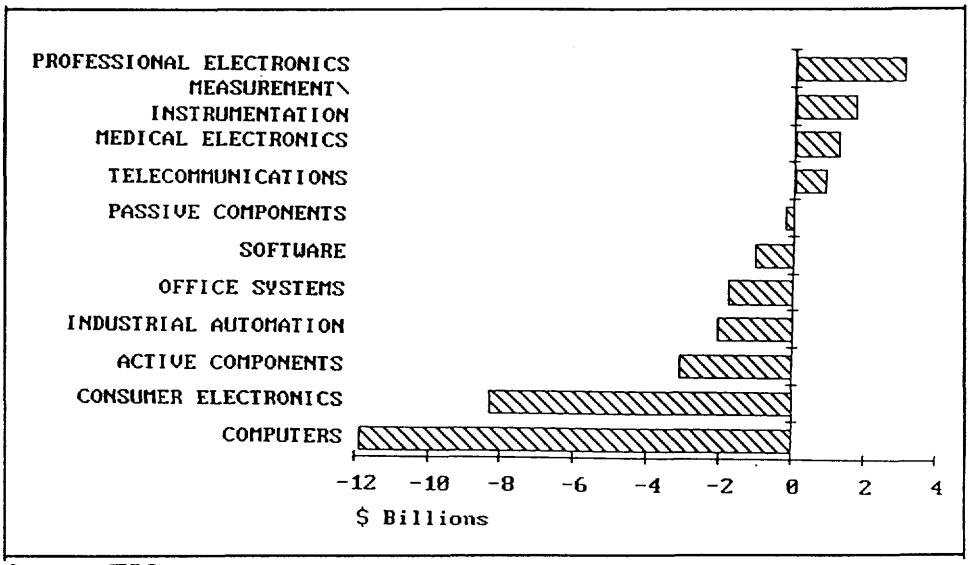
IT industrial output in Europe represents around 4.4% of European gross domestic product. Based on quite modest estimates of market growth, IT will represent 6.7% of GDP by 1993 which will be more than any other industrial sector. Moreover, almost two thirds of other industrial and service sectors depend for their efficiency and competitiveness on IT.

The area addressed by ESPRIT was and will remain of great importance for the future prosperity of Europe.

Trade deficit in IT

At the start of ESPRIT I, the Community was becoming rapidly more dependant on IT imports. In 1975 it still had a trade surplus in IT products. By 1980 the trade deficit had reached $5 billion. It has worsened since then and is predicted to continue to deteriorate for some time in all areas of electronics particularly IT.

Europe's trade deficit in electronics was $21.9 billion in 1987



Source: EIC

It is unwise to rely on the absolute values of these figures since there are serious problems with their collection and definition. Indeed, some governments within the community do not publish their national trade balances in IT at all.

To clarify the situation it is necessary to consider the position sector by sector.

ESPRIT focussed on the information processing and microelectronics sectors. Public telecommunications was excluded from ESPRIT and now has a programme, RACE, devoted to that area.

ESPRIT also addressed the use of IT in the office and the manufacturing environment. From a market appraisal standpoint, the office systems supported by ESPRIT are included within computer systems.

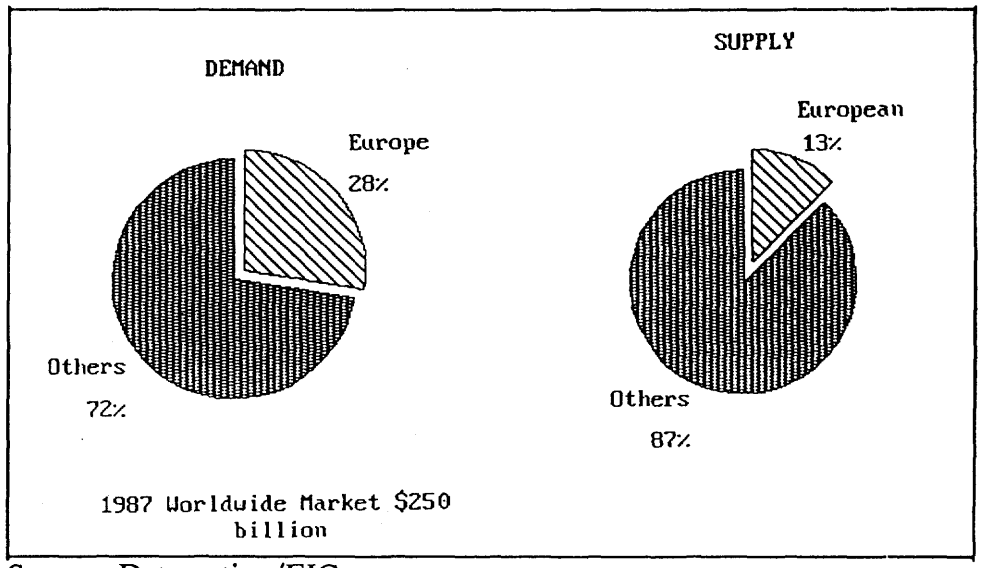
As well as computer hardware, computer systems also includes peripherals, software and service.

Computer Systems

In computer systems, Europe (Community and EFTA countries) represents about one third of a world market worth approximately $250 billion.

This proportion is broadly in line with what one would expect, bearing in mind Europe's gross national product as a proportion of the world total. It indicates that Europe is an advanced and heavy user of computer systems. Unfortunately, only some 13% of the world total came from European suppliers in 1987.

Europe within the world markets for information systems

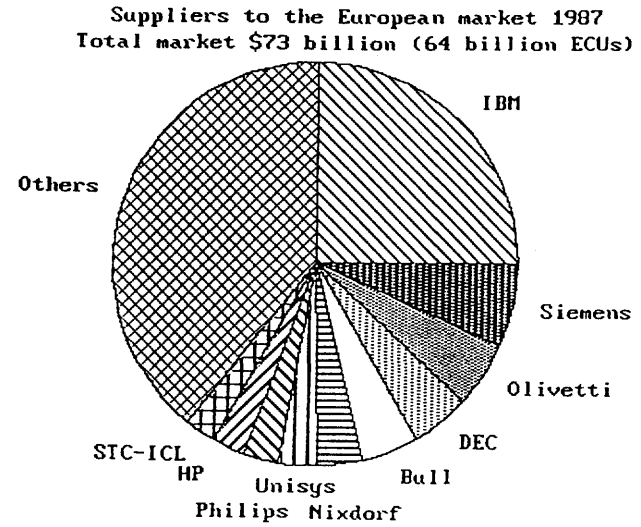


Source: Datamation/EIC

Since 1984, European computer companies have defended their positions well. Market share has been sustained by giving good service to the established customer base and by some continuing national support. In some instances, European vendors have kept their turnover up by adopting the role of system integrator or of product distributor which results in a reduction in value added and in export potential.

The chart shows the market shares of the top ten suppliers to the European market and the accompanying table illustrates the growth in their revenues over the period 1984-87.

Performance of European IT companies 1984-87



Turnover growth of the top 10 Suppliers to Europe ranked by average growth % per year 1984-1987 (Calculated from revenues converted to current ECUs)

Nixdorf	21.6%
Olivetti	20.3%
Philips	19.3 %
Unisys	18.2 % *
Bull	15.5 % *
DEC	14.6%
Siemens	13.1%
HP	10.6%
STC-ICL	8.2% *
IBM	3.6%

* significant merger or acquisition in the period

Source: Datamation

During the same period the European software industry has performed well with average yearly growth rates in revenue (22%) above that for the computer systems market as a whole (15%).

As a generalization, the software industry's success has been much more apparent within the customised systems market than in the market for packaged software, which remains overwhelmingly US dominated. The software industry seems therefore, to be in a strong competitive position within its home markets. It has yet to take up the challenge of trying to penetrate the US market or to start to compete in the packaged software market.

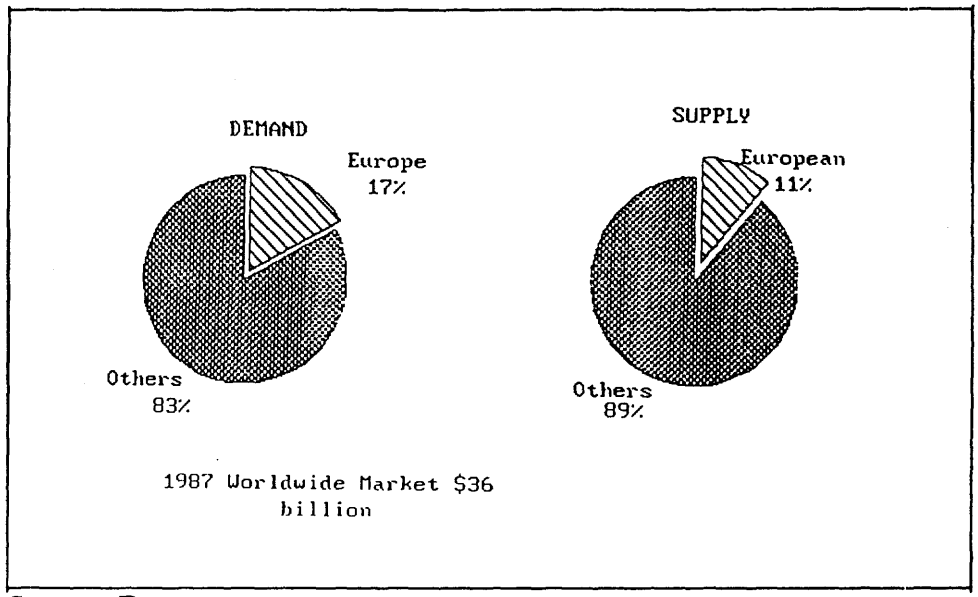
In peripherals, Europe's position remains very weak. At best, it has appreciable market share in a few niche market sectors. This is a matter of serious concern since peripherals represent 28% of the total market. Increased funding of "technology push" is unlikely to cure this problem as long as European companies have no ambition to exploit the results.

Microelectronics

In microelectronics (MEL), Europe is behind as a user and even more so as a supplier. Europe represented 17% of the $36 billion world market for microelectronics in 1987. In world-wide semiconductor markets, the share supplied by European companies declined from 15% in 1980 to 11% by 1984, a figure which has been maintained up to 1987.

The disparity between the figures for supply and demand is a cause for concern about the European industry.

Europe within the world market for microelectronics



Source: Dataquest

The principal reason why Europe represents such a small fraction of the world market is the relative absence of major users of microchips in Europe, which has virtually no world scale data processing or computer peripherals manufacturers and where the leading consumer electronics companies have only a rather modest production in Europe.

The European MEL market is satisfied in the main by US and European suppliers. Japanese companies at present have only a low share (17 %), whereas they have 50% of the world as a whole. The market share of the Far East suppliers will unavoidably rise in the short term particularly when one observes that the sectors of the market where Far East manufacturers are particularly strong are also those with the highest growth potential.

Industrial Automation

Few surveys address the industrial automation market specifically and in those that do, there is overlap with other researchers' estimates of the IT market. The world market for industrial automation in 1987 was $36.6 billion (including CAD/CAM, numerical control, robots, programmable controllers, flexible manufacturing systems and computers used in manufacturing). Europe represents 27% of these markets.

In the market terms, Europe is ahead in integrated automated systems and strong in machine tools. Japan, particularly, but also the US, lead in elementary robots, and numerically controlled tools, whilst most computer aided design systems come from the US.

Industry restructuring

Significant industrial restructuring has occurred over the past five years. Mergers, acquisitions and rationalization have been going on in all IT related industries most notably in telecommunication equipment supply but also in microelectronics and software companies. The least change has occurred in the computer companies where one can still identify the national champions in each of the larger member states. In addition, IT companies are also collaborating in a number of new ways in the promotion of international standards, in software development and within EUREKA. Industrial restructuring is one area where ESPRIT may have had a significant catalytic effect.

WORKPLAN FORMULATION AND FUNDING OF ESPRIT

Workplan formulation

Industry was the main driving force in defining first the research areas and then the goals and workplans for ESPRIT. The Round Table of twelve industrial organisations (AEG, Bull, CGE, GEC, ICL, Nixdorf, Olivetti, Philips, Plessey, Siemens, STET, Thomson) referred to as the "Big 12" was set up to advise the Commission in this regard. The hope was that through this process, research and development relevant to real market opportunities and exploitation possibilities would be attempted. Initially, this did not happen. Perhaps the main reason was the considerable current of scepticism among senior management within large organisations about the chances of ESPRIT achieving anything worthwhile. In any event the early workplans did not address the core business needs of the principal protagonists and concentrated on activities where competitors could actually agree to collaborate in a "precompetitive" way. Despite these problems at the inception of the programme the rather pragmatic work plan which resulted did address a number of technological issues of great significance in the three areas of microelectronics, software technology and advanced information processing, and their application to office systems and computer integrated manufacturing.

After ESPRIT was launched, the first call for proposals was made with commendable speed early in 1984.

The ERB heard from a number of interviewees that the "Big 12" are unrepresentative of industry as a whole and therefore, unsuited to the task of formulating the programme. The user voice was not represented either. Whilst this comment may have an element of truth in it, the ERB believes there was no practical or effective alternative to the approach adopted. Some augmentation with, for instance, the larger software companies might strengthen the process today.

It was unfortunate but understandable that, initially, the large companies involved did not have any accord on the product priorities for the industry as a whole. This situation compared poorly with the coherence of Japanese programmes as perceived in Europe. Today, following five years of working together and building up mutual trust, strategy is being more clearly articulated and, within ESPRIT II, pursued in a more focussed way.

Opinions of the workplan

Participants' criticisms of the workplan were few and its content was considered to be acceptable by the majority. Answers to the ERB's questionnaire indicated greater satisfaction with the ESPRIT II workplan than with that of ESPRIT I.

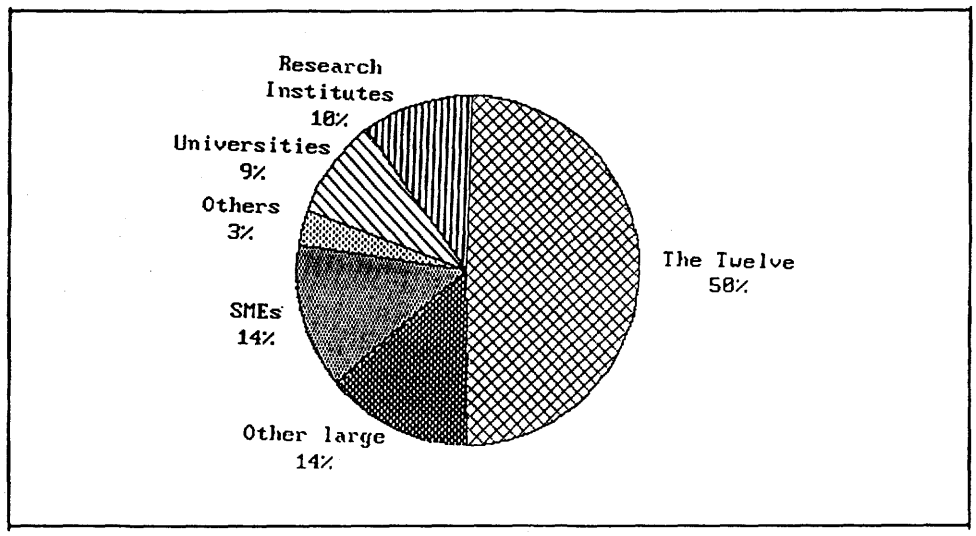
Funding

The allocation of funding to the various work areas was more or less equally divided, except for computer integrated manufacturing which received about one third less than the other areas.

ESPRIT funding was predominantly allocated to industry, appropriately enough given the industrial nature of the programme.

The "Big 12" received 50% of the total ESPRIT budget and were involved in 70% of projects. Their share of the programme has been falling with time as more small and medium sized companies joined the programme and, of course, when Spain and Portugal joined the Community. SMEs (enterprises with under 500 employees) participated in 65% of projects and received 14% of the funding.

ESPRIT I Funding allocated by sector



RESEARCH AREAS

Microelectronics

Microelectronics (MEL) is a key area. Arguably it is the key strategic area for IT research and development in the future.

Microelectronics is being used in an ever-widening range of markets from aviation to automobiles, from toys to telephones, from weapons to washing machines. The functionality of all this electronic equipment is becoming embedded with the chips to an ever increasing extent. Hence, one can see the really strategic importance of microelectronics to the future of the European IT industry, and many other industries besides.

The belief that all the industries which are becoming dependent on embedded microelectronics can develop competitively by purchasing standard components from remote and competing nations is fallacious. Close working relationships between major semiconductor users and suppliers are essential.

The research programme has produced some noteworthy achievements. Examples are:

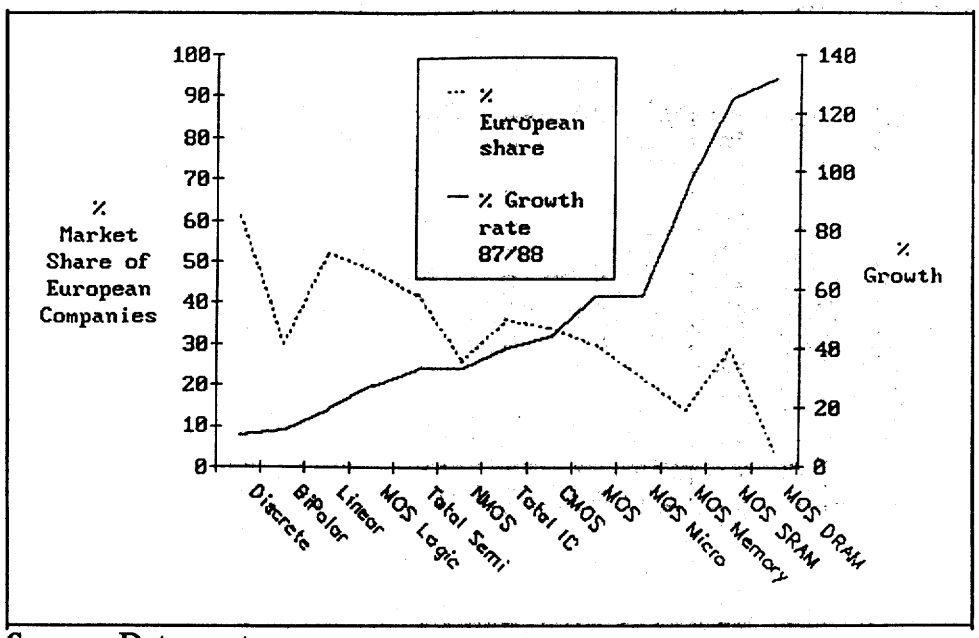
- In silicon technologies, many of the projects were of a "catch up" nature and have been successful in so far as the widening of the technological gap has been arrested.
- In computer aided design, valuable results were produced.

With hindsight, one must suggest that the MEL workplan was over ambitious for the funding available. The resources were spread too thinly over too wide a range of topics, including silicon bipolar, gallium arsenide and CAD technologies.

It is worth observing that most of the exploitation potential over the next decade is in silicon devices, yet much of the work was done in other technologies. It has to be noted, however that the major resources in CMOS technology were committed in the binational Mega project.

The weak position of Europe in the high growth areas of the technology is well known, and should have provided clear guidance for the R&D priorities in this area. The Mega project and that proposed in JESSI have a stronger sense of strategic direction.

MEL technology, growth potential, Europe's position.



Source: Dataquest.

Software Technology

Software technology is a foundation technology for almost all areas of IT and its application. It is also an area of relative European strength that deserves to be given emphasis.

The stated goal of this research area was to do what was necessary to put the software development process on a sound engineering footing. Sub areas were defined to deal with formal methods, development tools, management aspects, quality measurement and the development environment.

Progress has been made in formal methods. At the start of ESPRIT little use was made of formal description languages due to the inefficient code produced. The present position is an improvement but still largely confined to the research environment. Some of the software tools work can be rated successful and the portable common tools environment is moving towards acceptance as an international standard. The work has been valuable for inhouse developments but has yet to result in commercial exploitation.

Technology push has achieved a certain amount in this domain but the time when every commercial programmer uses standard techniques, or every university teaches them, is still far distant. The challenge now is to disseminate the results and see them applied.

More inputs from the major software system suppliers to the definition of what is required in this area would be valuable. Many of them claim to have achieved, and be routinely practising, the creation of software on a predictable and reliable engineering basis.

Advanced Information Processing

This area covered knowledge based systems (KBS), new computer architectures and speech and image processing.

It is a widely held belief that most systems within the next five to ten years will have key components based on KBS, which is therefore, a key technology which may have a significant bearing on Europe's competitive position in the 1990s.

The work in KBS has moved during the life of ESPRIT I from almost pure research towards application, reflecting the successful transfer of KBS theory into the industrial environment. With the benefit of hindsight, it is probably true that there was some over emphasis on this topic in ESPRIT I. There are always "fashions" in R&D and, early in ESPRIT I this topic became extremely fashionable. In ESPRIT II a more realistic view of this subject has been adopted.

New computers architectures leads potentially to exploitation in high performance microprocessor chips and in supercomputers. Both of these areas will be of importance in the 1990s. European industry does not seem either well placed or determined to attack these two market areas.

One project in this area which was a considerable success was the Supernode project which supported applications and, to some extent, the development of the floating-point transputer.

Technologies related to the processing of images, understanding natural language and processing speech will be of major importance in the next decade. Work in this area has been principally of a research nature. Some interesting demonstrations have been achieved. However, few projects have reached the stage of moving towards marketable products, nor would it be realistic to expect this at this stage. This area continues justifiably into ESPRIT II with increased funding.

Office Systems

When launched this work area was selected as a fast growing IT application area of major strategic importance for the efficiency of business throughout the Community. It represented one of the best test beds for the outcome of the three technology research areas, microelectronics, software technology and advanced information processing.

Viewed five years later it was disappointing for two reasons. First, the office systems environment was revolutionised by the personal computer, the local area network and some of the most reliable and, latterly, user friendly software the market had ever seen. Whilst some European vendors have had noteworthy successes in the market place, the technological base for office systems remains predominantly American. The changes in the marketplace occurred a good deal faster than the research projects could cope with.

The second point was that the use of office systems projects as a test bed for results obtained in micro electronics, software technology and AIP simply did not occur. The difficult management task of trying to cross fertilize one area with results from another was not undertaken.

Within the office systems area it is difficult to involve users since, typically, they would not think of carrying out research. This is quite different from,

for example, the manufacturing area where the larger users frequently have research personnel who can readily join ESPRIT projects.

Nevertheless, the area was not without achievements. Two projects have advanced the technology of high speed optical fibre local area networks. One project produced demonstrations of the use of optical disc technology for storing multimedia data, a technology which has good exploitation potential for the 1990s. The results of another are being exploited within automatic letter sorting systems. Another has made progress in the difficult field of handwriting recognition and useful work has been done in the standardisation of office documents for interchange between machines.

Computer Integrated Manufacturing

The ability of Europe's manufacturing sector to continue to compete in international markets in future is critically important, and computer integrated manufaturing (CIM) has an important role to play in ensuring this. It is also a very large potential market for IT equipment. For both these reasons, CIM is an area that should be viewed as of strategic importance.

The CIM area relates to the total range of computer integrated manufacturing activities including: computer aided design (CAD), computer aided engineering (CAE), computer aided manufacturing (CAM), flexible machining and assembly systems, robotics, testing, and quality control. The area was selected for its potential impact on the methods and economies of production, particularly in the IT industries, and also for manufacturing industry in general. Users and suppliers are both involved in CIM projects with the result that exploitation potential is high especially where complex integrated systems are concerned, which is the market sector in which Europe excels.

There have been a number of successful projects in the area including one in the standards area, involving a multivendor environment, where there are indications that Europe has achieved a position of technological leadership.

Participants in the CIM area showed the highest level of satisfaction when responding to the questionnaire concerning improvement to their organisations technological position.

CIM is the only work area which deals significantly with things mechanical. It is, therefore, appropriate to point out that a number of interviewees regretted the absence within ESPRIT of "mechatronic" projects which bring together mechanical and electronic skills in a disciplined way. Nor did the CIM workplan extend to the consideration of continuous flow processes.

For the future, attention must be paid to user attitudes and understanding in Europe. It is this, more than shortage of technology, which is holding up the wider adoption of computer integrated manufacturing.

Areas not covered

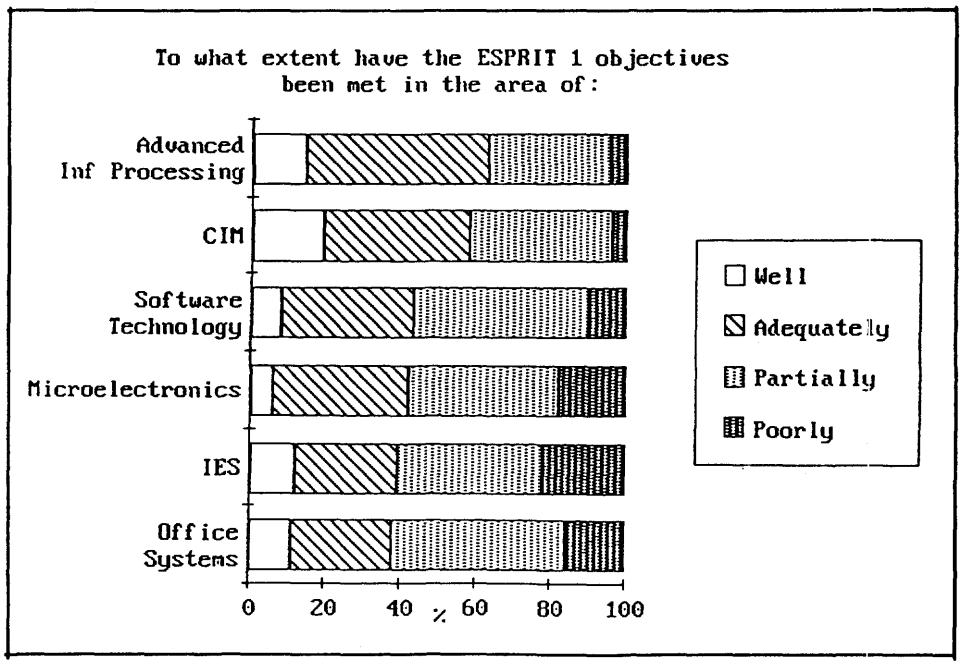
There were several IT related areas not included within ESPRIT which were drawn to the ERB's attention during the review process. This is no criticism. Indeed, in a focussed programme there should be more omissions than in an unfocussed one.

Some of the suggestions pointed towards the core businesses of the larger companies. The relative scarcity of projects in such areas and the reasons why this should be so have already been discussed.

Some of the topics mentioned address areas of technology which should be considered, but not necessarily included, in the formation of future workplans. Others, are already being worked upon within ESPRIT II. Examples quoted by participants include silicon materials, advanced CMOS, crystal growth equipment, mechatronics, optoelectronics, neural networks, domain languages and conceptual schema, portable displays, and the ergonomics and efficiency of software tools.

Opinions of Research Areas

The questionnaire responses showed that a larger number believed that ESPRIT objectives had been met adequately or well in the AIP and CIM areas than elsewhere.



INFRASTRUCTURE INFORMATION EXCHANGE SYSTEM

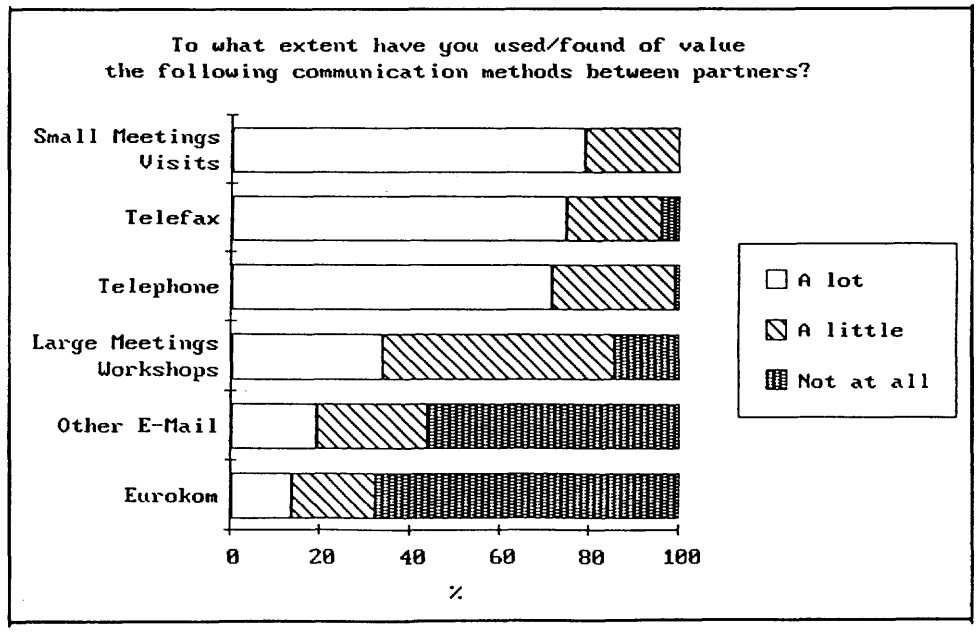
The Information Exchange System (IES) area within ESPRIT had two objectives:

- the provision of communications services to ESPRIT participants both industrial and academic.
- the encouragement of the development and adoption of Open Systems Interconnection (OSI) standards.

Communication services

The task of providing effective electronic mail services to ESPRIT users did not meet expectations. EuroKom, which is the principal IES service, and is provided by University College Dublin Computer Centre was initially chosen by the Commission. It has been continuously improved during the lifetime of ESPRIT, yet still provides only a limited set of the services needed by the R&D community. It is actually used by relatively few project consortia and DG XIII staff, although those who do use it, find it valuable. Other forms of electronic mail are also little used. Facsimile has now become the most prevalent means of telecommunication between participants.

Participants assessment of communication methods



OSI penetration

Shortly after the start of ESPRIT, IES received funding for OSI-related development projects. The object of this set of projects was to encourage and accelerate the availability of European OSI products, in order that the information exchange infrastructure services could become OSI conformant.

These projects have helped to strengthen Europe's position with regard to open systems. The experience of ESPRIT had an influence on the setting up of SPAG services and the projects, themselves, have created groups of people skilled and experienced in open systems software. They have not, as yet, had an appreciable impact on the availability of OSI products on the market thus demonstrating that the original objectives set in 1984 were overambitious.

A network is needed

A European value added service able to meet the needs of the collaborative R&D community remains both desirable and unavailable. The benefits to projects in terms of more rapid development and lower cost could be considerable. It is noteworthy that the US has been well equipped with such research networks (ARPA, etc) since the 1970s and is now investing considerable sums in improving them in terms of both speed, compatibility and facilities, whereas Europe has never invested in such services to anything like the same extent.

It is perhaps an anomaly that the provision of IES remains within ESPRIT, since it should be, and is to some extent meeting the needs of all collaborative R&D workers. It might therefore be more appropriate for a service to be defined and run that could meet the needs of the whole Framework programme in future.

Future activities

Activity to improve the networking infrastructure for research workers is being fostered by IES staff within the Commission, through COSINE (an OSI network primarily for academics) and by attempting to exploit the OSI products and experience of major European vendors. At the same time the general data communications infrastructure is only now being improved by the PTTs.

The take up of users on this sort of network is clearly key to its success. Whilst the critical mass of users is building up, funding will be needed well above the 50% level.

In this regard the Commission, which participates in all projects, and the largest companies, participating in about two thirds of all projects, are in a position to stimulate the use of networks considerably, which could mitigate this cost burden.

IES needs reassessment

European research networks and the information exchange services which could run over them are important and urgent topics. There is a need to reassess the whole of this area and the Commission's precise role within it.

RESULTS OF ESPRIT

Trans-European cooperation

The most striking result of ESPRIT is that it has influenced several thousand scientists and engineers in information technology fields to think European and to do so in a positive way. One of the objectives of ESPRIT was to promote trans-European industrial cooperation and this it succeeded in doing, initially by imposing the collaborative format onto project composition. Now those who have experienced such collaboration see it as an effective technique for many kinds of projects with a number of beneficial side effects.

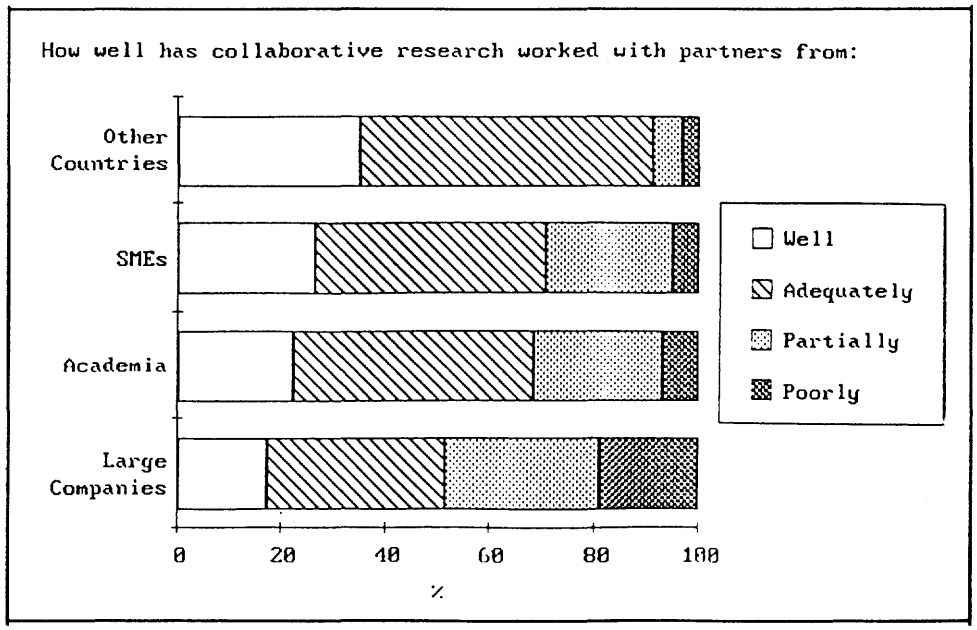
The thinking behind this way of working was partly that it would achieve results faster (with a larger team), results more broadly based, and results at lower cost per participant due to the sharing of results. All these have been realised although the extra cost of interworking has been considerable.

The more strategic purpose in making ESPRIT a collaborative programme was the realization that if European industry was to compete in world markets it must abandon its fragmented nationalism.

ESPRIT collaborations are having the positive effect of creating a large group of research workers and managers who have direct experience of what it means to work with other companies in other countries. Over time, as these people rise in seniority they will be influential in overcoming barriers of culture and mutual suspicion and will be catalytic in creating a more cooperative business environment than exists today.

As well as industrial cooperation, ESPRIT has fostered links between universities and industry in a surprising efficient manner. These are proving very valuable, particularly the newly formed international linkages.

Participants' assessment of how successful cooperation has been



Cooperation worked well according both to the ERB's interview findings and a significant majority of the questionnaire respondents. The questionnaire results suggested less successful co-operation with the large companies. Certainly, organisations find it easier to deal with enterprises of comparable size to their own, and, of course, the questionnaire response contained a preponderance from smaller enterprises. Therefore, this slightly negative finding is felt to be understandable.

Europe's technology base

The second important result of ESPRIT is the improvement which it has induced in the technology base.

Some of this improvement is in much needed "catch up" technology. Rather too much of the technological advance has been in niche areas with limited potential for market exploitation. Given the manner in which the workplan was constructed this is, perhaps, not surprising.

The improvements in the technology base were far from uniform amongst the recipients of ESPRIT funding. The large companies perceive moderate improvements to their technology base relative to their international competitors. The SMEs have a less international view and see the results of their projects as significant and relevant. Universities identified one reason for ESPRIT's influence on their technological strength as simply extra funding. They also see ESPRIT focussing their work on areas of greater relevance.

During interviews the ERB observed that the number of projects rated by participants as a success was exceptionally high for an R&D programme, ESPRIT was also praised for the stability it introduced by virtue of providing funding up to five years, in contrast to national and company funded projects.

Human resources

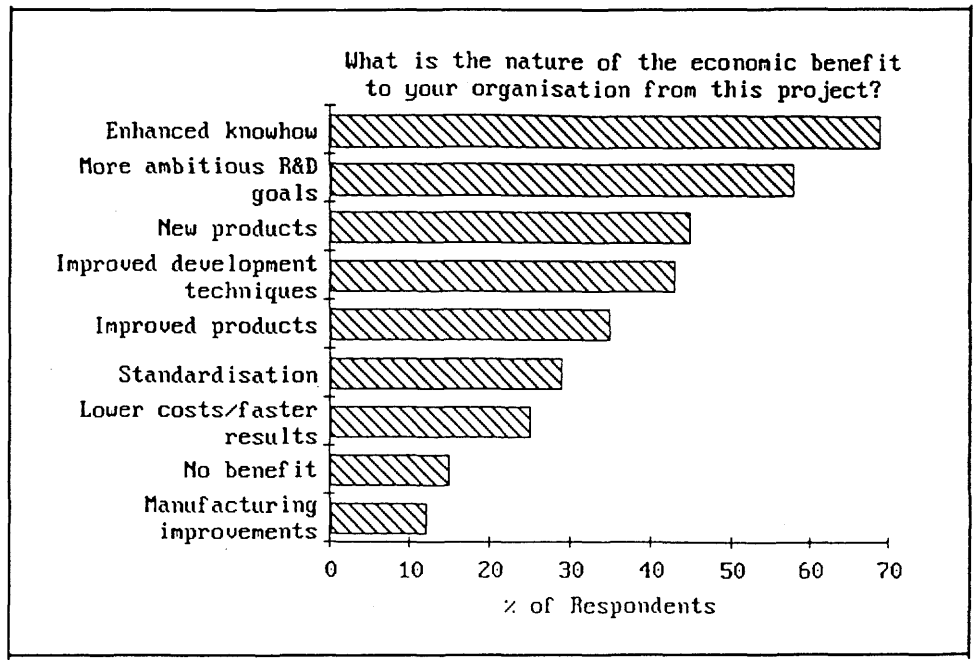
From interviews with large companies and national administrations it appears that there is a growing shortage of skilled staff in engineering and information technology. In some Member States enrolment in relevant university degree courses is falling and university funding is being reduced. Meanwhile, demand for trained people, especially software engineers, is likely to increase, particularly in industries applying IT.

There does not seem to have been a significant resource problem during ESPRIT so far, but the ERB is concerned for the future, especially in the light of demographic trends. ESPRIT has been successful in stemming this decline to some extent both by maintaining awareness of the strategic importance of IT to Europe and by channelling much needed funding for IT R&D into universities, thereby allowing more staff to be employed.

Exploitation

The questionnaire invited participants to assess the nature of the benefits which their ESPRIT projects had produced. Their replies are to be considered bearing in mind that many ESPRIT I projects are not yet finished.

Participants assessment of exploitation benefits of their projects



The most frequent response (69%) was increased knowledge, followed by a belief that research goals more ambitious than would otherwise have been set had been reached. Other responses (improved development techniques and lower cost/faster results) all suggested a rather high proportion of projects finding their benefit within the department where the work had been done. Changes in software methods and use of tools were cited, during interviews, as contributing to improved development techniques.

There was also a significant number of responses claiming contribution either to existing products (35%) or new products (45%). These are encouragingly high figures. The high percentage of new products should be qualified by observing that many projects are producing "demonstrators" or preprototypes which the project team hope will lead to fully fledged products but which, in practise, may not.

An appreciable minority (29 %) reported, a contribution to standards.

That 15% could see no direct benefit, is not wholly unexpected for an ambitious R&D programme but should perhaps be coupled with the thought that the Commission is not strong minded enough in stopping work of low value, nor, perhaps, are the participants who gave this response.

Knowledge transfer

The interchange and collaboration within projects was for the most part, good and knowledge was transferred well both between industrial partners and between industry and academic partners. Difficulties sometimes occurred between large and small industrial partners, who sought more information than the larger partner was willing to divulge, but these instances were not numerous.

Between projects, knowledge transfer was poor, results from other projects proving singularly inaccessible. Knowledge transfer outside ESPRIT participants was also low.

The Commission has arranged a number of sector specific workshops which have gone some way towards addressing the difficulties.

The annual ESPRIT Conference week has proved an important forum for demonstrating what has been achieved and for establishing contacts through whom knowledge transfers can take place later It has been less successful in effecting immediate knowledge transfer and in providing international recognition of its proceedings.

It would be highly desirable if the Commission could improve on the knowledge transfer between projects, e.g. by the promotion of a data bank with valuable information on the projects. The data bank could possibly also be accessible to other European companies.

International standards

A number of ESPRIT projects (15 %) aimed to work on standards. The IT marketplace is moving more and more towards the adoption of standards, out of necessity, given the complexity of the many levels at which dissimilar computer systems are required to communicate. Only companies with the largest market shares can afford to promote their proprietary standards. The rest need to use common international standards, where competitive advantage should lie with those who lead in standards development. ESPRIT has helped European companies to move from followers to leaders in the evolution of standards across a range of technologies including:

- Manufacturing automation.
- CAD.
- Operating systems.
- Document architecture.
- Software tools
- Communications (OSI).
- Data compression.

The ratification of international standards is always a lengthy process and few of those worked upon within ESPRIT have yet gone through all the stages. The full impact of this useful work will therefore not be felt for a number of years.

MODALITIES AND MANAGEMENT

The procedures and managerial techniques which have been used and refined during the five years of ESPRIT include the following features.

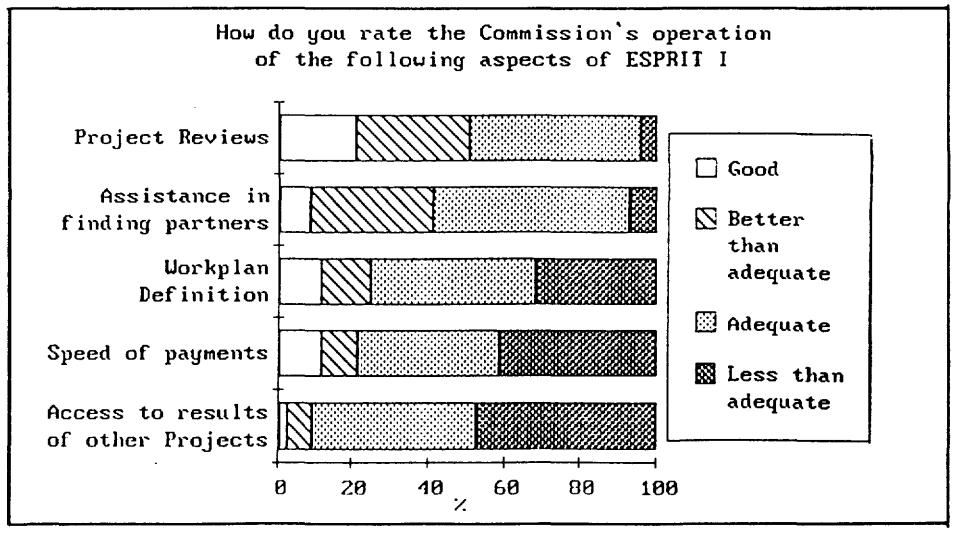
- Call for proposals against a published workplan.
- Evaluation by independent experts without their knowing who proposers are.
- Harmonization of the evaluators recommendations by the Commission and the ESPRIT Management Committee, which comprises representatives of each Member State.
- Contract negotiation with selected proposers including agreement of technical content, budget, labour rates and milestones.
- Project supervision by a Commission project officer.
- Periodic review by independent experts.
- Regular progress payments and retention of some money until the Commission accepts a project as complete.

Overall impression favourable

The ERB find these procedures to be sound and the overall management of the programme to have been satisfactory.

As part of the questionnaire, participants were asked to assess various aspects of the management of the programme. Some of the more notable results are summarised in the following table.

Participant's assessment of various aspects of the Commission's management of the programme



Proposals

The procedure for calling for proposals was felt to be satisfactory. However, the format in which proposals should be submitted could be more tightly defined to reduce both the cost and the workload of preparing proposals. One problem with proposals is that the Commission receives such a large number that it is inevitable that many will be rejected or have their budgets drastically reduced. The practise has therefore sprung up of participants submitting over inflated cost estimates within proposals. Budget guidelines should be included, when calling for proposals and consideration should be given to rejecting proposals which do not get close to the guidelines.

In the main, participants had few difficulties finding partners. Those who had used the infrastructure provided by the Commission to identify potential partners were critical of its effectiveness.

Evaluation

The evaluation phase was considered good, but was not without its critics. Clearly a careful balance has to be struck between the technical advice of the evaluators and other considerations thereafter. The evaluators are experts in the field of the proposal and, although there should, ideally, be more industrialists amongst their number, their judgements are respected and considered fair. The scoring system is such that very few proposals are shortlisted and proceed to contract without alteration by the Commission and the EMC.

Contract negotiation

The time taken for the technical evaluation and subsequent financial and contractual negotiations take typically five to nine months with some cases taking even longer. This should not be shrugged off as the bureaucratic norm in todays rapidly changing technological environment. Better feedback to proposers on the progress of their applications during this phase is desirable.

During the phase between proposal and contract start, some consortia have been pressured on a number of occasions into accepting either an additional partner or even whole consortia. Participants whose project team had been merged with another consortium strongly condemned such "shotgun marriages", which lessen the chance of success.

Large budget cuts

One of the Commission's responses to the heavy oversubscription which is occurring with each call for proposals is, in some instances, to impose large budget cuts on the selected proposals in order to have a reasonably high success rate. The effect of this is to cause consortia to reduce the work content, sometimes abandoning partners, particularly SMEs and universities from the consortia in the process. The revised technical content of the project may finally bear little relationship with the original. When this occurs it would be advisable to confirm with the original evaluators that the project is still of worthwhile quality.

Unified contract

The recently introduced unified contract was the source of some discontent. This would probably be true of any long and complex contract document, but there are areas of considerable complexity and difficulty. The clauses defining intellectual property rights were felt to be difficult to apply to all situations. Questions of whether a partner joining late in a project should have all the earlier results or whether a foreign company acquiring an ESPRIT participant should gain all the knowledge or whether a very small contributor to a project should gain all the results emanating from a very large contributor were all raised as problems.

At this stage, however, the ERB feels that it would be counterproductive to introduce numerous changes to it until more experience has been gained in its use.

Project officers

The project, once under way, is under the supervision of a Commission project officer. Project officers are perceived as being technically aware, overworked and supportive of the projects under their control. One way of reducing their workload would be to abandon the monthly project reporting which is perceived to serve little useful purpose. Project officers seem to have little influence on the pace of either finalisation of contracts or the speed of payments both of which have been sources of considerable criticism. This is particularly true of final payments. Project officers should provide a continuous point of contact with the Commission throughout the project. Clearly it is most desirable that staff turnover amongst project officers be kept to a minimum. More resources should be devoted to this area.

Review process a success

Projects are typically reviewed every six months. This process is deemed a particularly valuable feature.

ESPRIT was the first amongst publicly funded programmes to introduce this review procedure. Reviewers are seen as competent and helpful to both the project and the Commission, especially when work has to be redirected or even stopped. They also make valuable technical contributions to the work although sometimes their reports are slow to feed back to the consortia.

Project objectives naturally change with time and should be reviewed, at least annually. Minor changes in project direction are usually agreed to speedily but when major changes are needed, due to whatever reason (over-ambitious goals, withdrawal of one partner, or change of partners' business strategy) the contractual documentation has to be altered and delays of unsatisfactory length have often ensued.

It is apparent that when a project is running very unsatisfactorily, the Commission is not well equipped to deal with the problem. There appears to be a reluctance to exert authority in such situations.

Terminating projects prematurely

It will not be worthwhile to complete all projects. The small minority which may need to be stopped will usually be identified at a review. They should be dealt with as a matter of urgency. The sort of actions required are that senior management at the Commission should contact the prime contractor at director level and the project team should be given a relatively short time to rectify the problem. Another review should be scheduled perhaps three months later so that in the last resort, the project can be stopped without undue cost or delay.

It is no criticism of a programme such as ESPRIT if some projects have to be stopped. Rather it is an unhealthy sign when little pruning has taken place. During ESPRIT I less than 10% of projects were terminated prematurely.

Inadequate access to results

One aspect of management which received criticism was the lack of provision by the Commission of access to the results of other ESPRIT projects. The first cause of this weakness would seem to be that although every project has numerous paper deliverables few, if any, of these are agreed to give a technically informative description of the project in a form which contains no confidential information preventing wider circulation. Many participants requested more small technical workshops as a mechanism for disseminating results. In several research areas the Commission already organise workshops, yet there is a demand for an increased number of these.

A second contributory factor is the lack of commitment to the use of IT within the Commission. A database accessible to all participants providing the facility to retrieve synopses of project results was felt by many to be needed.

This failure to use computer techniques is not confined to information retrieval. Project reporting and management and even speed of payment could be improved with the establishment of consistent computer based systems.

The ESPRIT Review Board itself, in carrying out its enquiries, has suffered from the lack of an updated and appropriate project database for ESPRIT I. That for ESPRIT II is a great deal better.

Main contractors role

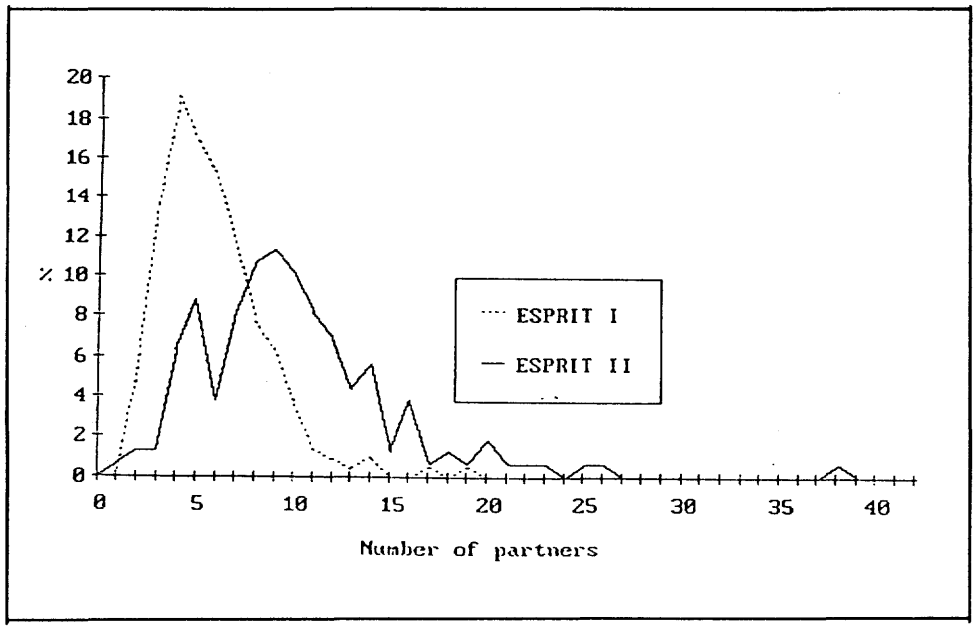
Turning from the Commission's management of the programme, one must not forget the crucial project management role of the main contractor. This is a difficult task particularly when the leader has no executive authority over members of the team. High quality people are needed. They are a scarce resource which companies find it unrewardingly costly to assign to the task. The larger companies are reducing the number of projects in which they are prime contractors, which is unsatisfactory. One suggestion to simplify the project managers task is to introduce simple common procedures for managing projects throughout the programme. Another is for the Commission to arrange project management courses at the start of the projects. The possibility of funding the project management task on a 100 % basis should be considered.

Consortia should be smaller

The greater the number of partners the harder a project is to manage. It is felt that for effective cooperation it is highly desirable for the project team to visit each participants premises once each year. At the rate of one meeting every six to eight weeks and allowing for holiday periods this sets an effective ceiling on the number of participants. It is also clear that, above a certain number of partners, it becomes extremely difficult to identify distinct complementary roles for each partner and the management of the project becomes inefficient. Very strong opinions were expressed that projects become unwieldy and inefficient when the number of partners rises above six.

ESPRIT I had a significant proportion above this size (some, of course, justified for their standard setting work). The proportion has risen in ESPRIT II considerably which gives cause for concern. The undesirability of large consortia, except in special cases was spelt out in the Mid-Term Review. The ERB can only stress again that consortia must not be allowed to become too large.

Participants per project in ESPRIT I and ESPRIT II



RELATIONSHIP OF ESPRIT TO OTHER PROGRAMMES

ESPRIT I was a much larger programme than any others managed by the Commission in related fields. It was also the first to introduce the co-operative mode of operation, which was adopted in virtually all subsequent programmes. With an expected ten year life and quite well-defined areas of research it provided a stable and continuous frame of reference in which other programmes could emerge.

National programmes

Community funding through ESPRIT was welcomed in all countries. Most administrations endeavour to perceive their national programme together with Community funded programmes as parts of a strategically unified whole. How they do this varies considerably between countries. The smaller ones have tended to encourage suppliers in their participation in ESPRIT. In larger countries this is less evident. In France, national funding has tended to shift towards other scientific fields and the EUREKA programme which is pursued with vigour. In the UK, as support for ESPRIT has risen, so the budget for the national programme has been reduced. Small, highly innovative projects and those of a long term research nature are now the targets for UK national funding. A similar targeted approach is adopted in Italy and Germany whereas the Netherlands tends to favour more market oriented developments. Spain has increased both national support for R&D and its participation in ESPRIT.

Experience in all Member States has established that there is a place both for collaborative European programmes and for programmes within each country. Some diversity and plurality in sources of funding for research should be maintained.

Other Commission programmes

During the past five years, an increasing emphasis has been placed on programmes which lead to exploitation in a fairly clear way. Application-oriented programmes have been introduced such as RACE (targeting broad-band communications throughout Europe), AIM (targeting the use of IT in health care), DELTA (IT in education) and DRIVE (IT for road transport). One might observe that the CIM area within ESPRIT has many of the characteristics of these programmes.

The international cooperation proven by ESPRIT was followed by EUREKA (funded from national sources). Although there is in no direct connection between the two programmes (with the exception of COSINE, and possibly JESSI in future), contacts are close as a result of the personnel put at the disposal of EUREKA by DG XIII.

Coordination between Commission programmes is informal. Awareness of what is occurring in other programmes could be improved. However, competition and duplication of effort between programmes does not seem to be a matter of concern to those interviewed by the ERB. Awareness outside the DG XIII of what is going on within ESPRIT could be raised by having more contact with senior technical managers, by organising user clubs and by increased international public relations.

Funding and timescales of European shared cost programmes in the IT field.

Programme	Start	Duration years	Total Cost B ECUs
ESPRIT I	1984	5	1.5
ESPRIT II	1988	5	3.2
RACE	1987	5	1.1
DELTA	1988	2	0.04
DRIVE	1988	3	0.12
AIM	1988	2	0.04

USA and Japan

ESPRIT is a ten year programme worth 4.7 billion ECUs (50% Commission funded). It is guided and steered through the consensus decisions of experienced and influential industrial managers from all member states.

The position in the US is rather different. The bulk of all industrial R&D support is channelled through the Department of Defence's DARPA programmes, whilst the National Science Foundation funds more academic research. DARPA runs at the level of approximately 1.3 billion ECUs per year (mostly 100 % funded). Each programme is controlled by a single programme director, who establishes one vision of how to extend technology in a given area.

In Japan yet other models pertain, starting with a strong consensus between the government and the national industries. The creation of common R&D teams between partners of similar size and competence is a specific feature of MITI's sponsored projects. The academic world and SMEs are effectively absent from those projects.

BEYOND ESPRIT

In reviewing ESPRIT, essentially at the half way point of a ten year programme, it is pertinent to consider what, if anything, should come beyond ESPRIT.

Strategic importance of IT

Information technology was perceived to be of strategic importance for Europe five years ago. If anything, it will be of even greater importance in five years time, especially in the microelectronics field where the ever increasing functionality becoming embedded in each chip and the pervasiveness of chip technology as a key component in so many commercial and domestic products and services is of great significance.

It has been said that the reason for the lead of the US and Japanese IT industries is that where these industries see opportunities, European industry and its customers see primarily risks. Both European industry and its customers must be more daring. Technology is changing so fast that if one does not start to invest in a new product until all problems have been solved, it will be obsolete before it reaches the market.

Due to the reducing development cycles it may be necessary to carry through IT R&D projects in a shorter time span (and with more intense efforts) than currently. Future Commission-funded programmes might try to encourage industry to do things faster. The technology base of Europe does not in general seem to be inferior to that of the US and Japan. It is above all, the ability and willingness of the European IT industry to bring products into the market rapidly that is lacking.

A major success of the ESPRIT programme has been the substantial increase in trans-European cooperation. This increase was made possible through the financial contribution of the Commission. If Community activity in the IT field was substantially reduced after ESPRIT II, the good climate of cooperation that now exists might not be strong enough to persist. This would be most unfortunate since European IT industry needs more, not less cooperation. This is true not only in the field of R&D, but also in production and marketing. European IT industries should wherever appropriate, join forces and compete with the world leaders.

The current emphasis on cooperation amongst, and sharing of results between, European companies is not made in order to create a "fortress Europe". Cooperations should eventually be possible with organisations in any country, but these cooperations would need to be considered on a case by case basis and in an environment of total reciprocity.

Goal-oriented programmes

ESPRIT has used the bottom-up approach in defining its workplan, with many projects spread over most of the IT field. A different approach which might be considered for any future initiative is to adopt programmes with a very few simply stated and challenging objectives.

To concentrate European efforts on a few major ambitious goals this would require a more structured cooperation of the partners and a fuller integration of the work. The JESSI programme, which intends to link all stages in the production chain, may be considered as an example of such a programme in the field of microelectronics.

Support must continue

Beyond ESPRIT, the ERB therefore believes community action targeting the IT industry must be continued. There sufficient financial resources should be provided to carry out both a broadly based technology-push programme, maintaining the fruitful transnational collaborations and for a few ambitious, structured goal-oriented projects to maintain a strategic focus on the core activities of the IT industry.

As well as the industrial aspects of what might follow ESPRIT it is necessary to consider basic research. Support must continue and even increase for basic research which underpins the long-term future. While being tailored to the specific needs of the academic world, the basic research programme should allow eventually for an efficient knowledge exchange with industry.

It is also important to identify programme modalities and mechanisms which can react to the extremely rapid changes which are occuring within the IT industry. Both technology and market conditions are developing with great rapidity. The pressure must be sustained to reduce timescales for all aspects of research and development within IT.

SUMMARY OF PRINCIPAL RECOMMENDATIONS

Strategic

1. As a whole IT remains an area of great strategic importance not only for its size as an economic sector but also for future employment, prosperity prospects and quality of life within the Community. Within IT, microelectronics is of critical importance. Continued support should be maintained, particularly in microelectronics and computer integrated manufacturing.

2. Cooperative 50/50 funded, transnational R&D projects has proven to be an excellent way of helping Europe's IT industry.

3. Workplans for R&D programmes must be driven by both suppliers and users, in order for them to be as relevant as possible to real market conditions. The emphasis on application of IT within ESPRIT II is commendable. However, the strategic focus should be even sharper.

4. Basic research remains of fundamental importance to the evolution of the IT industry. In evolving work areas which distinguish basic research from more targeted topics, care must be taken to maintain strong transnational links between universities and industry.

5. There is a clear place for continuing both national and collaborative European R&D programmes.

6. Awareness of and coordination with other European programmes should be improved.

7. All R&D activity in IT must be able to react rapidly to changing circumstances.

Tactical applicable to ESPRIT II

1. The larger software companies should join the primary workplanning process.

2. Senior management of large companies both suppliers and users should review the strategic relevance of the workplan.

3. Research and development work leading towards emerging standards should be emphasised.

4. Greater attention should be given to influencing user attitudes to manufacturing automation which is holding up the wider adoption of CIM concepts and technology, particularly amongst SMEs.

5. Information Exchange Systems should be reappraised, including the role of the Commission in the provision and management of European services.

6. Improvements which reduce the time from workplan defintion to achieving results must be sought continuously.

7. The Commission should take additional steps to improve access by participants to all valuable results of other projects respecting, where necessary, participants proprietary rights. Greater attention should be given to disseminating the results of ESPRIT projects and seeing them applied. This is particularly true of software technology.

8. The overall management of projects has a major influence on their success. The project objectives, the number of partners and the role of each, the resources devoted to project management in the Commission and amongst the participants as well as the management disciplines and procedures are all factors contributing to success or failure. A careful review of project management aspects, in the light of numerous detailed recommendations contained in the extended version of the report of the ERB, is needed.