COMMISSION OF THE EUROPEAN COMMUNITIES

SEC(92) 675 final

Brussels, 22 April 1992

COMMUNICATION FROM THE COMMISSION

EVALUATION OF THE SECOND FRAMEWORK PROGRAMME
FOR RESEARCH AND TECHNOLOGICAL DEVELOPMENT

(Article 5 of Council Decision 90/211/Euratom, EEC)

EXECUTIVE SUMMARY

The purpose of this Communication is to give an overall appreciation of the current state of execution and achievements of the specific programmes adopted under the second Framework Programme for research and technological development and to set out the principal lessons that have been learned from the execution of these programmes. The ultimate aim of this analysis is to provide the basic data for feedback into policy preparation and hence into future Framework Programmes and specific programmes.

In preparing this evaluation, the Commission has used a variety of documents and opinions. Wherever possible, the results of evaluations by independent panels of experts have been used. Where this has not been possible, reports prepared for the Commission by consultants, Commission reviews based on the work of outside experts or panels, reviews carried out by programme committees and internal Commission reports have been used. In addition, the findings from a number of specially commissioned studies on horizontal aspects of the effects of Community R&D programmes have been incorporated. The majority of these documents have been published.

An annex to this Communication contains the list of evaluations, studies and reviews used in preparing this document as well as short technical fiches on each of the specific programmes implementing the second Framework Programme and a list of programme acronyms.

The majority of the specific programmes of the second Framework Programme are still running, following their successive adoption, and some contracts will continue until 1995. Despite the fact that few post-completion evaluations are as yet available, the messages that emerge from analysis of the output of the programmes and the reports mentioned above paint an overall positive picture of achievements, leavened with certain clear areas of weakness.

In assessing the effect of the second Framework Programme, it is important to distinguish between direct scientific or technological results and indirect structural effects. Whilst the hard results of the specific programmes in terms of processes, products, standards and patents are still emerging and will continue to emerge over a number of years, given the precompetitive nature of Community research, there is already an impressive list of achievements to report. Likewise, the scientific output in terms of papers and conferences already demonstrates much interesting and high quality activity. Prenormative research activity is providing an improved basis for the harmonised regulations, standards, codes and practices that will allow industry to compete on an equal footing in the large internal market. The JRC has made a particular contribution in this area.

A particular feature of the programmes under the second Framework Programme has been that of financing R&D by giving support mostly to multinational collaborative projects on a cost-shared basis. This has differentiated Community activity from traditional national R&D funding. As a consequence, the main impact of the second Framework Programme perhaps lies in the structural changes it has introduced into the organisation of European R&D. The creation of research networks has produced a synergy of the best teams and a better use of equipment and is breaking the isolation of scientists in the less favoured regions, thus allowing the Community to make better use of its scientific and technological potential.

European R&D programmes have had a training effect, not only on the limited number of fellows who have received EC grants but mainly through the much higher number of young scientists who have been working on Community programmes.

Multipartner contracts are also bringing about a fruitful confrontation of different management and organisational systems and styles. Analysis shows that European R&D networks achieve the dual purpose of creating high quality and critical size. Industrial partnerships have allowed small and medium-sized enterprises to participate in high level research activities which they would find impossible to tackle on their own. In addition, the Framework Programme has also provided a diversified source of funding which has introduced further choices to individual scientists in the Member States.

Collaboration between universities and industry, which was largely limited within national boundaries, has been forced to extend to the entire Community. This has resulted in a better use of the specific capabilities of each region and allows universities and research institutions to be more fully involved in activities relevant for the most advanced industries in the core regions of Europe.

The transformation of scientific and technological progress into economic advantage is very difficult to measure and requires a longer period of analysis than has been available for the preparation of this Communication. Whilst the effect of European collaboration has been clearly demonstrated in many areas, the measurement of direct effects on industrial competitiveness are more problematic, since R&D is only one element contributing to competitive advantage. The role of Community supported R&D is, along with other Community policies, to help provide a favourable environment in which industrial innovation and competitiveness can thrive.

One particular area of weakness identified is the degree to which research results are exploited. In response to this finding, the third Framework Programme made particular provision for increased activity in this area. Other areas of weakness included the integration of the needs of users, the length and complexity of Commission administrative procedures and the insufficient weight given to the improvement of human resources. The problem of internal procedures had already been pointed out in the mid-term review of the second Framework Programme, where the Framework Programme Review Board noted that "overly punctilious criteria of financial accountability" result in administrative rules which delay procedures and can constitute obstacles. The Commission is currently considering ways by which such delays can be minimised. The other notable areas of weakness have been addressed in the specific programmes of the third Framework Programme. In particular, a large boost was given to efforts in developing human capital and mobility of researchers.

With the exception of these areas of weakness, this evaluation of the second Framework Programme and its specific programmes has revealed a positive picture overall. Results will continue to emerge and lessons will continue to be learnt over the years to come. The basis for new Community R&D activity up to 1994 has been adapted and the third Framework Programme has a new overall structure which will allow industries and researchers in the Community to meet the technological challenges to come in the 90s.

EVALUATION OF THE SECOND FRAMEWORK PROGRAMME

Table of Contents

Introduction 1

I. **The second Framework Programme : characteristics and coverage of the evaluation** 2

General objectives 2

Specific objectives 2

Coverage of the evaluation 3

II. **Results achieved and lessons learned** 4

- Impact on the scientific system 5
- Results in technology and standardisation 6
- European science and technology within global competition 9
- SME participation 11
- European collaboration 12
- Economic and social cohesion 14
- International scientific and technological cooperation 15
- Dissemination and exploitation of research results 16
- Programme management 16

III. Conclusions 17

Framework Programme of Community Activities in the field of Research and Technological Development (1987 to 1991) 19

INTRODUCTION

The second Framework Programme for Community research and technological development activities was initiated in 1987 and the associated research projects are now nearing completion. An evaluation of all the specific programmes which implement the Framework Programme is now called for, in addition to those evaluations already carried out, in order to provide an appreciation of the effectiveness of the activities undertaken and to fulfil legal requirements.

The Council Decision adopting the third Framework Programme for the period 1990-1994 provides for a first review of Community R&D activities to be undertaken during the third year of implementation of the programme. By this, the Commission understands a mid-term review of objectives, priorities, activities envisaged and financial means according to the changing situation. Article 5 of the Council Decision also requires the Commission to undertake an evaluation of all the specific programmes carried out under the second Framework Programme over the period 1987-1991. The Commission is to communicate the results of this evaluation to the Council along with any necessary technical and financial comments.

The Framework Programme fixes the objectives and priorities, the overall framework of Community activity in the area of research and technological development and its breakdown into main areas. It forms the basis for the decisions on specific programmes which implement it. The drawing up of the technical content of the specific programmes is the subject of a wide consultation with representatives of industry and research.

The implementation of the Framework Programme and the specific programmes thus arises from a decision making process which brings together the overall policy for Community activity and operational recommendations from research professionals.

Given the legal context outlined above, this evaluation of the second Framework Programme outlines the main strengths and weaknesses of the specific programmes. This highlighting of achievements, successes, limits and failures provides valuable lessons for the implementation of future Framework Programmes.

A multi-disciplinary analysis of the impact of specific programmes on the Community's scientific and technological system is required. This covers four main areas: the technological and economic effectiveness with respect to the programmes' objectives and the means devoted to them, the socio-economic impact in terms of mobilisation of the operators targeted, the degree to which the specific programmes agree with the evolution of major technological challenges, and the efficiency of management procedures.

I. THE SECOND FRAMEWORK PROGRAMME : CHARACTERISTICS AND COVERAGE OF THE EVALUATION

The adoption of the second Framework Programme on 28 September 1987 was a turning point in the history of Community research. The ratification of the Single Act in 1987 gave the Community a particular competence in research and technological development (Title IV). The Single Act gave a new institutional dimension to the concept of the Framework Programme and considerably enlarged its coverage. From this moment, the Single Act also brought together Community activities covering many objectives with the aim of optimising the potential of the internal market (scientific, technological and economic objectives as well as standardisation, economic and social cohesion etc).

GENERAL OBJECTIVES

In accordance with the provisions of the Single European Act, the general objectives given to the second Framework Programme respond to the following requirements:

1. To reinforce the scientific and technological base of European industry, and in particular SMEs, especially in strategic areas of high technology;

2. To encourage the development of European industry's international competitiveness by promoting the technological base allowing it to acquire sufficient critical mass through networks set up between large companies, SMEs, research centres, universities etc;

3. To contribute to reinforcing social and economic cohesion in the Community, in particular through the added value obtained from activities at the Community scale and with the Single Market in mind.

The general objectives of the Framework Programme also include activities in prenormative research. The prenormative dimension aims at defining adequate norms and standards to contribute to the realisation of the Single Market and to a unification of the European technical area.

Other associated criteria were outlined for Community activities. In particular, these were to be carried out in a complementary fashion with other international research and technological development activities undertaken in the COST and EUREKA frameworks.

The criteria of economies of scale and complementarity of research on large scale projects, given the possibilities at national level, were also requirements for Community activity.

SPECIFIC OBJECTIVES

Within this general context, the objectives of the specific programmes are aimed at promoting an environment for cooperative and precompetitive industrial R&D and at contributing to the development and application of international standards and regulations (information technologies, manufacturing technologies, advanced materials, biotechnology, medical research, measurements and testing, food technologies), contributing to the installation by 1995 at Community level of integrated broadband communications (telecommunications) or encouraging the integration of

telecommunications technologies in new applications responding to common socio-economic needs (multimedia teaching, transport, health care, environmental protection).

A number of the programmes in the second Framework Programme have objectives relating to the achievement of Community policies other than industrial competitiveness or the achievement of the Single Market. Examples include the promotion of increased scientific cooperation between the EC and third world countries (STD), the provision of scientific and technical support for the environmental policy of the Community (STEP, EPOCH), the development of systems for the management and storage of radioactive wastes, and the provision of a scientific basis for the effective implementation of the Common Agricultural Policy (CAMAR) and the Common Fisheries Policy (FAR).

The widest possible dissemination of the results of Community research, particularly to small and medium sized enterprises, is also a main objective (dissemination and use of results).
The second Framework Programme has a pronounced industrial aim. An important part of the budget is devoted to "enabling" technologies (information and communication technologies, materials, biotechnology...) aimed at finding rapid application in industrial production and other socio-economic activities.

COVERAGE OF THE EVALUATION

The second Framework Programme covers the period 1987-1991 and gives an indication of the actions to be decided during this period. The successive adoption of the specific programmes has thus led to an implementation phase running up to 1995[1]. Some of the larger programmes of the second Framework Programmes are still running, thus reducing the possible scope of any evaluation.

Any inventory of the results of the research must be necessarily partial in the current state of completion of the specific programmes, although a large number of results are already available. Measurements of scientific and technological progress and any further economic consequences need a longer period of observation than the administrative life of the programmes. Any limitation imposed by the absence of full results can, though, be partly offset against the lessons which have been learnt during the running of the current and previous specific programmes.

The state of implementation of the programmes has been, and is being, constantly examined through a large number of reports. These include external evaluation reports, annual progress reports, mid-term reviews of the programmes, the special report of the Court of Auditors[2], a Parliamentary Commission report[3], and impact studies. In addition, the second Framework Programme has itself been the subject of a mid-term review[4]. Finally, a general study was carried

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1 This is the case for the agricultural research and radioactive waste programmes; 1993 for VALUE; 1992 for ESPRIT II and RACE

2 Special report N°2/91 on the exploitation of the results of Community research, accompanied by replies from the Commission

3 Draft report on the management, exploitation and evaluation of Community research and technological development activities - Budgetary Control Commission - January 1992

4 The Report of the Framework Programme Review Board, June 1989, drawn up in accordance with Article 4 of Council Decision 87/516/EURATOM, EEC.

out for the Commission with a view to examining the possibilities of improving the management of Community research activities through reforms to the Commissions's structure and procedures[5].

The conclusions of the above-mentioned reports, in particular those outlined by the independent panel during the mid-term evaluation of the second Framework Programme, have highlighted the main areas of strengths and weakness of Community activity.

- The principle of cooperation on precompetitive and prenormative research has without doubt helped to strengthen the scientific and technological basis of European industry. The preparation of the European "scientific humus" is under way, even if still at a level which is too restricted.

- However, Community funding allocated to R&D has often proved to be insufficient given the scientific and economic ambitions allocated to the specific programmes. A growth in funding and a limiting and better targeting of the number of activities had become an urgent need. Project selection and management procedures were also judged to be too complex.

These points were taken up in the reviews recommendations which were used in formulating the third Framework Programme.

The various sources of information outlined above have provided the basis for a systematic evaluation of the Framework Programme. This has been carried out with a view to the coherence and direction of Community activity in research and development and the extent to which synergies have been created and the different research operators have been stimulated.

II. RESULTS ACHIEVED AND LESSONS LEARNED

A number of trends and guidelines common to all the specific programmes can be extracted from the evaluation and progress reports in existence. An inventory and an assessment of the results already available also requires a cross-check of analytical methods and information sources.

The impact of the Framework Programme on the scientific fabric and the technological and standards system of the Community can first of all be measured by drawing up an inventory of results such as patents, bibliometric indicators, numbers of products and processes, standards etc.

An economic evaluation of scientific and technological progress in terms of possible improvements in competitiveness is much more complex. Commercial success or failure of a technological innovation requires the eventual bringing together of a whole number of factors outside the immediate sphere of influence of Community programmes.

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[5] Study of the administration of the research activities - Andersen Consulting - November 1991

The setting up of cooperative networks between complementary European operators is the main means by which important results can be obtained. The creation of a real scientific and technological community which brings together the whole range of research operators in Europe is also an objective in itself. In this respect, a better integration of SMEs and organisations based in less favoured regions (LFRs) is also a prerequisite.

- **Impact on the scientific system**

  The nature of each specific programme determines the relative importance of scientific research within the networks that Community policy has aimed at promoting.

  Thus, the programmes dealing with the large market and the modernisation of industrial sectors have a large proportion of industrialists participating, whereas universities and research organisations make up some two-thirds of project coordinators and participants in the shared-cost activities relating to quality of life and use of natural resources, for example.

  The quantity and quality of scientific output are evaluated using qualitative methods, such as interviews and questionnaires as well as quantitative bibliometric methods. Worldwide scientific activity is still dominated by the USA, but the proportion of publications arising from the Member States has remained at around 30% of world production. Within the Community, the level of collaboration (measured by the nationality of co-authors of papers) has grown by more than a third in ten years. This is a higher rate of growth than for other types of international collaboration.

  Some 900 scientific conferences have already been organised by half of the specific programmes and 17,000 publications or communications have resulted from a third of them. More than 1,500 scientific and technical articles have been published as a result of the RACE programme and 2,500 from the Biotechnology programmes alone. As many of the programmes are still some way from completion, the eventual output is expected to be much higher.

  The quality of these publications and the added value derived from interactions between European teams have been confirmed by an analysis of citations in later articles. Transnationally co-authored publications are, on average, cited twice as much as those which have a strictly national origin. In addition, the time delay between publication and citation has been shortened in the case of articles which result from work carried out with Community support (Biotechnology for example), thus demonstrating the effective networking created by Community programmes.

  Other examples give added weight to these general data. The Joint European Torus (JET) team at Culham and the Fusion research programme have recently achieved a decisive step towards the realisation of thermonuclear fusion - a genuine "world first". In the Large Scale Scientific Facilities programme, 17 facilities have been selected for support. This activity has led to their use by over 400 new user groups which have not had such access up till now.

  Quantitative or factual information is, however, not capable of demonstrating the overall structural effects that the Framework Programme has had on the fabric of European science.

Studies show that a quarter of public teams in France and 10% of enterprises active in R&D in France and in The Netherlands have interacted with Community programmes.

Measuring the efficiency of the specific programmes implies devoting as much attention to research practice as to the production of science itself. This is one of the priorities given to the SCIENCE programme which had a coordinating role in this respect. This action was complemented by activities in a number of specific programmes which provided for research scholarships in order to encourage mobility and exchange of researchers, in addition to support for research itself.

Just as important, although a more indirect effect is the fact that many young scientists have been involved in shared-cost activities and have thus furthered their training through research. In this way, one PhD thesis in eight in France has been supported directly or indirectly by a Community programme.

In view of the ever increasing demand and the major part which research operators are asked to perform in disseminating results and transferring technology, several evaluation panels have suggested an increased role for the Community in this area. These suggestions have been taken up in the third Framework Programme. The Human Capital and Mobility Programme will have a clear role in upgrading human resources with a view to easing constraints on training, mobility and highly qualified manpower.

■ Results in technology and standardisation

Most of the main technological objectives of the second Framework Programme are being achieved and the framework of general programme objectives is still valid. There have been many notable technical advances and clear progress has been made on the formulation and adoption of international standards, particularly in IT and telecommunications. Technological research and prenormative activities are closely linked. Progress in certain large scale technological areas could not occur without the assurance provided by international compatibility of systems. This is particularly the case for IT and telecommunications.

Progress in standards

Setting up the Single Market implies the establishment of standards on a Community scale. Such standards underpin the harmonisation and reinforcement of Europe's science and technology base.

The normative dimension varies considerably between the specific programmes. The RACE programme has undoubtedly contributed the most to the definition of harmonised systems of standards.

The telecommunications operators in Europe now act in a coherent fashion. The development of integrated broadband communications has been accompanied by an enormous effort in standardisation. More than a thousand international standards and 69 systems of common functional specifications have been adopted.

The role of the Community Reference Bureau (BCR) in standardisation has brought a number of other significant successes in the area of harmonisation of processes and procedures between official metrology laboratories. More than a third of the 310

reference materials now available have been produced by the BCR and are currently used by 2,800 laboratories. Some 75% of the projects conducted under the programme are connected to the application of directives or standards.

Activities related to standards in other programmes is also noteworthy: food quality in FLAIR; electrocardiograph equipment and NMR imaging in medical research; materials specifications in BRITE/EURAM; construction standards in the JRC programmes.

Lastly, programme activities not directly linked to standardisation can contribute to standard setting. Examples include the defacto standardisation around Teleman projects for the handling of radioactive wastes, the input to expert groups on safety standards resulting from the Radioprotection programme and the preparation and distribution of materials and reference products for quality control in the Medical and Health Research programme (MHR4). Of other indirect effects, it is worth noting the harmonisation of management procedures (Radioactive Waste Management Programme) and the establishment of centralised information systems (MAST, AIM, MHR4).

Measurement of technological results

Patents are an indicator used widely for measuring the intensity of innovation generated by research activities. It is to be expected, though, that relatively few patents would have been filed, given the progressive launching of the specific programmes implementing the second Framework Programme. A more complete analysis of research results patented requires a longer observation period given the time required for the maturing of projects.

Nevertheless, a number of noteworthy results have been patented and can be a useful indicator of technological progress achieved.

Some 30 patents arising from RACE projects have already been filed in 1989. Progress made in research on components has been remarkable. Technical and economic feasibility has been demonstrated through demonstration projects and prototypes covering digital information transmission systems. More than 20 patents have been filed in optoelectronics alone allowing the use of optical fibres on a large scale.

Research in the area of mobile communications adapted to the needs of the 90s have brought forth third generation system concepts which are nearing the commercialisation phase.

Significant technological progress has also been made in the area of manufacturing technologies and advanced materials. 15 patents have resulted directly from the BRITE/EURAM programme and some 25 new products and processes, including a significant breakthrough in high temperature superconducting materials with better mechanical properties. Within the BRITE/EURAM programme, some 37% of projects gave rise to patent applications in 1990.

Experience shows that most patents are generated, on average, some 4 to 5 years into a research project. It is not unreasonable, therefore, to expect that the specific programmes of the second Framework Programme will give rise to rather more patents by their conclusion.

The measurement of technological results is, though, not limited to an inventory of patents alone.

A series of new or substantially improved products and processes, such as the supply of important commercial services, has resulted from Community research programmes. For example, some 8,000 reference materials deriving from the BCR programme are sold each year to some 2,800 laboratories. The JOULE programme has given rise to important results in the area of rational use of energy (batteries, fuel cells, heat exchangers) and the exploitation of non-nuclear and renewable energy sources.

Around 500 major results deriving from the ESPRIT programme were recorded in 1991[6]. More than half of these results have a bearing on products and services, around a third concern more productive and less costly industrial processes and methods and over 10% are concerned with standardisation.

Beyond the launching of the large technological programmes such as ESPRIT, RACE and BRITE/EURAM, the Commission has explored the most promising areas of application for information and communications technologies, taking into account the evolution of lifestyles and social and professional needs. Two exploratory programmes were conceived in the areas of teaching and distance learning with multimedia support (DELTA) and healthcare (AIM). Although given only relatively limited funding[7], DELTA and AIM have been able to organise a genuine scientific community around important technological, social and economic goals in synergy with other Community programmes (RACE, ESPRIT, COMETT etc).

The first results show the technical feasibility and the economic need for promoting systems based on advanced technology in these two areas. Results range from interactive systems using the principles of artificial intelligence to the "electronic blackboard" which creates a virtual classroom. The exploratory activities of DELTA and AIM have raised the profile of the debate in Member State ministries on the necessity to develop telematic systems for their area at the European level.

Specific research programmes have been forerunners in a number of areas - Marine Science and Technology (MAST), Agro-industrial Technology (ECLAIR), Food Technology (FLAIR) and the optimal management of large scientific installations.

Joint Research Centre (JRC)

The Joint Research Centre (JRC), the Commission's in-house research facility, has contributed to several lines of the second framework programme in areas in which the central and independent role of the Centre is of specific advantage. The JRC has made notable contributions to prenormative research, especially that on high performance ceramic and other materials, studies on structures and reference materials, in nuclear and other areas. In collaboration with national bodies, the Centre has presented new results and added to scientific knowledge on environment protection (air, water, chemical waste), and on industrial safety by means of novel experimental facilities. Research on new

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[6] 182 new results were registered in 1990 alone; a quarter of the new products relating to open systems put on the market by one of the largest European electronics companies were derived from ESPRIT research.

[7] 20 MECU for 24 months

techniques in remote sensing from space has given rise to applications in agricultural statistics, land use in the Community and the fight against marine pollution. Nuclear fission safety research with national research laboratories has generated new knowledge for the understanding of hypothetical accident phenomena and methods for nuclear waste management and the safeguarding of fissile materials, while in the thermonuclear fusion safety area, the construction has been completed of a tritium handling laboratory for use in association with national research organizations and JET.

■ European science and technology within global competition

The Framework Programme had as an objective to contribute to the reinforcement of the scientific and technological base of European industry and thus to stimulate its international competitiveness. Community R&D activities, however, are based on the principles of precompetitiveness and prestandardisation, by definition relatively far from strictly economic and commercial considerations.

Acquiring or keeping competitive advantage implies a permanent adaptation to the needs of the market. Mastering this requires from industrialists the management of product and service turnover reconciling the depreciation of equipment with a need to follow ever changing demand. It also requires an aptitude for integrating new technological opportunities and a flexibility in action and reaction to the strategies of competitors. The need for competitiveness thus implies a rapid adaptation of industrial structures and the whole range of productive elements (a combination of factors of production, exploitation of R&D, marketing, etc) in order to keep or increase market share in the face of competition.

The world economic environment is changing rapidly with the effect of globalisation of markets and company strategies as well as recent geopolitical changes. The economic scenarios which underlie the strategic ambitions of industries have to be constantly revised to remain valid.

The European electronics industry, in particular, has been going through a profound crisis since the beginning of the decade after years of rapid expansion of its markets. There are a number of economic causes for this. Worldwide economic instability has put a brake on any inclination to invest in production capacity and research and development, where financing requirements are considerable.

In this difficult context, structural adjustment in the European electronics and informatics industries has been insufficiently adapted to the evolution of market conditions[8]. Thus, the potential of the Community market has not been sufficiently integrated into the industrial strategy of European enterprises, with the exception of precompetitive research. Likewise the rate and level of diffusion of innovation has stayed well below what is possible and the integration of research activities with overall strategy could be bettered.

Measuring the effects of Community R&D programmes on the competitiveness of European industry is even more difficult.

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[8] For an overall analysis see "The European electronics and information technology industry : state of play, issues at stake and proposals for actions" - Communication from the Commission - SEC(91)565.

The responsibility for adapting production systems to worldwide economic change falls in the first instance to companies themselves. Public authorities, though, have the task of facilitating the process of industrial adjustment by creating an open and competitive environment which is favourable for industrial regeneration.

The main lines of the Community's approach to industrial policy were clearly set out in a recent Communication from the Commission[9]. Development of the Community's technological capacity was singled out as a factor for accelerating the process of adjustment of industrial structures.

The role of public authorities and the Commission in particular is to put in place an environment which allows companies to exploit fully the conditions of conception, development, diffusion and exploitation of generic and enabling technologies. The role of the Commission is mainly limited to reinforcing cooperation amongst enterprises on research areas of common interest before these become competitive issues and to promoting the development of human resources, uniform standards and regulations at the Community level. The other area in which the Commission intervenes concerns the promotion of an active innovation policy aimed at the exploitation and rapid transfer of research results.

The evaluation of the second Framework Programme is not the place to undertake a detailed analysis of the strengths and weaknesses of European high technology industry on the world scene. However, a number of common threads can be identified relating to Community R&D support.

European telecommunications companies are strong at world level. Recent technological progress obtained in the RACE programme, such as mobile communications and the Asynchronous Transfer Mode system, are reinforcing the already favourable competitive position of Community industry in this area. The European electronics and informatics industries have suffered particularly from the worldwide crisis in these sectors, notwithstanding notable technological and economic advances in areas such as digitally controlled machine tools, ultra-violet laser wafer steppers, or promising results in silicon chips and software achieved in the ESPRIT programme.

The Community has played a very important role in the adoption of open standards in informatics architecture, encouraging new connections between producers and users. In particular, users benefit from a lower cost and more diversified supply.

A major problem in many European industries derives from an insufficient level of productivity overall and increasing demands being placed on the technical and productive capacities of component suppliers. Other industrial sectors are characterised by a high proportion of small companies and a relatively low research intensity. The BRITE/EURAM programme has placed a particular emphasis on intersectoral and interdisciplinary research and development into the whole design-materials-manufacture-quality-maintenance chain with a view to helping these European industries adapt to the challenges posed by international competitors. These efforts have assisted the development of generic, enabling technologies in many industrial sectors and have contributed to reconciling the needs of technology users and producers.

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[9] Industrial Policy in an Open and Competitive Environment - Communication from the Commission to the Council and European Parliament - COM(90)556.

Research efforts have also paved the way for promising consumer goods such as high definition television or interactive compact discs.

The technological results from the specific programmes do not, though, hide the overall areas of weakness of exploitation of research results (as noted by the Court of Auditors[2]) and management of highly qualified human resources.

The commercialisation of results remains often suboptimal, despite the financial means invested by the partners in projects and the orienting of programmes towards the needs of users (for example in ESPRIT, FLAIR or ECLAIR).

Although the commercial application of research projects is largely a question for those who carry out the projects, the Commission needs to adapt the definition and management of the programmes better to common interests. The help provided by consultative or management committees in this respect is extremely important. IRDAC, the Industrial Research and Development Advisory Committee, which is composed of representatives of industry, has drawn the attention of the Commission on several occasion to the importance of the role of fundamental research in the innovation process and on the need for a better balance between the interests of producers and users of technology in the management of Community programmes.

Beyond the production of high quality scientific knowledge, the impact of the R&D programmes on industrial competitiveness will depend, amongst other things, on the capacity of researchers and industrialists themselves to transform knowledge into knowhow and knowhow into added value.

The degree to which technological advances are taken up within the production system and more widely within everyday social and economic practice is the best criterion for evaluating technical and economic progress over a long period.

- **SME participation**

The objectives of the Framework Programme recognised the importance of SMEs to the economy of the Community. Overall, SMEs are able to react rapidly and have a structure which is more receptive and capable of adaptation to market signals compared with large enterprises. This gives them particular advantages in the innovation process. High technology SMEs are particularly important and creative means for exploiting the results of research by addressing particular technological niches in the market. SMEs provide an important element for diffusing new technology within industry. However, due to their limited financial and human resources, SMEs have difficulty in investing in large scale and risky research projects, particularly fundamental research.

It should be noted that only a small proportion of small and medium sized enterprises carry out research - less than 5% on average. This situation shows that the large majority of SMEs use other means to assimilate science and technology, in particular the buying in of knowhow and technology already embedded in equipment.

The complementarity of advantages enjoyed by SMEs and large firms has led the Commission to encourage successfully the participation of small and medium sized enterprises in Community research programmes. SMEs specialised in high technology products participate to a high degree in the programmes. Half of industrial contractors

in the ESPRIT programme and 40% in RACE are SMEs. Nearly 50% of industrial participants in BRITE/EURAM from the 1990 call for proposals were SMEs as are over 50% of industrial participants in ECLAIR.

The Framework Programme has also given many SMEs access to areas of research where they would otherwise have been excluded (for example, the radioactive waste management programme).

SMEs in general have benefitted directly or indirectly from Community activities in training and mobility of researchers and diffusion of knowledge and technology transfer.

Barriers to the involvement of SMEs remain, though, largely due to their limited financial capacity. The organisational costs for SMEs to collaborate in Community projects is relatively much higher than for large firms, even without considering any eventual benefits. Any delays in contract negotiation and payment can give rise to potentially damaging problems of cash flow for SMEs.

With a view to informing SMEs better on means of participating in Community programmes, the Commission has developed an interactive system for dissemination of information targeted towards the particular needs of these firms. Since 1987 a network of 211 Euro Info Centres has been providing general information throughout the Community[10].

The Commission has set up other systems for encouraging SME participation in research programmes. Assistance in locating suitable partners can be a deciding factor in a decision to collaborate. A particular instrument put in place in the BRITE/EURAM programme provides Community finance for SMEs for up to six month (and 75% of costs) for feasibility studies on research ideas which should then lead to collaboration in a regular R&D project with other industrial partners.

Finally, at the suggestion of its industrial advisors in IRDAC, the Commission has put in place the CRAFT Pilot Scheme to help those SMEs who have limited or no research facilities of their own.

- **European collaboration**

The most notable impact of the Framework Programme is without doubt in the encouragement it has given to collaborative working between research organisations which have up till now had limited opportunities to work together: SMEs, large companies, universities and research centres of different nationalities.

Relations between the academic and industrial worlds have long suffered from problems in communication and even of mutual misunderstanding. The creative and innovative talents of the academic sector have not always led to commercial exploitation by industry. Equally, academics have also been unwilling to take the industrial possibilities of their research into account.

The gap between university research activities and industry is even more noticeable in the

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[10] Around 200,000 enquiries from SMEs were addressed to the Centres in 1991 (40,000 in 1988)

less favoured regions and countries of the Community. In Greece, for example, university/industry R&D collaboration was virtually non-existent before Community funded research activity[11]. A considerable change in behaviour has taken place since.

The advantage of the Framework Programme initially was to demonstrate a unity of purpose between organisations from different backgrounds by showing the economies of scale which could be obtained at the Community level in the areas of research and technological development. The particular merit was to convince these organisations to share risks and rewards on large scale projects based on a new type of partnership.

The large response to the different programmes from all the various organisations demonstrates the success of the shared-cost action formula proposed by the Commission amongst others. Requests for funding from all the projects sent to the Commission have exceeded the budget allocated to calls for proposals by a large margin; the sum for proposals registered is several times greater than the budget available.

The benefits collectively derived from multinational cooperation exceed considerably the extra costs involved. In particular, the benefits include privileged access to other sources of knowledge, skills and equipment, and an accelerated transfer of innovations within permanent cooperative structures and networks[12].

The specific programmes have brought about the formation of a genuine European scientific community, firstly by mobilising multinational teams on projects of common interest and, secondly, by facilitating a better integration of fundamental research specialists within the innovation process (ESPRIT basic research, BRITE/EURAM, EUROTRA etc).

The involvement in research programmes of a large number of organisations which had been hitherto relatively isolated and dispersed has gradually been transformed into networks for the exchange of knowledge and knowhow. Examples include ESPRIT with its 6000 engineers and research personnel, RACE with the large European telecommunications operators, BRIDGE with the 34 networks of "laboratories without walls" and MHR4 with its 160 concerted actions, averaging 30 to 35 teams per concerted action (thus involving more than 4800 teams).

Cooperation in the area of fundamental research has also changed basic ways of working. The Large Scale Scientific Facilities programme was designed to optimise the use of such facilities and installations and to provide access to those facilities by researchers who would not normally have such access. Making such facilities available has enlarged the horizons of "regional" research teams whilst improving the use of the facilities.

Overall, the specific research programmes have stimulated exchange of knowledge and knowhow and brought about a better exploitation of European potential.

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[11] Impact of EC S&T policy upon Greek S&T policy - report for DGXII

[12] 70% of participants in BRITE intended to pursue their collaboration beyond the end of their projects. Prolongations of ESPRIT collaborations have been very successful.

Lastly, the bringing together of producers and users of technologies has undoubtedly changed ways of promoting innovation by integrating better the strategies of the former with the needs of the latter.

■ **Economic and social cohesion**

The reduction of regional disparities is essential for the construction of Europe. Economic and social cohesion is an objective which must be served by all Community activity.

The structural funds play an essential role in realising the objective of overall social and economic convergence. Community R&D policy is one of the means used and serves specifically to reduce the gaps in scientific and technological development.

Collaboration in itself has a positive effect on cohesion. The growing participation of enterprises from the less favoured regions (LFRs), mostly SMEs, helps reinforce social and economic cohesion in the Community[13]. Community R&D activities have contributed significantly to reducing the isolation of researchers and to stimulating national scientific systems. This applies to all the specific programmes and not simply to those whose objectives are particularly well suited to regional issues, such as agriculture (CAMAR), fisheries (FAR), and renewable raw materials.

The cohesive effect of the Framework Programme exists without concessions having to be made to the principle criterion of eligibility, that of scientific excellence[14]. The criterion of excellence used in the Framework Programme is in itself an element for cohesion inasmuch as it encourages the association of scientists from LFRs in the most advanced European research activities. Organisations from LFRs have benefitted from networks that facilitate cooperation and learning thus allowing them to consolidate their scientific and technical knowledge. Collaboration within community networks has loosened local constraints which are inherent in a lack of financial resources and infrastructure, such as shortages of highly qualified personnel. In addition, such collaboration has lead to an improvement in management and a heightened awareness by regional authorities of the beneficial role of R&D in development.

This overall positive evaluation must be offset against a number of gaps which need to be addressed. International credibility of research organisations from LFRs has improved, however, their role in co-managing projects could be improved and balanced better with other partners, to the benefit of all.

Barriers to the integration of organisations from LFRs are, above all, a function of insufficient links between the scientific and technological fabric and the production system. Both the generally low level of exchange between different industrial sectors and uncoordinated relations between universities and industries are damaging to the full integration of research activities within the local economy. The general lack of research

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[13] 20% of organisations participating in ESPRIT II come from Spain, Portugal, Ireland and Greece; specific regional activities aim to reinforce their participation

[14] Evaluation of the effects of the EC Framework Programme for research and technological development on economic and social cohesion in the Community - Report of the external panel - September 1991

and telecommunications infrastructures are other obstacles which particularly hamper SMEs.

The need to provide for the infrastructure needs of the less favoured regions of the Community has led the Commission to propose two specific accompanying programmes linked to the structural funds. STRIDE promotes improvement of scientific infrastructure and STAR is concerned with telecommunications networks.

■ **International scientific and technological cooperation**

The second Framework Programme is addressed in the first instance to organisations specialised in research and technological development in the Member States. This requirement does not, though, exclude consideration of third country organisations through appropriate cooperation agreements[15].

The international renown of the Framework Programme has spread to the member countries of EFTA, organisations from which are associated with more than 100 ESPRIT projects, some 60 RACE projects and around 50 BRITE/EURAM projects. In addition, a number of programmes have concluded agreements with various EFTA countries to allow full participation of these countries in the programmes. These include STEP, EPOCH, SCIENCE, SPES, and BCR amongst others.

Relations between the Framework Programme and COST activities, which bring together a number of countries outside the Community have developed in a largely complementary way to the mutual advantage of both. A number of Community R&D actions have grown out of exploratory COST activities and in some programmes, notably those concerned with environment and telecommunications, the connection between COST actions and Community concerted actions is very close indeed.

The procedures for consultation and collaboration are, though, susceptible to improvement. The selection of research areas in COST needs to take careful account of those of the Framework Programme in order to avoid duplication of effort. The risks of duplication are limited by the involvement of COST delegates from the Member States in the Community circuit (e.g. CREST, Research Group of the Council). Nevertheless, tensions could arise due to the Commission providing the secretariat of COST committees at its expense. COST and Commission officials are currently examining ways of reducing possible conflicts.

Overall, coordination between Community activities and EUREKA has also been fruitful. The DRIVE programme has demonstrated the possibilities in mobile systems of traffic information in collaboration with the PROMETHEUS project carried out under the EUREKA framework. The same mutual benefit has resulted from the MAST programme and the EUROMAR project.

In some instances, such mutual benefit has been recognised through direct Commission support to EUREKA initiatives. For example, the ESPRIT programme participates in the financing of the JESSI project in the area of semiconductors.

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[15] The STD programme was specially conceived to promote scientific cooperation between the EC and developing countries

A reinforcement of such synergies and an improvement in the structures for cooperation is still required[16]. Community action and EUREKA activities need to work together towards the same objective of consolidating the scientific and technological basis of European industry.

■ **Dissemination and exploitation of research results**

A better economic justification for Community projects is necessary. The inclusion of commercial considerations in the selection criteria has been taken on board in the new programmes (Information Technologies, Industrial and Materials Technologies, for example)[17].

Downstream, the general means of disseminating and exploiting the results of Community research is susceptible to improvement. The first programme prepared and put into practice to achieve this, VALUE, has made a significant contribution to a more thorough understanding of the management of the interface between the scientific and technical world and the economic system. Some 350 reports have been published on Community research activities since the programme was launched at the end of 1989 and over 2000 users of the CORDIS information service have been logged[18].

The budget allocated to the VALUE programme, 0.7% of the Framework Programme, has proven to be insufficient when considering the growing number of requests for participation in projects[19]. Community activity in the area of dissemination and exploitation of knowledge needs to be reinforced and concentrated on a number of strategic lines. These include increased funding for exploitation at the level of each specific programme, and reinforcement of the coordination activity and general expertise. This finding informed the preparation of the new programme on exploitation under the third Framework Programme. The interdisciplinary and horizontal nature of exploitation activities has also been reaffirmed.

■ **Programme management**

Overall, management of the programmes has been judged to be satisfactory particularly in view of the large number of multinational partnerships involved. However, on average, administrative procedures are still too long and complex particularly for the management of smaller projets and the participation of SMEs, notably between the selection of proposals (carried out with the assistance of external evaluators) and the signing of contracts.

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[16] Report of EUREKA Assessment Panel, 1991

[17] ".... projects must demonstrate that the development of improved technology capabilities can equally be transformed into clear market place benefits". (ESPRIT information package, 1991)

[18] CORDIS manages 6 databases on Community R&D activities: programmes, projects, publications, results, partners and abbreviations

[19] 1 in 30 dissemination proposals and 1 in 10 "prototype" proposals financed

The management of Community programmes is a delicate balancing act between two objectives. The objective of networking implies the widest possible participation of partners in order to attain a critical mass effect. The objective of management efficiency, on the other hand, leads to the definition of an optimum size for consortia. The balance between these objectives and the different constraints varies according to the specific programmes.

In a number of big projects, the large number of partners in the consortium has proved to be a handicap for following projects other than those of a prenormative character. A reduction in the average size of consortia is a characteristic of the new means of management of some programmes (e.g. the Information Technologies programme in the third Framework Programme), alongside a better definition of the role of the partners in the exploitation of joint work.

These objections must be offset against a consideration of the specific nature of Community research. The Community does not finance individual organisations directly, but provides funding to pan-European consortia. These consortia reflect all the diversity (linguistic, scientific cultures, administrative and legal procedures) which provides both the richness and the problems of European integration. This diversity of possibilities influences the formation of consortia, their working methods and communications between these consortia and the Community services given the task of managing the programmes. This results in inevitably slower procedures on both sides and damaging delays which are highlighted when these affect transfer of payments between partners in a consortium (even more so where SMEs are concerned, with their particular cash flow problems).

The length of decision making procedures for the Framework Programme and the specific programmes on the one hand and the rules for administrative, financial and personnel management on the other do not take into account the particular nature of the R&D objectives to be attained. These procedures strongly govern the productivity of the administrative machinery and the overall efficiency of Community research policy.

Management of Community programmes should be rigorous and rational. With a view to adapting means of programme management to the new economic situation and simplifying and harmonising the procedures, the Commission has delegated certain aspects of project and programme management to external organisations.

III. CONCLUSIONS

An examination of the first results to emerge from the specific programmes of the second Framework Programme has allowed an incomplete, although instructive, picture of Community activity to be drawn up.

Preliminary results on science, technology and standards show the direct effects of the Framework Programme. To these should be added other effects which are more difficult to quantify because they are indirect. These include an increase in the pool of trained researchers in Europe, exchanges of knowledge, technology transfer between partners and an improved mobility of researchers.

The cumulative effects of the second Framework Programme have undoubtedly reinforced the scientific and technological base of European industry.

The transformation of scientific and technological progress into economic advantage is more difficult to measure and requires a longer period of analysis. The gradual setting up of a unified economic area at Community level will provide a sound environment for consolidating European competitiveness. Community support to research and technological development is providing an additional factor for growth which industrialists can integrate fully into their overall strategy.

The principle of cooperation on precompetitive and prenormative research has brought about the mobilisation of the different economic actors, producers and users of technology (large companies, SMEs, universities and research centres) around common projects and has led to the formation and consolidation of networks of scientific excellence. Carrying out such work has generated new alliances and synergies and critical mass by using the complementary scientific and technical resources of each of the Member States.

The participation of organisations from the less favoured regions in Community networks has given a significant stimulus to their research activities. Up to now these have been inhibited by a number of particular constraints, notably scientific isolation and a lack of means of technological production.

Partnerships in precompetitive research based on shared financial risk have led to greatly increased activity in scientific and technological cooperation with the Commission acting as a facilitator and catalyst for initiatives.

All the independent evaluation panels set up during the second Framework Programme agree in painting a largely positive picture of Community research and technological development activities. This finding does not, though, hide a number of areas of weakness concerning the means of exploiting research results, the integration of the needs of users, the length and complexity of administrative procedures and the insufficient weight given overall to the improvement of human resources.

The second Framework Programme is nearing completion. Some of the specific programmes are continuing and research projects will continue in the Member States. They will give rise to new results in the years to come after a period of "technological ripening". The third Framework Programme is just beginning. The lessons from experience gathered during the evaluation of the different specific programmes have been taken on board. The basis for new Community R&D action up to 1994 has been adapted. In particular, there has been a concentration of effort on a more limited number of specific programmes, increased account has been taken of the needs of users, there is now a better economic basis to projects, a rationalisation of administration and management are taking place and new means for exploiting knowledge and improving human capital have been developed.

The third Framework Programme has a new overall structure which is adapted to the new economic situation and which will allow industries and researchers in the Community to meet the technological challenges to come in the 90s.

FRAMEWORK PROGRAMME OF COMMUNITY ACTIVITIES IN THE FIELD OF RESEARCH AND TECHNOLOGICAL DEVELOPMENT (1987 to 1991)

Breakdown of the amount deemed necessary between the various activities envisaged

(million ECU)

1.	**Quality of life**		375
1.1	Health	80	
1.2	Radiation protection	34	
1.3	Environment	261	
2.	**Towards a large market and an information and communications society**		2,275
2.1	Information technologies	1,600	
2.2	Telecommunications	550	
2.3	New services of common interest (including transport)	125	
3.	**Modernization of industrial sectors**		845
3.1	Science and technology for manufacturing industry	400	
3.2	Science and technology of advanced materials	220	
3.3	Raw materials and recycling	45	
3.4	Technical standards, measurement methods and reference materials	180	
4.	**Exploitation and optimum use of biological resources**		280
4.1	Biotechnology	120	
4.2	Agro-industrial technologies	105	
4.3	Competitiveness of agriculture and management of agricultural resources	55	
5.	**Energy**		1,173
5.1	Fission: nuclear safety	440	
5.2	Controlled thermonuclear fusion	611	
5.3	Non-nuclear energies and rational use of energy	122	
6.	**Science and technology for development**	80	80
7.	**Exploitation of the sea bed and use of marine resources**		80
7.1	Marine science and technology	50	
7.2	Fisheries	30	
8.	**Improvement of European S/T cooperation**		288
8.1	Stimulation, enhancement and use of human resources	180	
8.2	Use of major installations	30	
8.3	Forecasting and assessment and other back-up measures (including statistics)	23	
8.4	Dissemination and utilization of S/T research results	55	
TOTAL			5,396

ANNEX

Evaluation of the second Framework Programme

Specific programme acronyms and abbreviations

Technical fiches

List of evaluations, reviews and impact studies

SPECIFIC PROGRAMME ACRONYMS AND ABBREVIATIONS

AIM	:	Advanced Informatics in Medicine (DG XIII)
BCR	:	Bureau Communautaire de Référence (DG XII)
BRIDGE	:	Biotechnology Research Programme for Innovation and Development Growth in Europe (DG XII)
BRITE/EURAM	:	Basic Research in Industrial Technology for Europe & European Research in Advanced Materials (DG XII)
CAMAR	:	Competitiveness of Agriculture and Management of Agricultural Resources (DG VI)
DELTA	:	Developing European Learning through Technological Advance (DG XIII)
DOSES	:	Research and Development of Statistical Expert Systems (Statistical Office)
DRIVE	:	Dedicated Road Infrastructure for Vehicle Safety in Europe (DG XIII)
ECLAIR	:	European Collaborative Linkage of Agriculture and Industry through Research (DG XII)
EPOCH	:	European Programme On Climatology and Natural Hazards (DG XII)
ESPRIT	:	European Strategic Programme for Research and Development in Information Technologies (DG XIII)
EURET	:	European Research in Transport (DG VII)
EUROTRA	:	Programme Européen de Traduction Automatique de Conception Avancée (DG XIII)
FAR	:	Fisheries and Aquaculture Research (DG XIV)
FLAIR	:	Food Linked Agro-Industrial Research (DG XII)
JOULE	:	Joint Opportunities for Unconventional or Long Term Energy Supply (DG XII)
JRC	:	Joint Research Centre
MAST	:	Marine Science and Technology (DG XII)
MHR	:	Medical and Health Research (DG XII)

RACE	:	Research and Development in Advanced Communication Technologies for Europe (DG XIII)
SCIENCE	:	Stimulation des Coopérations Internationales et des Echanges Nécessaires aux Chercheurs en Europe (DG XII)
SPES	:	Stimulation Plan for Economic Sciences (DG XII)
STD	:	Science and Technology for Development (DG XII)
STEP	:	Science and Technology for Environmental Protection (DG XII)
TELEMAN	:	Télémanipulation dans les Environnements Nucléaires Dangereux et Perturbés (DG XII)
VALUE	:	Valorisation and Utilisation for Europe (DG XIII)

Other programmes not in the Framework Programme :

SPRINT	:	Strategic Programme for Innovation and Technology Transfer (DG XIII)
STAR	:	Special Telecommunication Action for Regions (DG XIII)
STRIDE	:	Science and Technology for Regional Innovation and Development in Europe (DG XII/DG XVI)

TECHNICAL FICHES

THE SPECIFIC PROGRAMMES - OBJECTIVES, RESULTS AND REVIEWS

1. QUALITY OF LIFE *6*

1.1 Health 6

Medical and health research 6

Human genome analysis 9

1.2 Radiation protection 11

Radiation protection 11

1.3 Environment 14

STEP/EPOCH 14-18

2. TOWARDS A LARGE MARKET AND AN INFORMATION AND COMMUNICATIONS SOCIETY

2.1 Information technologies 22

ESPRIT 22

2.2 Telecommunications 26

RACE 27

2.3 New services of common interest (including transport) 30

DRIVE 30

DELTA 33

AIM 35

EURET 38

3. MODERNIZATION OF INDUSTRIAL SECTORS

3.1 Science and technology for manufacturing industry 40

BRITE 40

3.2 Science and technology of advanced materials 43

EURAM 43

3.3	Raw materials and recycling	45
	Raw materials and recycling	45
	FOREST	49
	REWARD	52
3.4	Technical standards, measurement methods and reference materials	54
	BCR	54
4.	***EXPLOITATION AND OPTIMUM USE OF BIOLOGICAL RESOURCES***	
4.1	Biotechnology	57
	BRIDGE	57
4.2	Agro-industrial technologies	60
	ECLAIR	60
	FLAIR	63
4.3	Competitiveness of agriculture and management of agricultural resources	66
	CAMAR	66
5.	***ENERGY***	
5.1	Fission: nuclear safety	68
	Radioactive waste	72
	Decommissioning	76
	TELEMAN	76
5.2	Controlled thermonuclear fusion	79
	FUSION	79
5.3	Non-nuclear energies and rational use of energy	83
	JOULE	83

6.	*SCIENCE AND TECHNOLOGY FOR DEVELOPMENT*	*87*
	STD	87
7.	*EXPLOITATION OF THE SEA BED AND USE OF MARINE RESOURCES*	*92*
7.1	Marine science and technology	92
	MAST	92
7.2	Fisheries	95
	FAR	95
8.	*IMPROVEMENT OF EUROPEAN S/T COOPERATION*	*97*
8.1	Stimulation, enhancement and use of human resources	97
	SCIENCE	97
	SPES	100
8.2	Use of major installations	103
	Large installations	103
8.3	Forecasting and assessment and other back-up measures (including statistics)	106
	MONITOR	106
	DOSES	110
8.4	Dissemination and utilization of S/T research results	111
	EUROTRA	111
	VALUE	114
Joint Research Centre Programmes		118

MEDICAL AND HEALTH RESEARCH (MHR4)

Objectives

The second Framework Programme provided for the fourth Medical and Health Research Programme (MHR4) in a series which started in 1978. The Council Decision was on 17 November 1987 (87/551/EEC); (O.J., 24.11.87, L 334/20).

The main objectives of European collaboration in medical and health research were to:

- increase the scientific efficiency of the relevant research and development efforts in the Member States through their gradual coordination at Community level following the mobilization of the available research potential of national programmes, and also their economic efficiency through sharing of tasks and strengthening the joint use of available health research resources,

- improve scientific and technical knowledge in the research and development areas selected for their importance to all Member States, and promote its efficient transfer into practical applications, taking particular account of potential industrial and economic developments in the areas concerned,

- optimize the capacity of economic efficiency of health care efforts throughout the countries and regions of the Community;

and, more specifically, to:

- obtain, through coordination of similar projects in Member States, results from a larger sample more quickly and with a higher degree of confidence,

- harmonize, through coordination of initially differing projects, their methodologies so that their results may be compared directly,

- produce benefits in health care more quickly through dissemination of information and results, and through making knowledge of developments in medical technology more widely available.

Background

The programme consisted of the coordination at Community level, within the research areas described, of those activities which formed part of the research programmes of the Member States. The budget was 65 million ECU. Projects in the MHR4 programme were carried out mainly by means of the concerted action (CA) method, with the Commission meeting the coordination costs. In other cases, such as cancer research fellowships and support for centralized facilities, a more substantial funding was provided. The research areas covered by MHR4 were:

Subprogramme I: Major Health Problems

Target I.1: Cancer
Areas: Cancer research training scheme; Clinical treatment research; Epidemiological research; Early detection and diagnosis; Drug development; Experimental (fundamental) research.

Target I.2: AIDS
Areas: Disease control and prevention; Viro-immunological research; Clinical research.

Target I.3: Age-related health problems
Areas: Reproduction; Ageing and disease; Disabilities.

Target I.4: Environment and life-style related health problems
Areas: Breakdown in human adaptation; Nutrition, Consumption of illicit drugs; Infections.

Subprogramme II: Health Resources

Target II.1: Medical technology development
Areas: Diagnostic methods an monitoring; Treatment and rehabilitation; Technical and clinical evaluation.

Target II.2: Health services research
Areas: Research on prevention; Research on care delivery systems; Research on health care organization; Health technology assessment.

By the end of MHR4, six COST States - Austria, Finland, Norway, Sweden, Switzerland and turkey - were also participating, paying more than 5 MECU to the Commission; this extra funding was used to support 15 concerted actions (CAs) which could not otherwise have been started. Such third States joined the whole programme or parts of it, and contributed via a formula comparing their Gross Domestic Product with that of the EC plus their own country.

Results

By 1991 some 140 CAs had been funded under MHR4, averaging 30-35 teams per CA (within a range of 5-100 teams). The approved uses of CA funds included the organization of meetings of all sizes, from small workshops to plenary meetings of all participants; short-term international exchanges of personnel; preparation and distribution of materials and reference products, i.e. for quality control; centralized data handling, storage and statistical analysis; and dissemination of information and results as early, as fully and as frequently as possible through a wide range of publication outlets. That range covered general international journals, European specialized journals, European Communities official publications and hardback versions from commercial publishers. Copies of all publications were submitted as part of the annual and final reports of CAs. In addition a "centralized facility" was provided in 10% of CAs to ensure appropriate European resources or services where it was necessary for a CA to have access to particular quality control products, experimental materials or some other specialized or reference-type service.

Three examples of success stories were:

1. The publication of the "European Community Atlas of Avoidable Death" (first and second

editions).
The Atlas clearly showed, for the first time, the considerable variations in avoidable mortality across the EC, i.e. deaths which should not occur since medical knowledge about their prevention or cure is sufficiently advanced. For 14 disorders during the age range 5 - 65 years, e.g. appendicitis, asthma, certain cancers, and maternal deaths, the potentially avoidable mortality was illustrated in special maps for each geographic administrative unit. Striking contrasts in these death rates provided an intriguing illustration of new measures of health which can be included in future programmes: the "avoidable death indicators".

2. Common standards for qualitative electrocardiography (ECG). Two measurement databases were established for the standardization of computer-derived ECG measurements. They became internationally recognized yardsticks for the evaluation and improvement of European, USA and Japanese ECG programmes, analyzing three- and multi-channel ECG recordings. This was a step towards developing common diagnostic criteria to build the next generation of intelligent software tools for automated interpretation; a diagnostic databank was finished in 1990. 70-80 million ECGs are now taken each year in the EC, at an estimated cost of nearly 1 billion ECU. Computerized reading will help to reduce these costs in all EC Member States.

3. Magnetic resonance imaging and spectroscopy. As part of the CA activities, the manufacturers of magnetic resonance equipment were brought together on several occasions and they finally agreed to accept the test objectives and procedures which this CA had developed for the assessment of the performance of magnetic resonance imaging equipment. A proposal for a standard was submitted to the International Electrotechnical Commission, a "first" in this field.

Reviews

There was an external evaluation of MHR4 - "Research evaluation - Report No. 44", EUR 13001, July 1990. This report made recommendations about better defining the goals of the programme, future developments of CAs, increased basic biomedical research funding, research developing multicentre studies with common protocols (emphasizing cost effectiveness), collection of health service data and epidemiological information, harmonization of policies with appropriate international agencies and European national organizations, fellowships in all topics (and not only cancer), sabbatical periods, additional programme funding, anonymous peer reviewing in project selection, improved project data collection, updating and retrieval, increased publicity covering application procedures, even wider publication of results, and more emphasis on primary care and health services research; these recommendations were accepted and have been implemented as much as possible.

Recommendations not accepted were to create heavily funded European Centres of Excellence, and to reduce the funding of CAs. The then exclusion of "Health" from EC competency was also regretted in the report but that situation was later rectified in the Treaty for European Union signed at Maastricht on 7 February 1992.

An auditors' review of the programme was carried out in 1991 but the final report is still in preparation.

HUMAN GENOME ANALYSIS

Objectives

The second Framework Programme foresaw that in the field of health new initiatives towards the understanding of genetic functions should be developed. The programme Human Genome Analysis was adopted on 29 June 1990 (90/395/EEC); (O.J., 26.7.1990, L196/8) with the following objectives:

- use and improvement of new biotechnologies in the study of the human genome for a better understanding of the mechanisms of genetic functions, as well as the prevention and treatment of human diseases. In the pursuit of these objectives, optimal cooperation will be sought with the programmes of third States and international organisations;

- at the same time, measures will be taken to draw up an integrated approach to the medical, ethical, social and legal aspects of possible applications of results obtained through the programme to ensure that they are not misused and also, with prenormative aspects in mind, to establish a set of bioethical principles to be followed in the developments to come;

- alteration of germ cells or any stage of embryo development with the aim of modifying human genetic characteristics in a hereditary manner is excluded from the programme objectives.

Background

The human genome is the complete set of genetic material - DNA. It is now possible to map and to analyse human DNA, and in doing so to locate genes and to assess variations in individual genes. Along the way many new fundamental discoveries in biology will be made and there will be opportunities to acquire new technologies for medicine.

The programme is a European response to the international challenges presented by the large-scale biological research projects in the United States and Japan. Although it is a programme of fundamental research, one may expect that new information and new materials of potential commercial value will result in a later phase.

The approach of the Human Genome Analysis programme is to develop a scientific infrastructure in order to make the necessary resources available to all European research teams. At the same time collaborative efforts of small networks to achieve specific goals will be supported.

Special attention has to be given to ethical, social and legal aspects not only of the RTD programme itself but also to the implications and applications of its results.

Results

Already in an early phase of the programme, through significant support to "Resource Centres", the access to information and materials for European research teams has been improved. Most of these "Resource Centres" became operational in 1991. Also EUROGEM (European Genetic Map), a network of more than 20 laboratories (two of which function as resource centres), has been fully operational since 1991 and will map more than 1000 new markers during the course of the programme.

Through shared-cost contracts 17 networks with 63 participating laboratories - with two industries among them - began their work between December 1991 and March 1992.

A working group dealing with the ethical, social and legal aspects of human genome analysis and its implications and applications, called WG-ESLA, was established and had its first meeting on 26 April 1991. WG-ESLA and its members have been mainly involved in the ethical review of research projects, in launching a call for proposals for studies - 18 studies (running from 1 January 1992 to 31 December 1992) are currently supported, in planning a conference project - Human Perspectives in the New Genetics, and have drafted a report.

Collaboration with third States and international organisations, in particular with the Human Genome Organisation (HUGO), has successfully started. There are very close contacts with the US programme via the EC-US task force on biotechnology and, furthermore, possibilities for international funding of the Genome Data Base (GDB) at Johns Hopkins University in Baltimore are now being discussed in detail between the US, Japan and Europe.

Reviews

An auditors' review of the programme was carried out in 1991 but the final report is still in preparation.

It is planned to carry out an evaluation of the programme in 1992.

RADIATION PROTECTION

Objectives

The Community activities in the field of Radiation Protection are based on the EURATOM Treaty which endowed the Commission with the instrument of research and training programmes to be carried out by means of contracts with scientific institutions in the Member States.

The various Radiation Protection Programmes since 1961 were conceived as multinational programmes, mainly for 5-year periods. The objectives of the 1985-1989 and 1990-1991 periods aimed by a cooperative European effort:

- to screen and assess problems related to the protection of man and his environment against ionizing radiation;
- to study such problems by scientific research;
- to suggest action before such problems become a threat to man;
- to improve the methods necessary to protect workers and the population by updating the scientific basis for appropriate standards and by further developing techniques to prevent and counteract harmful effects of radiation;
- to provide methods to cope with the consequences of radiation accidents;
- to assess radiation risks and set them in perspective to other risks arising in modern society;
- to provide pertinent and up-to-date information for decision making;
- to assure advanced training necessary to maintain and expand competence in the Community.

Background

Living organisms have always been exposed to radiation from natural sources which represents about 60% of the overall human exposure. Medical and industrial developments have added man-made sources of radiation which have caused increasing concern to the public.

In the European Community about 30% of the electrical energy is produced with nuclear techniques; medical techniques using ionizing radiation are widely employed and are essential to good health care. Over one million workers are potentially exposed to radiation as a result of their employment and nearly every second inhabitant is examined by X-rays once a year. New technical developments might still increase these numbers.

Serious nuclear accidents are extremely rare events, but, in 1986, the Chernobyl accident showed that emergency situations of such a dimension pose great problems of social, regulatory and economic nature. Due to cross-border contamination, harmonized approaches within all Member States are essential.

The professional scientific community has, consequently, important reasons for vigorously pursuing radiation protection studies.

The sixth Radiation Protection Research and Training Programme for the period 1985-1989 was adopted in 1985, with a budget of 58 MECU. In 1987 the Programme was revised and 10 MECU

were added to cover supplementary research for the study of the radiological consequences of the nuclear reactor accident at Chernobyl. Four hundred and three research projects, including 53 for research related to Chernobyl, were carried out in the Member States by cost-shared actions. In the 1990-1991 period, 20.5 MECU were allocated to the Programme, and 211 research projects, essentially taken up in multinational cooperative groups, were launched. Sweden became associated with the Programme, and cooperation with the US Department of Energy and the Atomic Energy of Canada Ltd was further developed.

Results

Scientific knowledge in the field of radiation protection has advanced significantly in recent years, and the concepts and principles of radiation protection have undergone a gradual evolution. The Radiation Protection Programme has notably contributed to this development by advancing the understanding of mechanisms, diagnosis and treatment of effects, and the evaluation of risks of ionizing radiation.

The results of these scientific studies were made available in about 600 publications per year in scientific journals and proceedings of conferences. Focal points of interest of such studies were the development of dosimetric methods, the long-term behaviour of radionuclides in water, soil, plant and animals, the treatment of syndromes due to general and local accidental exposure to ionizing radiation, the influence of dose and dose rate on the induction of cancer and genetic effects, the study of exposed human populations, risk assessment and optimization of radiation protection, including reduction of patient exposure in medical diagnostic radiology. Procedures, techniques and methods developed during the Programmes are continually being implemented into radiation protection practices. Coordination of activities has been achieved by annual meeting of contractors, the organization by the Commission of some 150 seminars and workshops relating to urgent problems in radiation protection, and contributing markedly to the deliberations of the Article 31 Group of Experts.

The Commission's Radiation Protection Research and Training Programme is coordinating indirectly about 80% of the Community research in that field.

Reviews

An external evaluation of the 1980-1989 period by a panel of independent experts (Report EUR 12147, 1989) was carried out.

The evaluation panel noted that the programme is mature, well balanced, productive and comprehensive. Most of the major laboratories in the Community are involved. The programme at the time of the evaluation was highly productive and the scientific publications constituted an important input in other international programmes, eg, the reports of UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation).

The panel noted the following shortcomings:

- A reduction of certain aspects of basic research which might have adverse effects in the long term.
- The administrative response to unanticipated events is too slow.
- Cooperation and information exchange with other Commission programmes require

improvement.

- More emphasis has to be placed on issues of public importance.
- Operations, deliberations and discussions of the Advisory Committee should be made more transparent.
- The reduction in funding has severely compromised the future of radiation research in the Community.

The panel recommended that:

- All the important elements of programme content, management and coordination can be successfully maintained in the future.
- The level of funding should be increased.
- The programme should establish contacts with other national programmes (Scandinavia, Eastern and Central Europe, Japan).
- Critical needs in training for radiation protection research must be addressed.
- A socio-economic study on the impact of the Radiation Protection Research Programme must be undertaken.

In the meantime, most of the panel's recommendations have been implemented successfully.

ENVIRONMENTAL PROTECTION (STEP)

Objectives

EC level research and development in the field of the environment has the following broad objectives:

- to provide scientific and technical data which support the Community Environment Policy
- to address longer-term environmental problems in support of preventive and anticipatory policies
- to serve as an instrument for enhancing further, at Community level, the coordination of research activities in the environmental field.

Background

The importance of environmental protection in economic and societal development is recognized throughout the Community. Our ability to ensure this protection crucially depends on reliable, high quality and compatible environmental data and measurements, leading to an improved understanding of the environment and the environmental impacts of human activities. Within FP2, EC Environmental R&D has made a significant contribution to providing such data, improving understanding, and developing appropriate methods and techniques.

The development of EC environmental R&D during FP2 should be seen in the context of major environmental issues and challenges which occurred during this period. These include the following:

- The European Single Act substantially increased Community competence for environmental policy, and underlined the importance of a sound scientific and technical basis. Environmental policy is now primarily formulated at EC rather than at Member State level. Furthermore, the Single Act confirmed the need to integrate environmental protection requirements into Community sectoral policies (e.g. industry, agriculture, energy, transport, development, etc.).
- EC environmental policy has gradually shifted from a reactive to an anticipatory and preventive approach.
- There was rapidly growing concern about possible irreversible global environmental change resulting from human activities.
- At the same time, environmental protection and industrial development were no longer considered as incompatible. Rather, the notion of environmentally sustainable development became the guiding principle.

These and other factors necessitated a significant enhancement of environmental R&D. The Community played its part and the resources allocated to as well as the scope of EC environmental R&D expanded substantially.

In addition to EC Member States, EFTA countries joined the Programme, and towards the end of the FP2 period, some preliminary contacts with Eastern and Central Europe were made.

EC Environmental R&D has addressed a broad range of environmental issues and problems including the following :

- Environment and human health
- Assessment of risks associated with chemicals
- Atmospheric processes and air quality
- Water quality
- Soil and groundwater protection
- Ecosystem research
- Protection and conservation of European cultural heritage
- Technologies for environmental protection
- Major technological hazards and fire safety.

Two environment research programmes were executed during the 2nd framework programme. The 4th Programme was adopted in 1986, running from 1986 to 1990. The 5th Programme, STEP (Science and Technology for Environmental Protection) was adopted in 1989, running from 1989 to 1992. The budget of the two programmes was 130 million ECU, bringing its total cost to more than 260 million ECU.

Since 1989, about 220 projects have been started involving close to 1200 research teams, the majority from universities and research institutes and a minority from industry. About 3000 scientists worked, and are still working fully or partly, in the projects of the two programmes.

Results

The overall achievements of EC environmental R&D Programmes during FP2 were clearly recognized by the Evaluation Panel. The figures speak for themselves. A very large number of publications in the peer-reviewed literature resulted from the Programme. Furthermore, the 5 Environmental COST Concerted Actions resulted in over 100 reports published by the Commission, many of them of major significance.

Due to the broad range of environmental issues covered, the Community's R&D effort is also a broad and varied one. It includes investigations of the sources and pathways, health and ecological effects of selected pollutants; the development of techniques to reduce or prevent pollution and waste; studies of fundamental processes in the environment - to provide a scientific basis for rational environmental protection and conservation measures. Clearly, only a few illustrative results and achievements can be reported here. In broad terms, these provide direct support of environmental legislation; improve our understanding of fundamental environmental processes thus promoting a basis for preventive environmental policies; improve the prevention or reduction of pollution, waste, etc.

Protecting human health and ecological targets
Projects contributed substantially to understanding health effects of priority pollutants (e.g. lead and cadmium), identification of population groups at risk, and provided a scientific basis for regulation.

The work also led to important improvements in screening environmental chemicals for their carcinogenic and mutagenic potential, as well as their risks to environmental targets. Progress has been made in understanding the mechanisms of environmental carcinogenesis and mutagenesis.

Understanding fundamental terrestrial and aquatic ecosystem processes
Improved understanding of the effects of air pollutants on the natural environment has contributed to formulation of air quality standards (e.g. ozone) and more effective monitoring systems. Long-term research on terrestrial and aquatic ecosystem processes has led to the definition of ecological criteria e.g. acceptable degree of biodiversity, transfer of chemicals between different ecosystem components, etc. These criteria provide important foundations for implementing environmentally sustainable development policies.

Atmospheric processes and global change
Understanding of tropospheric processes was substantially improved by development of measurement techniques, and coordinated measurement campaigns. Significant advances were made in understanding reaction mechanisms of key pollutants, including those contributing to photochemical pollution and acid deposition.

Research on stratospheric chemistry and ozone depletion has enlarged understanding and prediction of changes in stratospheric ozone. The European Stratospheric Ozone Experiment (EASOE) was initiated as a major campaign, intended to provide a sound scientific basis for environmental policy decisions in this area.

Protecting soil and groundwater
Estimates of nitrogen losses from land surfaces supports evaluation of technologies to reduce nitrate pollution of groundwater. Results from studies on soil erosion have improved assessments of soil loss and support conservation strategies.

Preserving European cultural heritage
Work in this field has made a substantial contribution to overall understanding of the relationship between environmental factors and the deterioration of historic monuments in the Community. In particular, methods for evaluating and recording the condition of monuments were developed; quantitative relationships between pollution levels and monument decay rates, as well as an improved scientific basis for decisions on mitigative actions were established.

Improving pollution abatement, waste management and industrial safety
Emission abatement technologies in a number of industrial sectors were studied; cleaner technologies and improved measurement techniques for emission and process control were developed.

Progress was made in understanding health and environmental risks of toxic wastes, and in analysing its constituents. Progress was made in various waste management techniques, including biodetoxicification, landfill, incineration techniques, etc.

Research on industrial safety has led to better prediction of accident effects; improved understanding of the causes of accidents, including the human influence; and an improved scientific basis for accident prevention. Such advances are assisting Member States in satisfying specific policy requirements on major hazards and in developing better policies for accident prevention.

Reviews

Environmental R&D undertaken within the framework of FP2 has been extensively reviewed at several levels.

In 1988 a full independent evaluation (Evaluation Report N° 36, EUR 11953) was undertaken by a distinguished group of external scientists under the chairmanship of Professor Dooge, former Foreign Minister of the Irish Republic. The Evaluation Panel was satisfied with the scientific output of the Programme, and its relevance to environmental policy. However, it considered that greater attention should be given to the dissemination of results obtained.

There are detailed reviews of progress within the various research areas. They are carried out by regular meetings of project leaders and of contractors. (Contract Group Meetings), as well as by meetings of COST Committees and Working Parties.

Finally, the achievements of the Programme and the critical directions for future R&D are discussed at major European Symposia, organized within the framework of the EC Environment R&D Programme. Some examples of these symposia are :

Air Pollution and Ecosystems, Grenoble 1987
Science, Technology and European Cultural Heritage, Bologna 1989
Response of Terrestrial Ecosystems to Environmental Change, Firenze 1991.

CLIMATOLOGY AND NATURAL HAZARDS (EPOCH)

Objectives

The first R&D programme in the field of climatology was adopted by the Council in 1979. The second programme was defined in the Environment programme (1986--1990), and was enlarged under the heading of Climatology and Natural Hazards (CNH). EPOCH resulted from the midterm revision of this programme.

The EPOCH programme was adopted together with the STEP programme, as two specific programmes in the field of environment for 1989 to 1992, by the Council decision of 20 November 1989. The common objectives of the two programmes are:

- to provide scientific and technical support for the environmental policy of the Community, and for other relevant Community policies;

- to improve the productivity of the overall research effort in the Community, the reduction of overlaps and the identification of gaps, through the coordination of the national R\&D programmes in the field of environmental research.

- to promote scientific excellence in the field of environmental research and to contribute to the strengthening of the economic and social cohesion of the Community, and of the strengthening of industrial competitiveness within the Community.

EPOCH has been conceived as a means of orientating and coordinating European research towards the solution of the very serious and impending problems of man induced climatic changes and of natural hazards, and is also an European contribution to such international programmes as the World Climate Programme, the International Geosphere-Biosphere Programme, and the UN-established International Decade for Natural Disaster Reduction.

Background

Since the beginning of the industrial era man has been burning increasing quantities of fossil fuels, with the result that CO_2 has been accumulating in the atmosphere, from its pre-industrial concentration of about 280 ppm to the present level of 350 ppm. Since CO_2 is a "greenhouse" gas the net effect of higher concentrations is a global warming of the earth surface and lower atmosphere. The concentration of other greenhouse gases (e.g. methane, nitrous oxide, tropospheric ozone and CFCs) are also increasing, and this adds to the global warming, with the result that the world may already be committed to an average global warming of 1.5 C to 4.5 C within the next 30-40 years. Although quantitative uncertainties in present predictions of climatic development exist, even in terms of global averages, the scientific consensus is that significant climatic changes will occur during the next century. Greenhouse gases and their climatic effects may be the single most important environmental issue facing Europe as we begin the 21st century.

The climate change will have significant impacts upon various sectors of our environment and of our society.

Regional and seasonal changes have not been modelled and predicted with confidence as yet. However, for Europe, model results show that summer temperatures could increase by 2°C to 6°C, and winter temperatures by as much as 5°C to 10°C. Precipitation will possibly be reduced in summer, which, coupled to the higher temperatures, could increase the stress upon vegetation in general and cause problems for European agriculture.

Sea level will change due to global warming. Estimates of this effect differ considerably, but the mean sea level could rise by 0.5 to 1 m by the year 2100. High tides would penetrate further inland in many places, erosion of beaches and coastal margins would increase, with serious consequences for economy and society.

Plants and natural ecosystems will be affected both by the higher levels of CO_2 and by the climate change. The yield of many crops might increase due to the enhancement of the photosynthesis, but adverse effects appear to be predominant.

Frequencies of extreme climatic events (e.g. droughts, storms) is feared to increase as a consequence of the climatic change, and would require re-adjustment of human activities to new risk levels. Other natural hazards, which are partly climate dependent would be affected as well: Floods, storm surges, landslides, avalanches, soil and vegetation degradation.

Natural hazards (except earthquakes) may increase as a result of climate change, the study of their causes, of the processes involved, of the ways of predicting their occurrence, mitigating their consequences and rehabilitating the areas damaged, may -in part- be seen in the perspective of the changing climate.

The research effort within CNH and EPOCH was defined, in response to the above impending problems, in the decision of the second framework programme: "Research on Climatology and Natural Hazards will focus on efforts to understand the mechanisms which govern the phenomena concerned, e.g. by developing powerful models capable of forecasting such phenomena in temporal and spatial scales useful for planning and prevention, by refining our ability to assess impacts on specified segments of European Community geography, society and economy, and by establishing a sound scientific basis for any preventive or corrective measure."

The total budget for CNH was 17 MECU, and a total of 96 research contracts, each involving one research institution, were adopted: 89 in the field of climatology and 7 in the area of seismic research.

The total budget for EPOCH is 40 MECU, and by the end of December 1991 a total of 36 contracts were approved with a total EC contribution of 35.3 MECU. Approximately 300 institutions, mostly universities and research establishments, are involved in the programme.

Results

A major outcome of the pre-EPOCH programmes is the "distinct contribution to the effectiveness of European science in this particular field. The actual scientific achievement under the programmes compared with that of national science programmes may not appear significant in the larger member states, but can be of crucial importance in the case of smaller and less developed member states. ... the promotion of coordinated transnational research proposals has strengthened the coherence of European research in a number of areas in environmental research" (EUR

11953 - Evaluation of the Research and Development Programmes in the field of the Environment (1981-1985 and 1986-1990). CEC Research Evaluation - Report No 36).

This impact on the productivity in the particular scientific field is even more pronounced for EPOCH. A greater effort has gone into the establishment of transnational collaboration of outstanding European scientists and research institutions in large projects and complex experiments, which provide indispensable coordinated input in the understanding the mechanisms of the climate system, quantifying effects of the emissions of greenhouse gases on the climate and on various sectors of our environment.

The integration of the progress in the relatively small individual projects under the CNH programme was aided by the organisation of coordination groups in selected key areas, and these were instrumental in the definition of the larger and more closely integrated EPOCH projects. Of the more important of these are:

Climate changes during the last 30,000 years. A major coordinated effort, involving 17 institutions, for the reconstruction of recent palaeoclimates. Generally considered as a unique EC contribution in a field, which without this effort would show only little progress.

Climate of the 21st. century. A joining of forces of the leading European centres (16 institutions) for global climate modelling.

The global carbon cycle. A coordinated effort to clarify the natural carbon cycles (11 institutions involved).

Land surface processes and desertification. Two large coordinated projects: EFEDA (23 institutions) on the role of vegetation on the hydrological cycle, and MEDALUS (16 institutions) on Mediterranean desertification and land use impacts.

Climate change, sea level rise and associated impacts in Europe. A large coordinated effort (21 institutions) for assessment of past and future sea levels and associated impacts for Europe.

All of these larger projects have already resulted in very important benefits in terms of effectiveness, which could not be obtained on a national level, even considering the large Community nations. They demonstrate, as do many of the smaller ones not mentioned here, the synergy of trans-national cooperation and the subsidiarity of the Community support.

The majority of CNH projects are now coming to an end. To date a considerable number of technical and scientific reports have been produced as well as 45 reviewed papers in relevant international journals.

For the EPOCH programme most project have been running for less than one year, but nonetheless, the few periodic reports already received list more than 30 papers that have been published in international reviewed journals in addition to numerous reports and conference contributions.

In the field of seismology two data centres were established, which will be important for the future rapid intervention in case of major seismic events, as well a basis further progress of

research in this area.

Four international symposia were organised in the period 1986-1990.

Within the education and training activities five courses were organised between 1986 and 1991. Four were held within the framework of the European school of Climatoloy and Natural Hazards.

Proceedings of these activities have been published, together with three books on major themes in the research programmes.

Reviews

As already described above, the EPOCH programme was developed in close collaboration with leading European scientists, in addition to the statutory Community institutions and bodies, to ensure an effective and targeted approach.

A review by the Court of Auditors of the specific programmes were conducted in 1988.

A major shortcoming of the programmes is the chronic lack of funds, which imposes a) shortening of project duration, b) reduction of planned activities, and c) underexploitation of the available intellectual potential.

EUROPEAN STRATEGIC PROGRAMME FOR RESEARCH AND DEVELOPMENT IN INFORMATION TECHNOLOGY (ESPRIT)

Objectives

Conceived as a 10 year programme, ESPRIT was launched in February 1984 for an initial phase of 5 years with the following objectives:

- to promote cooperation in the field of IT between firms, research centres and universities in the member states (and since 1988 in the EFTA countries as well);
- to contribute to the development of the basic technologies needed by European industry to be competitive;
- to help draw up the international technical standards essential for the development of IT.

Background

With an annual growth rate of around 15% throughout the 1980s, well in excess of the rise in GDP, the IT and electronics market has become one of the biggest sectors of the European economy, and is expected to become the largest by the end of the decade.

IT has two quite different characteristics. On the one hand it constitutes an increasingly important industry producing a complex range of goods and services: electronic components, computers, consumer electronics, software, computer advisory services, computer-integrated manufacture, etc. On the other hand it is a vehicle for generic, enabling technologies which are incorporated in products and services produced or used in a whole range of economic activities which thereby become more competitive. What makes the IT and electronics industry so strategic for the Community is not only its size, but also its all- pervasive and catalytic nature. Its impact on employment is considerable: an estimated 60 to 65% of the working population is directly or indirectly dependent on these technologies and their applications. Its products and services provide a vital part of society's infrastructure and its technologies are now used in virtually all economic and social activities. As a result, the IT and electronics industry has a major role to play in maintaining and strengthening the competitiveness of European industry as a whole.

However, during the programme period, the European IT industry was undergoing a major reorientation and restructuring, and facing increasing competition both in the European market place and on a global scale. This is leading to reduced revenues at a time when the needs for investment in R&D are greater than ever.

The approach of ESPRIT is to provide an environment in which the industrial and research participants can benefit from sharing R&D resources, risks and costs. The ESPRIT programme has been designed in close consultation with IT industry, user industries and the research Community, taking into account the results of in-depth independent reviews of the Programme conducted by high level experts. The programme addresses four technological areas, selected in consultation with industry, in accordance with their expected impact on industrial competitiveness. These areas are Microelectronics, Software and Information Processing Systems, Business Systems and Computer Integrated Manufacturing. The main objectives for the areas selected were defined by industry as follows: in Microelectronics, the aims were to strengthen the Community

capabilities in ASICs and to ensure the capability to design and produce high density ICs. In Software and Information Processing Systems, the work concentrated on improving system design and engineering, parallel architectures and on developing and applying knowledge engineering techniques. In Business Systems, the major goal was to develop and demonstrate integrated business systems. Computer Integrated Manufacturing addressed, in particular, open distributed systems for manufacturing applications, robotics and shop- floor systems. The programme also contained a small element (5%) of Basic Research.

Results

A major initial outcome of ESPRIT was the establishment of links between companies in Europe. These comprised links between suppliers, between suppliers and users and with research institutes.

The programme has been taken up enthusiastically by industry and research. The desire for cooperation amongst European companies has manifested itself beyond all expectations and continues to grow. The rate of oversubscription, which is the ratio of requested funding contained in proposals, against actual funding on projects, has risen from 4:1 to 7:1. One of the crucial reasons for this overwhelming response is that industry itself selects the research areas and defines and regularly updates the work programme on which successive calls for proposals are based.

In the 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. Furthermore, ESPRIT has set a leading example for cross-border industrial cooperation, which has been emulated in other Community programmes, and in EUREKA.

Europe's technological base has improved as a result of ESPRIT, in techniques and facilities; and, most importantly, in human resources. Links between industry and universities have been strenghtened and transnationally, have often been created for the fist time. Managerial awareness of the strategic importance of IT has been heightened. The programme has, last but not least, provided outstanding technical results and standards.

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. Second, projects may produce tools, methods or processes which enhance the development or 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 direct contribution to international standards.

The 1991 ESPRIT annual report lists over 500 major technology results which have come out of ESPRIT projects.

The degree to which technological results have been exploited varies from area to area.

In Microelectronics considerable technological progress has been made leading to Europe not losing ground and even gaining a technological leadership in some cases. For instance, in

lithography a Dutch company has brought to the market a deep-UV stepper that is the most advanced of its kind in the world which has been marketed successfully in Europe and abroad. European capability in ASICs has been ensured, however, there is still evidence of a reluctance from the users to take up this technology into products. The contribution to JESSI focused on CMOS technology. Excellent results were achieved in BICMOS technology. For bipolar technology, although the technological results achieved in ESPRIT projects were of world class, the market relevance has declined. Consequently, bipolar technology is not being further pursued in the programme.

Promising technological results have also emerged in Software, for instance, a distributed operating system (CHORUS) and a software environment (PCTE). These results are now available in the market from European companies. However, there is some concern about the fact that these technological results which were generated within ESPRIT, were first marketed by US companies before they were taken up by European companies.

In Information Processing Systems, the work on advanced parallel architectures has been singularly successful from the technological point of view and has also been exploited very successfully. The transputer, developed under ESPRIT, is the most widely sold, 32-bit RISC processor. More than 500 products worldwide have stemmed from the ESPRIT work on the transputer. European vendors are currently selling more machines based on parallel architectures than their US competitors. This is a good starting point for exploiting the rigourously growing market for high performance parallel computing systems and networks.

Work in knowledge engineering has not matured at the rate that was originally thought likely. It is now being dropped from the programme.

One of the main thrusts both in the Business Systems and Computer Integrated Manufacturing (CIM) areas is Open Systems. The last two years have seen major Open Systems product announcements from the European IT industry based on R&D results achieved in ESPRIT Business Systems. In the CIM Open Systems Architecture concept CIM-OSA, which was developed in ESPRIT, was established as a European pre- standard and accepted as the basis for standardisation work by ISO.

In Business Systems also the work addressing multimedia concepts is progressing rapidly. The concept of CD-I (Compact Disc Interactive), which is now being launched as a product, was developed in an ESPRIT project.

In CIM, numerous results were achieved and exploited concerning design and implementation of manufacturing systems, engineering design, robotics and shop-floor systems. The growth of the world market for robotics systems was overestimated in the past. The R&D priorities for robotics have to be adjusted accordingly.

In the last twelve months, the number of major, concrete results from the ESPRIT work has increased from 313 to 495, making an significant addition of 182 new results in one year. 270 led to products or services brought to the marketplace, 167 enhanced tools, methods or processes leading to shorter development times, higher quality and reduced cost. Finally, 58 results were fed directly into the work of international standardisation bodies.

Reviews

The following reviews of the ESPRIT programme have been carried out :

- Communication from the Commission to the Council and the Parliament Concerning a review to assess the performance and results of the ESPRIT programme. SEC(89)1348 final
- ESPRIT 1989 Annual Report
- ESPRIT Progress and Results 1990/91
- Mid-Term Review in progress

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. The outsiders view can help both the project and the Commission, especially when work has to be redirected.

Furthermore, a selection of results is demonstrated at the annual ESPRIT exhibition. At the 1991 exhibition concrete technology results were demonstrated on 110 stands, thus making it the biggest exhibition of R&D results in the world.

The overall perception by participants in the programme, collated in an extensive series of interviews and desk research was positive.

Cooperative generic research and development is a formula which has now established its effectiveness, and should be retained. However, it will not be possible nor desirable for Europe to promote equally all areas. Technology moves very quickly. New areas emerge. Other areas are either de- emphasised or stopped. Europe must concentrate efforts in selective areas. Emphasis must be given where there is a strong industrial commitment and a position of strength. Focusing on such technologies will provide the impetus which will lead to meet the competitive requirements of the future.

RACE, DRIVE, AIM, and DELTA

In telecommunications and telematics, there is a very close relationship between policies, regulations, service provision, standardisation and technology. Social, political, regulatory, economic and technological factors are inextricably interlinked: Industry can only provide what is economically and technologically feasible; service providers can only maintain services which are attractive to the user, and Governments can only impose regulations with the technical means to enforce them. For this reason, R&D in communications technologies and telematic systems calls for a careful mix of evolution, innovation and verification involving all sector actors. The R&D actions in the 2nd Framework Programme were part of a coherent set of Community policies: telecommunications regulation, standardisation, information market development and internal market policies.

This applies particularly to the work addressing social and economic priorities such as health care, transport and flexible training. Research on ways of using technology has to be carried out with the sector actors directly concerned. Actions such as DRIVE, AIM and DELTA play such a role.

The conception and implementation of the actions was guided by the need to contribute to the establishment of a single market and the convergence of the economic policies of the Member States; to strengthening the international competitiveness of the sector actors (industry, operators, service providers and users), and to regional development and to social and economic cohesion. In all these actions, the European community dimension was important because of the strategic importance for Europe's economic and social development, the added value of transnational cooperation and the ability of the Commission to establish consensus on credible actions.

Following the Council decisions on the RACE, DRIVE, DELTA and AIM Programmes in 1987 and 1988, the programmes were implemented with a common management system. A Management Audit in 1989 confirmed the effectiveness of the programme management arrangements put in place.

The two specific programmes in the third Framework programme, on communication technologies and telematic systems of General Interest, will ensure the continuity of this research and will extend its scope to other areas of social and economic importance: development of a European Nervous System linking administrations in the European Community; ensuring easier access to the wealth of information in European libraries, overcoming the problems of the linguistic diversity of the Community and addressing the specific needs of rural areas.

All programmes are carefully coordinated to take maximum advantage of the synergies between them and all involve a large number of key industrial and sector actors.

RESEARCH AND DEVELOPMENT ON ADVANCED COMMUNICATIONS IN EUROPE (RACE)

Objectives

The objectives are to prepare for the introduction of Integrated Broadband Communications (IBC), taking into account the evolving Integrated Services Digital Network (ISDN) and national strategies, proceeding to Community-wide services by 1995;

The RACE effort lies between basic research and market-oriented development. It creates opportunities for innovation in product design, development and manufacture, and reflects the realities of telecommunications operations, equipment manufacture, the need for evolution from current systems and the importance of cost. It is also concerned with the usability of equipment and services, and makes full use of the Community's intellectual resources in assessing requirements and in developing pilot applications.

Background

Effective and cheap communication services are vital to economic performance and are therefore crucial to Europe's economic and social development. Already, more than half the jobs in Europe are related to information and services and involve the use of telecommunications in all its forms.

Development of digital electronic and optical technologies opens the way to greatly improved and economic voice, data and image communication. New technological developments include high-definition television, digital recording and transmission of sound and pictures, optical fibres for very fast transmission of information, super-fast computers and satellite broadcasting. These will allow telephone and data transmission services to be brought together with video services to meet a large variety of needs.

A RACE Definition phase was set up in 1985 to plan a major programme of consultation, standards and technology R&D. The RACE programme, which is part of the 2nd EC Framework Programmes (1987-1991), was adopted by the Council of Ministers in December 1987 and work started in January 1988.

Results

The RACE Programme has strengthened the harmonisation of the European Telecoms Infrastructure. This is a prerequisite for the completion of a Single Market. The creation of the Common Functional Specifications has provided a 'blueprint' for European Integrated Broadband communications. This achievement highlights the cooperation of all the European Network Operators, telecommunications Industry, Broadcasters and major leading edge users, which has been the hallmark of the RACE programme.

By developing a strategy for the introduction of IBC in less favoured regions, the programme has fostered the close cooperation of central and peripheral regions. The Telecommunications network operators and Industry have contributed to their international competitiveness through the shared conceptual and system development of IBC. Development of Asynchronous Transfer

Mode (ATM) techniques, which is the basis of the next generation systems, has given European industry a lead in international competition. Major advances in advanced multigigabit optical systems, photonic switching, key optoelectronic components and their integration have kept European industry abreast of developments outside Europe.

The research in Network Management, which is fundamental for the future complex networks, has resulted in European Network Management Systems which are internationally recognised.

The research on "mobile" communications has set the conceptual framework of a 3rd generation of Mobile Systems. It has resulted in the definition of Universal Mobile Telecom Systems (UMTS), which will be able to meet major European market demand in the mid-1990s.

Digital video and TV, which is one of the important components in Integrated Services, has been the subject of a major research effort. This has resulted in international standards in coding, pioneering multimegabits studio systems, multigigabit distribution systems, digital videorecorders, and many more systems.

The development of services and applications, which constituted the cornerstone for the justification and viability of the future sophisticated networks, was addressed through the introduction of special pilot experiments, where in the 'triptych' of user-telecoms operator-industry, the user played the leading role. This cooperation proved successful and yielded excellent results in distributed publishing, remote expertise, banking, manufacturing. These new applications are now moving towards commercial exploitation.

In the area of standardisation, the programme has contributed more than 1000 draft specifications to the European and world- wide bodies: ETSI, CCITT, CCIR, etc. The development and sharing of a 'vision of European communications in 2000' has promoted close interaction among the programme participants with heavy emphasis on 'forward consensus building' in Concertation Meetings and workshops. Over 1500 scientific and technical articles have been published.

Reviews

The following reviews have been undertaken :

- RACE '91 : The RACE programme and project summaries : March 1991.
- Establishing Advanced Communications in Europe : IBC Strategic Audit : February 1989.
- Perspectives for advanced communications in Europe : 1990.
- Progress report and 30-month review of RACE SEC(89)2050 final : November 1989.

The strategic orientations of the Programme had been verified through independent 'strategic reviews' verifying that the Programme is meeting its strategic objectives, and that continuation was required. The annual Technical Audits of all projects verified or rectified the course of the individual projects vis-à-vis the Workplan of the Programme and ensured coherence through their interaction.

The need to consolidate the results as well as to accommodate new requirements lead to the introduction of RACE II (1990- 1994) where the emphasis has shifted from 'exploring options' to 'preparing for implementation. The strong interest of the sector actors for the Programme's vision towards the 21st century, was manifested again in 1991 by the large number and excellent quality of proposals. The 80 new projects in the second phase of RACE ensure a detailed interlocking of activities of the RACE workplan.

Looking towards the 4th Framework Programme, it is clear that R&D on integrated Photonic Networks, digital multimedia communications (including HDTV), mobile systems, service creation, as well network and service testbeds, will continue to benefit from cooperation at a European level. The leading-edge RACE results in telecommunication networks (ATM switching, multimegabit and gigabit systems, network management, etc.) will have to be integrated in focused multidisciplinary projects on advanced networking and global interconnections, and the integration of services over optoelectronic and photonic networks for 'virtual presence'.

DEDICATED ROAD INFRASTRUCTURE FOR VEHICLE SAFETY IN EUROPE (DRIVE)

Objectives

The objectives of the Council Decision on DRIVE (Council Decision 88/411/EEC, OJ No. L206, 30.7.88.) state that through R&D on application of Information and Telecommunication technologies in Road Transport a breakthrough in road safety, a major improvement in road transport efficiency and a significant reduction in pollution should be achieved. In addition, the Community Action should establish in the medium term the framework for a large- scale investment in the field of Road Transport Informatics (RTI), thus promoting the competitiveness of the Community's industries, operators and service providers.

Background

There is still rapid growth of car ownership in Europe, but the development of the road infrastructure is now slow. This situation has given rise to three problems: congestion, costing the Community an estimated ECU 150 billion per year; road safety problems, with 55,000 people killed on the roads each year, and environmental damage.

Problems are particularly acute in urban areas and on some motorways. The DRIVE programme seeks to alleviate these problems through R&D on the application of advanced information technology and telecommunications. It focuses on the requirements for common infrastructure technology and operational issues of concern to public authorities. It complements the cooperative efforts in the EUREKA framework in which industry is already engaged through pre-normative R&D on telematics systems for motor vehicles.

The DRIVE programme was planned in 1985 and 1986 in consultation with industry and transport administrations. The Council of Ministers adopted a "Community Programme in the field of Road Transport Informatics and Telecommunications (DRIVE)" on 29 June 1988 (Council Decision 88/416/EEC) for a 3 year period and with a budget of ECU 60 million. 72 projects were successfully negotiated representing over 1000 man-years of effort by 480 participants.

The projects involve leading-edge users and industry (Automobile and IT&T) collaborating with research establishments, transport, telecommunication and broadcasting operators. All the main actors in transport activities were involved in DRIVE. In addition, a specific DRIVE project involving Prometheus, Europolis, Carminat (EUREKA projects) and the IT&T industry, the Telecoms industry and users was set up. This project brings together all European activities in this domain.

Regular concertation meetings with all projects, 16 in all,were organised to keep continuous technical control of the programme and to allow all participants to exchange information and to promote consensus on common specifications and practices.

All DRIVE projects have been audited each year (3 independent audits). Nearly all projects finished in 1991.

Results

Technology systems and introduction strategies have been addressed in the areas of traffic control, traffic safety, telecommunications, databases, freight and public transport services, modelling and systems engineering. Projects have proven the viability of mobile cellular telephones (GSM) for multi-services in road transport, whilst other communication media (infra-red, microwave) have proven their utility for route guidance and automated debiting systems. RDS based standards for information and navigation systems have been developed. The "Black Box" concept for road vehicles has been proven as well as standards for a generic intelligent driver support system. Incident detection systems using computer vision are developed as well as new algorithms for traffic signal control. The specifications for the logistics chain in freight transport are defined and new systems for on-line public transport scheduling and passenger information are developed. In total 26 proposals on special topics for standardisation have been introduced to the specially created standardisation committees. CEPT has allocated a frequency spectrum for Road Transport Telematics applications.

A mid-term Independent Strategic Audit assessed and evaluated the performance of the DRIVE Programme as a whole with respect to the strategic and policy objectives of the Community. The work was reviewed both with respect to the evolving demand and to new technological developments. It was carried out by experienced advisers from different backgrounds, acting in a personal capacity. The Auditors found that the programme strengthens the economic and social cohesion of the Community, contributes to the establishment of European norms and standards, addresses problems on the appropriate geographical scale and enables savings to be made through transnational cooperation. The Auditors confirmed and strongly underlined the integrated approach taken by the programme. They concluded that "Road Transport Informatics can bring a much larger variety of practicable options for transport policies and also more flexibility. In this respect it can be a decisive instrument to be used in suitable policies and industrial strategies to achieve the necessary breakthrough in safety, efficiency and environmental quality of the transport system. Hence there is a definite need for a follow-up and deepening of DRIVE". The participants identified key issues in the establishment of Road Transport Informatics in Europe and came up with a set of recommendations for the European Commission, national governments, industry and the other actors in the sector of road transport.

The limited budget for the DRIVE programme and the rather ambitious objectives of many projects led to a situation that many projects had to modify their goals. This was in particular the case in the field of modelling and preparing algorithms. The projects in the area of safety and environmental impact of telematics underestimated the difficulties of their work.

Reviews

The following reviews have been carried out :

- DRIVE '91 : R&D in Advanced road transport telematics in Europe : April 1991.
- DRIVE Strategic Consultative Committee Report : June 1990.
- DRIVE Strategic audit report : November 1989.
- Progress report and mid-term review : SEC(89) Final, 1989.
- Final Evaluation Report in progress.

A Strategic Consultative Committee (SCC) has been set up, consisting of personalities from the main industrial and service sectors that use road transport, acting in a personal capacity. It has provided a strategic perspective on the Programme, policy advice on Road Transport Telematics, and a high-level forum for industry/operators/users to exchange views and develop strategic plans for future developments and exploitation of the results of research. They stressed the need that any future R&D actions on Advanced Transport Telematics need a coherent and global approach and a critical mass of resources whilst user acceptance shall be given emphasis. Special priority has to be given to large scale field trials which as part of precompetitive R&D will verify the technical, economic and social performance and impact of the systems to be developed. The first report of the Committee (DRIVE Strategic Consultative Committee Report; June 1990.) concluded that "To provide the European Countries with improved transport systems together with a better quality of life, the proper identification of a critical amount of R&D efforts, suitable field trial experiments and effective implementation strategies has appeared as the essential prerequisite for the much needed final success".

DEVELOPING EUROPEAN LEARNING THROUGH TECHNOLOGICAL ADVANCE (DELTA)

Objectives

The DELTA exploratory action concerns the use of newly emerging technologies for learning (ie. training, re-training and education), not only information technology, but perhaps even more importantly telecommunications and broadcasting technologies.

The aim was to prepare the way for more effective use to be made of training material by reducing the cost of production of quality software and support mechanisms.

Background

In the European Community, 22% of the population of the Community is in some sort of full-time education or training at any one time. In addition, 10 million people receive part- time training each year. Flexible and distance learning systems already play a major part in meeting the demand for specialised education and training.

The programme was developed through a careful study of the situation in Europe, the USA and Japan and other countries, by a group representing all actors in the domain; the IT industry, PTTs, media publishers and academic/pedagogic organisations. The DELTA action was adopted by the Council on the 29th June 1988. 20 MECU was allocated to an "Exploratory Action" during 24 months.

A Call for Proposals in 1988 generated a substantial response. Over 170 proposals were received. Technical evaluation of proposals was followed by the successful negotiation of 30 contracts. These started in July 1988 and finished between July 1990 and February 1991.

There was close collaboration with ESPRIT (primarily on software development and user interfaces), with RACE (for telecommunications) and with COMETT (on the training contents and services).

Results

The results achieved by the 28 projects involved in the Exploratory Action were extremely encouraging. They included the specifications of prototypes and systems which are now close to the exploitation in the market. These include prototypes of highly interactive multimedia authoring systems, including advanced features from Artificial Intelligence, and hypermedia tools and tutoring systems using advanced modelling techniques. Specifications have also been agreed on distributed production systems enabling the use of pre-stored video sequences which are broadcast by satellite; computer conferencing systems able to handle graphics and telewriting for "electronic blackboard" distributed facilities, and videoconference systems enabling virtual classroom configurations.

All projects underwent a Technical audit in 1989 and 1990, and a final assessment of the results of the exploratory action has been made by a team of independent evaluators. It concludes that "the Exploratory Action was successful in stimulating incremental research and development in an area of central importance for the future of Europe. The programme has produced a number of significant results and even led to development of products or services that are at the point of immediate exploitation on the market. It has furthermore played a decisive role in focusing the future research and development effort in the area of learning technology on the most significant issues, and thereby fulfilled the central role of an Exploratory Action. Particularly, it has created a much greater awareness of the problems of the field, as borne out by the validation considerations of the assessors. A significant number of the original objectives and deliverables of the action have been met. Furthermore the action has been decisive in making possible a reasoned evaluation of the original aims of the action as set out in the Annex II of the Council Decision" (Final report on the DELTA exploratory action, May 1991.)

The Exploratory Action has clearly shown that there is a need, and a potential, for further research and development in the area, and that there is a significant European dimension of added-value in the development of learning technology. It has fulfilled its function of identifying the most promising areas for collaborative development work and by fostering a spirit of co-operation amongst the organisations involved in distance learning in Europe.

Reviews

A Strategic Review Board identified strategies and priorities for future work in March 1990.

The results of the exploratory action supported the extension and reinforcement of this area of EC R&D, with a shift of emphasis towards pilot experiments and development of technologies and systems suited to user needs. This extension has been implemented as an area of R&D in the Specific Programme of R&D on Telematic systems of General interest in the 3rd Framework Programme. The R&D will support the emergence of telematic services and infrastructures for flexible and distance learning and will promote the emergence of European training services. It will make possible the emergence of an Electronic University in Europe; a concept developed in the exploratory action.

Beyond the actions in the 3rd Framework Programme, there will be a need in the mid-1990s to reinforce the pan-European provision of specialised training services as part of an emerging European Nerve system, making use of the common telematic system infrastructures that will be put into operation. Training system issues will need to be addressed as part of a major focused action on pan-European telematic services.

The following reviews have been carried out :

- Final report on the DELTA exploratory action : May 1991.
- Progress report and mid-term review : SEC(89) 1989.
- DELTA '90 : R&D on information and communication-based learning technology : July 1990.

ADVANCED INFORMATICS IN MEDICINE (AIM)

Objectives

The objectives of the exploratory action were to advance health-care using information technology, to improve the quality, accessibility and flexibility of care, to increase the effectiveness of patient care, bringing about reductions in cost, to contribute to establishing minimum standards and common functional specifications, to contribute to agreed codes of practice, protection of privacy and reliability, to stimulate cooperation in the analysis of requirements and opportunities and to contribute to the common adaptation of the regulatory framework.

Background

Recent decades have seen a rapid rise in the use of new technologies in medicine and health care. However, new methods of health care are expensive and there are conflicts between the expectations of people and the service that can be widely provided. Telematic systems will be essential to improving the quality of health care, its cost/efficiency and its transparency.

The need for action at European level has been driven by demand from health-care professionals. The growing complexity and cost of medical diagnosis and treatment, the aging of the European population, new health and social problems related to the free circulation of people in the EC, have all made EC action a necessary complement to National initiatives.

Following a Planning Exercise in 1986, the Council adopted a Community Action in the field of Information Technology and Telecommunications applied to health care" AIM (Advanced Informatics in Medicine) on November 4th 1988. The exploratory action ran for 24 months from June 1988, with a Community contribution to cost-shared actions of ECU 20 million.

As a result of a Call for Proposals in late 1988, 42 R&D projects started in 1989. They involved some 250 independent partners. Half of them are Universities and Research Institutes, 25 % represent industry (information and communications industry, pharmaceutical industry and others) and 25 % represent hospitals, medical practitioners and other users.

A Technical Audit was carried out in February 1990 and all R&D projects were completed by the end of 1990.

Results

The projects covered the health-care domain in the broadest possible way, from pure medicine to administration. For example, the research addressed the distance-sharing of expertise and knowledge, home-care instruments and services linked to hospitals or to primary care, transmission of medical records and images, standards for inter-operability and compatibility, as well as legal and regulatory issues. In parallel, working groups and workshops dealt with data protection and confidentiality, telemedicine, and the use of data cards for healthcare.

The major achievement was the creation of a European "AIM" community, with a network of

contacts amongst over 3000 health-care professionals, industrial companies and service providers. This community of common interest has made major steps towards the definition of common goals and specifications for the use of telematics in health-care in Europe.

Three books were produced: Data Protection and Confidentiality in Health Informatics (IOS Press), Perspectives of Information Processing in Medical Applications (Springer-Verlag) and Advances in Medical Informatics (IOS Press).

Although prototypes and pilots were not an important requisite for this exploratory phase, some products came near commercialization such as: a workstation for cancer treatment monitoring, a pathology laboratory workstation, a bedside nursing system, a laboratory communication system, a functional model for chronic disease management, and software for ultrasonic bio-signal preprocessing.

Because of the exploratory nature of the programme, projects were selected with the broadest possible number of different user types. This, together with the very limited budget, led to a level of funding for each project that was not attractive to many large industries. It also became apparent that the health ministries of each member state had not yet defined clear strategies for use of telematic services. The exploratory action therefore also needed to serve as a learning exercise and as a stimulation to the development of clear strategies for implementation and financing of telematic systems.

Reviews

The AIM Exploratory Action has been evaluated by an independent team of assessors with experience in health-care and the use of information and communication technologies. The report of the evaluation has been communicated to Council and Parliament in July 1991. It concludes that the action succeeded in creating a sense of common purpose in European activities related to information and communications technologies applied to Medicine and Health Care. The Call for Proposals had an outstanding response, which highlighted both the needs of the sector actors and their willingness and ability to co-operate in collaborative pre-competitive and pre-normative R&D projects.

The work initiated under the AIM exploratory action is only the first, albeit essential, step towards improved communications and creating better tools for integration in Health Care in Europe. The next step will involve a substantial expansion of the work to consolidate the links which have been established between the health care community, research institutes, universities and industry.

A Strategic Audit has been completed, and has concluded that the objectives of AIM remain valid. The Auditors recommended a continuation and reinforcement of the efforts, with a shift of emphasis towards pilot experiments and development of technologies and systems suited to user needs. This extension has been implemented as an area of R&D in the Specific Programme of R&D on Telematic systems of General interest in the 3rd Framework Programme. The R&D will support the emergence of telematic services and infrastructures for health-care and will promote the emergence of pan-European health-care services.

The following reviews have been issued :

- Final report on AIM : SEC(91)1420 Final.
- Final technical report on the AIM Exploratory Action : November 1990.
- AIM '89/90 : R&D in medical and bio-informatics, October 1989.
- Progress report and mid-term review : SEC(89) 1989.

EUROPEAN TRANSPORT RESEARCH PROGRAMME (EURET)

Objectives

EURET is a three year programme which came into force with the adoption of the Council Decision published on 11 January 1991 (OJ N°L8). The objectives of the programme, split into the sub-programmes, are as follows:

- Optimisation of use of transport networks;
- Optimisation of logistics;
- Reduction of harmful external effects.

The sub-programmes include activities in the following areas: guided land transport, road transport, maritime transport and air transport.

Background

The realisation of the large internal market cannot be separated from a Community transport system capable of being adapted to the needs of the future and of responding to the increasing demand, both by volume and quality, which it will bring about in all areas of transport. This situation is characterised by two serious risks:

- Transport systems could hinder the economic transformation and development of the Community if they do not respond appropriately to market needs and the social environment;
- Transport industries will see their competitiveness compromised more and more if they do not offer products responding to needs and with a sizeable Community internal market.

A Community research programme is necessary for this reason. It should complement activities undertaken at national and European level.

In particular, it should create or stimulate research that the Member States cannot undertake for reasons of scale or which are carried out in a dispersed fashion without the efficiency which is required. On the other hand, the programme should facilitate the adoption of common standards in the case of international transport systems by coordinating certain research and by encouraging cooperative or collaborative activities.

The EURET programme responds to the need to give a European dimension to research activities that are traditionally marked by national boundaries. Several cost concerted actions have shown this clear need without, however, providing the overall conception and stimulus that a Community programme can.

The means of implementation of the research areas are divided between shared-cost actions and concerted actions.

Results

The Communication from the Commission to the Council proposing the EURET programme was published in the Official Journal of the European Communities (N° C318/5 of 20.12.1989). A call for expressions of interest was also published in the Official Journal (N° C146/6 of 15.06.1990). The aim of this call was to allow organisations intending to participate in the call for proposals to prepare their collaboration with partners from other countries.

600 expressions of interest were received covering the 11 areas of the programme.

Subsequently, 42 proposals were received in reply to a call for proposals (O.J. N°C9/9) of 15.01.1991) for a total sum of 138 MECU and requested Community contribution of 74 MECU.

9 contracts were signed in February 1992 for an overall total of 19.5 MECU bringing together 120 organisations representing industry, research centres, universities and SMEs. These 9 contracts cover all the shared-cost actions.

Organisations from all 12 Member States participate in the various consortia in the programme. Organisations from the member countries of EFTA are also present in the consortia.

INDUSTRIAL MANUFACTURING TECHNOLOGIES AND ADVANCED MATERIALS APPLICATIONS
BRITE/EURAM (Areas 1 to 4)

Objectives

Building on the achievements emerging in the first BRITE and EURAM programmes, BRITE/EURAM was launched in March 1989 with the following objectives :

- to help enhance the competitive position of community's manufacturing industries in world market
- to provide the industrial and materials technology required for strategies, innovative product and process development
- to encourage transfrontier collaboration within the Community and synergies among the different actors (Industry, University, Research Centres)
- to encourage transfer of technology between sectors and particularly to those sectors which a high predominance of SMEs.

The programme covers 5 technological areas, regrouped into two parts, but managed by different directorates :

Areas 1 to 4 dealing with multisectoral research covering the work on : Advanced materials technologies, design methodology and assurance for products and processes, application of manufacturing technologies, technologies of manufacturing processes.

Area 5 : Specific activities related to Aeronautics (see separate sheet).

Background

Manufacturing industry is and will remain an essential part of the Community's economy. It provides around 30% of GNP and accounts for 75% of the industrial workforce in Europe. This was recognized by the Commission when its R+D policy on strategic resources came to fruition (coal and steel, nuclear and alternative energies with 50 % self sufficiency) : the industrial fabric, its technical and human factors had to be kept at a productive, competitive level.

Increasingly the distinction between leading edge and mature industries is disappearing. The potential for increasing productivity and flexibility is greater in mature industries as is the incentive to employ new technology. For the future the dividing line will be between those who make full use of the available technology and those who do not, even within the same sector. Already this "dematuring" process is evident in established sectors such as motor vehicle or clothing.

The BRITE/EURAM programme has therefore been focused on in the development and adoption of new technologies, a crucial need for the continuity of the manufacturing sector. However, the challenge of diffusing new technology in the manufacturing processes is important not only for the machines sector at such, but extends largely beyond its sectoral limits since improved or advanced machines lead to cheaper, better products at all levels, a "snow-ball" effect on the economy as a whole, through enhanced European competitiveness and ability to exploit opportunities.

The three following key-areas of the manufacturing and innovation process were addressed to improve the Community's technological competitiveness :

- the development of new technologies, or new materials,
- their use in the production process and
- their implementation in products.

During the 1st phase (1985-1989) of the BRITE and EURAM Programmes, 306 projects were approved and funded following the 1985, 1986 and 1987 calls for proposals.

The BRITE/EURAM programme - 2nd Framework Programme (1989-1992) - has supported a further 386 new projects since 1985. Therefore a total of more than 670 projects have been launched, involving about 2000 researchers from industry and research centres - 55% industrial participants - including 22% SMEs-, 24% universities and 21% research centres. Organisations from all 12 Member States are participating with a significant number of partners from EFTA countries.

In addition to the Shared Cost Actions of approximately 425.0 MECU for areas 1 to 4, by the end of 1990, and 65.0 MECU for areas 5 (aeronautics) several concerted and coordinated actions have been conducted successfully i.e. CEAM (magnet), EMRS (European Materials Research Soc.) and SME oriented actions.

Results

Cost-share action under the BRITE and EURAM programmes has succeeded in the first place in establishing networks between the academic and industrial research organisations. Such consortia have proved to be viable and extended beyond the duration of Community support scheme in 70% of the projects. However the establishment of such structures has been heavy burden, especially for SMEs.

Consequently special measures were designed to involve more SMEs in order to harness their dynamism : publicity actions, feasibility awards allowed SMEs to increase their participation rate (in the more industry oriented projects) from 18% in 1985 to 31% in 1990.

The exploitation of the technical results of the project was one of the concerns of the independent evaluator in 1988. The 2nd programme launched actions to enable an increased programme relevance and a diffusion of results, more targeted to actual potential users. Greater involvement of industry at the definition of priority themes, emphasis on training, and coordination with parallel programmes (ESPRIT, BCR, SCIENCE, VALUE, MONITOR, ESA, EUREKA) was instituted. Detailed assessment of 200 terminated projects for the purpose of the exploitation of the resulting products (jointly with VALUE) revealed :

- the high commitment of organisations, leading to positive results for 70% of projects;
- the majority of participants expecting to reap commercial benefits within 3 years following project completion, with a trend towards a shortening of the return time;
- in 1990 37% of projects resulted in patent applications.
- impact indicators score high for cooperation efficiency, know-how acquisition and organisational learning. Two original indicators are used for monitoring exploitation of results : the potential of exploitation, or the capability of exploitation of the partnership.

A project concerned with laser-welding in the ship building industry (20-100 KW range laser-beam welders) provides an illustration of the market orientation of the Programme. Another successful achievement concerns the seeding of synthetic polymer with human epithelial cells. Artificial blood vessels tolerated by the human body have been produced representing a 20 MECU market and a social progress in health care. Recently (in early 1992), research teams supported by BRITE-EURAM announced a significant breakthrough in high temperature superconducting materials with improved mechanical properties.

The empirical estimate of the economic potential linked with the exploitation of BRITE-EURAM R+D results, gives encouraging hints of competitiveness (as shown in a recent consultants' report): adding up potential direct profit (on sales of improved or new products) and foreseeable indirect gain to society (i.e. economy in fuel consumption due to lighter cars, fewer catastrophic events due to more reliability, less pollution after waste treatment...) brings more than 10 ECU in return for each ECU invested in R+D. However, individual companies are far from achieving such a return and a separate study aimed at main contractors found a majority of them facing financial barriers and welcoming more public support to overcome partner choice and cooperation costs.

A statistical analysis of the factors determining the impact of the projects brought out two areas of activities : industrial technology and material technology. Industrial technology (dealing with production) has more impact on the short-term and on SMEs than material technology. It is also the area which is the most socially effective, leading to numerous improvements in working conditions.

Material technology, on the contrary has a much larger potential of multisectoral diffusion but represents a more long term prospect.

Reviews

Two recent reviews have been carried out by independent external experts

- BRITE Report No EUR 11782, 1988
- EURAM Report No EUR 11950, 1988

Advisory bodies (CAN, IRDAC) have been closely involved in the development of the Programme. Several studies have been contracted externally (Bossard, Yellow Window, Van Dijk) to assist programme management.

The generic approach taken by BRITE-EURAM is most efficient for the development of industrial technology. It is closer to the market and should be kept with a more exploitation oriented approach, involving different actors and more particularly end users. Diffusion material should be targeted towards potential users and sectors and should include a.o. codes of practice... Dissemination actions at regional and national levels should complement an enhancement of the mechanisms for transfer of technology at participant levels (marketing advice, search for partners, funding of prototypes).

Nevertheless the programme should continue to include material technology. This should consider the whole life cycle of products or processes, from raw materials to recycling. Diversity of approach and the consideration of both up-stream and down-stream developments should guarantee a reservoir of ideas on which to draw in order to build future competitiveness.

INDUSTRIAL MANUFACTURING TECHNOLOGIES AND ADVANCED MATERIALS APPLICATIONS
BRITE/EURAM (Area 5 - Aeronautics)

Objectives

A new technical area specifically dedicated to aeronautical technologies was introduced in the Brite-Euram Programme with a view to:

- encourage and support European cooperation in aeronautical research;
- encourage integration and coordination of the Community programme with the relevant national research activities;
- stimulate research in areas of public interest;
- give a wider range of institutions and businesses in all Member States the chance to participate in high-tech' research and cooperate with other organisations already experienced in the aeronautics field.

These activities were limited to a duration of 2 years, in the context of a pilot phase.

Background

Aeronautics is an area of major importance for Europe. This activity contributes up to 2% GDP and 1/2 millions highly skilled employees in several Member States. It supports the level of employment as well as the skill base and provides an overall trade surplus. European capabilities in this field, which have improved in the past 20 years, need to be secured through increased cooperation in research in order to share risks and to focus the advancement of a large range of technologies towards competitive aircraft improvement, in order to remain competitive on the world market. The European aeronautic industry must not be critically dependant on knowledge generated outside Europe.

The workprogramme defined by the Commission took into account several preliminary studies, more specifically one made by the Euromart group which includes most of the relevant European leaders.

The specific aeronautic activities of the Brite Euram Programme addressed 4 areas: aerodynamics; acoustics; airborne systems and equipment, and propulsion systems.

Results

The implementation of the programme has resulted in:

- the launching of 28 projects including the 3 main segments of the aeronautical industry together with academia and SMEs;
- increased attention paid to European cooperation in aeronautics, from industry and public authorities, as demonstrated by the huge success of the 1st Aeronautical days in April '91;
- improved dialogue between the Commission and the aeronautical industry at large.

Notwithstanding the nature and the short duration of such a pilot phase, the activity allowed substantial technical advances, which can lead to practical applications in economically relevant areas like laminar flow technology, systems, deicing etc.
Furthermore, the pilote phase futher more demonstrated that there are significant opportunities for future main Community activities in this field.

Reviews

An interim evaluation report was carried out by a panel of independent experts in June 1990, followed by a final report established in June 1991 (EUR 13524). The Commission expressed it own view on the interim report in the document SEC (91) 311.
Both the reports underlined the effectiveness of cooperation achieved so far and the relevance of the technical objectives pursued.

The interim and the final evaluations recommended that

- the Community should adopt a full programme of research and technology validation (RTA) in aeronautics, committing greater resources and taking account of the long term perspective needed in this particular field;
- improvements should be made in the definition of objectives and in the dissemination of results;
- an advisory body covering the whole spectrum of aeronautical interests should be established to assist the Commission.

The Commission decided to propose the continuation of the aeronautics research activities in the 3rd framework programme, over a period of 3 years, without precluding any further initiative in the 4th framework programme.

RAW MATERIALS AND RECYCLING

Objectives

This Programme was launched in November 1989 (Council Decision: 20.11.1989. J.O. n. L359/16 of 08.12.89); its purpose is three-fold. Firstly it is aimed at enhancing the competitiveness of the EC's industry involved with raw materials and recycling in world markets. Secondly it is aimed at helping to provide the technology base required for strategic, innovative development in support of the supply and processing of raw materials and recycling. And thirdly at encouraging transfrontier collaboration within the Community in strategic industrial research and transfer of technology between different sectors of raw materials and recycling industry and other industries. It has 4 main areas of research:

a. Primary Raw Materials
b. Recycling of non-ferrous metals and strategic metals
c. Renewable raw materials, forestry and wood products (FOREST)
d. Recycling of wastes (REWARD)

The Programme is implemented by means of share-cost research contracts; concerted actions; coordination activities; education and training activities; studies and assessments.

FOREST and REWARD are dealt with in separate sheets.

Background

The availability of primary and recycled raw materials is an important aspect of the European economy. This is not only due to the intrinsic value of the materials themselves but also because availability from within the Community best serves the needs of users in the manufacturing and process industries. In addition to security of supply and saving of costs for transformation of intermediate minerals and metallic materials, there can be closer matching of the materials characteristics and primary processing to the needs of the customers.

The availability of economic raw materials of the required quality has a major impact particularly on the competitiveness of mineral production and metal transformation industries. In the case of the mining and metallurgical industries which, as employers of some 350,000 people, extract minerals and transform them and others from secondary sources, there is a high sensitivity to market and currency fluctuations. In order to reinforce the bargaining power of European industry it is necessary to have a stronger presence in the mining and metallurgical industries. The programme aims at encouraging innovation which will improve the technical infrastructure within which the industry operates.

There is an average external dependance of some 75 % for minerals and metals, and 45 % for wood and wood products from outside the Community. Against this backcloth the Community must shepherd the available resources for technological improvement, balancing the effective exploitation of Europe's reserves of primary raw materials both minerals and renewables - against the conservation of the materials already extracted through recycling or recovery of waste.

The more effective the industry, the less sensitive it will be to these external forces and so more resistant to the challenge of international competitors. Using the most up to date technology is one of the key factors in improving effectiveness. A particular and major concern continues to be the supply of minerals to produce the metals used in the advanced technology industries.

The trend with wood-based products is for imports to have an increasing content of processes and finished material. With forests covering 22 % of the Community's surface and some 2 million people involved in the wood-related industry there are obvious advantages in improving the availability, quality and value of raw materials and the effectiveness of the forest industries. In addition to the direct benefits to the industry itself, efficient forestry makes an important contribution to soil protection and water management. The wood industries need those technologies which can improve their international competitiveness both in price and performance.

The importance of recycling has much in common with primary raw materials in aiming to minimise the effects of imports of processed and finished metals. At the same time recycling and waste treatment can reduce the disposal problem in the environment by reduction of metal containing residues and the total volume of the waste. The rate of recycling is an important factor in meeting the needs of material users. Too many valuable metals and materials are lost due to the lack of suitable technology. If a full recovery level was to be achieved, the recycling and recovery industries require considerable modernisation, through the development and implementation of more effective technologies.

Both recovery and recycling are associated with major environmental and social considerations. Through securing industrial competitiveness - conserving raw materials, energy saving, alleviating waste disposal problems - there will be the efficient means for true environmental and social benefits.

This programme was adopted in november 1989 ; selection of projects took place for Primary Raw Materials and Recycling of non ferrous metals in the period march - april 1990. For Primary Raw Materials and for Recycling of non ferrous metals the first contract was signed on october 1990 and the last one in december 1991. For a budget allocation of 45 Mecus for the 4 sub-programmes, a total of 90 projects were selected. These projects involve the participation of 365 organisations from all Member States except Luxembourg - of which 34 % are big and small industrial enterprises, 30 % research organisations and 36 % universities.

Results

The objectives of the programme, as specified in the Council Decision establishing the programme, have been met, with respect to the selected projects, in that :

- The research projects selected are all devoted to actions leading to an increase in the competitiveness of the industrial sectors of the mining and recycling industries, at a European but also at a world wide scale.

- All industrial sectors, particularly the strategic sectors of advanced technologies in exploration, mining, mineral processing and recycling are present as participants to the research projects. This participation (SME's + Industry = 34 % of total participants) together with a comparable participation of research centers and universities, clearly

demonstrates that the strenghtening of the scientific and technological basis of the European industry is the major objective of all research projects.

- The economic and social cohesion is fully respected as the whole range of industrial sectors from the european mining and recycling industries are represented in the programme, favouring the development of these industries in the whole community.

- Participation of SMEs is relatively important, with an average percentage of participants of e.g. PRM 27% and RNF 26%.

- The transnational cooperation is fulfilled as all member states, except Luxembourg, participate to the research projects.

In terms of impact on fields of science it must be stated that after more or less 6 months period of effective work for most projects and some contractors having received advanced payments only in january 1992 (more than 40 % for the domain Raw Materials and Recycling of non-ferrous metals) - which means no work done - it is difficult and certainly too early to make any valuable assessment.

Nevertheless, in relation with continuation of projects in the field of exploration, the programme has allowed to the development of new concepts to be applied worldwide for the location of strategic and precious metals. For example, in geophysics, important steps have been made in respect to interpretation of georadar data, opening new fields of application for this newly developed technique and reducing exploration costs; and in technology applied to mining, important progresses are being made in respect to miniaturisation of down-hole logging tools, enabling the collection of the number of data much larger than with other techniques.

In mining technology, important steps towards the development of computer aided mining systems is foreseen with special importance for safety in mine and profitability (selective exploitation and improved management techniques).

In mineral processing, the knowledge on the treatment of complex ores is considered to be improving significantly during the course of the programme through the development and application of new kind or reagents in the separation and upgrading of useful minerals. In fact some preliminary developments in new projects have helped in improving the recovery of valuable metals (Cu, Zn) by selective flotation (Almagrera plant (E), CNR (I), Aljustrel (P); 2 patents pending).

Reviews

Results of the most recent external evaluations of the Primary Raw Materials and Recycling of non-ferrous metals Programme are reported in the following documents :

- Primary Raw Materials : EUR 11952-1982-85 (1985 evaluation date)
- Primary and Secondary Raw Materials : EUR 12146-1986-89 (1989 evaluation date)

These evaluations recognised a high level of measurable success with projects leading to the development of industrial processes, and improving mineral exploitation. These conclusions were endorsed by IRDAC.

The evaluations and reviews by the programme committee also pointed out the following difficulties, problems and shortcomings :

- Lack of personnel to run two programmes in parallel Raw Materials and Recycling (1990 - 92) and Industrial and Materials Technologies (1991 - 94), plus possible new actions for central and Eastern Europe.
- Money spread too thinly on small projects.
- Even being a programme with industrial implication, there has not been much interaction with IRDAC.
- Lack of coordination with Member State activities in this field and a lack of a raw materials strategy at the Commission level.

On the basis of the analysis of these difficulties and shortcomings the following actions have been recommended :

- More effort should be devoted to create a sort of centralized information unit containing information on projects done throughout Europe (broader than the EC programme) and their results.
- More financial resources should be allocated to these activities, but efforts should be concentrated on fewer, larger projects.
- Increased staffing for the programmes.
- A deeper relationship should be set up with R & D policy bodies advising the Commission, by creating a specialized group of experts in Mining and related activities to help define a clear strategy.

RENEWABLE RAW MATERIALS, FORESTRY AND WOOD PRODUCTS
(Sub-programme FOREST)

Objectives

Conceived as a 3 year programme, FOREST was launched in August 1989 (Official Journal L359, dated 8.12.1989) with the following objectives:

- to increase the availability of forest resources and to provide better quality raw materials in keeping with economic and environmental requirements;

- to improve the international competitiveness of EC forest industries (in particular SMEs) and to facilitate the rational use of forest products in the EC.

Background

The FOREST programme covers the whole spectrum of activities within the forestry and wood industry sector in the Community. The Community's 39 million hectares of exploitable closed forest and 4.3 billion m^3 of growing stock are far from adequate to allow it to be self-sufficient in wood and wood products; in fact, net imports account for around half of consumption and represent about 110 million m^3 of round wood equivalent. Forests are widely distributed through all member states and because they often occur in economically disadvantaged and ecologically sensitive areas, have an importance in terms of well-being far greater than may indicate the bare figures of the value of wood produced. Forestry and forest industries have an important regional dimension. They are rural industries and therefore well placed to contribute to the improvement of the socio-economic conditions of these areas.

The Community R&D activities in the forest sector started in 1982, with the sub-programme **Wood as a renewable raw material**, part of the R&D Programme in the sector of Raw Materials 1982-1985. This first attempt was followed by the sub-programme **Wood, including cork, as a renewable raw material** included in the Research Action Programme on Materials 1986-1989.

Apart from the practical results achieved, these two programmes preceding FOREST acted as a catalyst for R&D activities at the national level in participating countries, and contributed to strengthening cooperation between research institutions, universities and industries at the national and international levels.

The FOREST programme represents a step forward in the EC efforts to improve through R&D the forestry and wood industry sector in the Community which may be called upon to play an increasingly important role in rural development, the rational use of resources and the protection of the environment.

The call for proposals for the FOREST programme was launched in August 1989. The 144 proposals received claimed a total budget of about 127 MECU and requested about 87 MECU form the Community and included 640 participating institutions.

As the total budget of the FOREST programme was only 12 MECU, a selection was undertaken which lead to 40 proposals being retained, some of them merged into joint projects. The total

budget is about 36 MECU and some 189 institutions are participating from industry, research and technical centres and universities.

Organisations from the 12 Member States are participating in the programme, together with institutions from Finland and Sweden as a result of the cooperation agreement between the EC and these countries for their participation as full members in the FOREST programme.

Results

At the time of this evaluation, work on the FOREST programme has barely begun (contracts signed in 1991) and therefore no results are available. The selected projects cover the priorities stated in the Council Decision, and the research themes relate principally to long-term strategies for R&D in the forestry and wood industries sector, and the contribution that the Community might add to them. The Programme is divided into three technical areas.

In the area of forest resources, the research projects are grouped around three main themes: tree improvement, forest protection and forest management. Based on the work carried out since 1982 an outstanding achievement in this area is the cooperation established between the research institutions from a broad spectrum of European countries in the field of forest genetics which has allowed the EC to maintain a forefront position in this research area of key interest for future developments.

In the area of Wood Technology, the research projects can be grouped into three broad themes. Firstly, there are those dealing with the relation between forest practices and wood quality which are highly relevant to the question of how to achieve better control of the quality of timber produced by fast growing trees. Secondly, projects on wood processing which are of special interest because each contains approaches involving innovatory or not yet introduced technology or techniques. The third research theme clusters projects dealing with the development of new products. Finally, in the Pulp and Paper sector the Programme tackles the two major factors affecting the development of this industry; the adequacy of raw material supply and environmental regulations.

The FOREST programme contributes to the European cohesion covering subject matters of primary interest for the development of the forestry sector in regions lagging behind research on cork-oak stands, upgrading of southern pines, Spruce stands, Eucalyptus breeding and processing.

The participation of private industry in the programme is higher than in previous actions but still insufficient. This is mainly due to the fact that the timber processing industry is characterised by operating through a large number of relatively small units, most of them without technical capacity to undertake research actions, and therefore, traditionally the research work has been carried out in technical institutes. The FOREST programme is acting in both directions: increasing the direct participation of private industry in the research projects and reinforcing the collaboration between the technical research centres and the European industry.

Reviews

The scope and objectives of the FOREST programme have been established after consultations with representatives of all interested parties in the Forestry sector. The Advisory Committee (CAN-Renewable Raw Materials) has provided significant advice on the preparation of the

programme and the selection of projects. In the different phases of the programme the recommendations of previous evaluations and opinions from several EC Committees in forestry and forest industries have been taken into account. The programme is implemented in close collaboration with the relevant industrial sectors and research organisations.

The coordination carried out in the FOREST programme has been reinforced with the implementation of projects in the framework of COST and the appointment of an Ad-hoc Technical Committee in Forestry and Forest Products.

With the adoption of the 3rd Framework Programme, research in the field of forestry has been incorporated into specific R&TD on Agriculture and Agro-industry.

Future research efforts in European forestry and wood products will need to be directed to long-term goals and emerging problems of forestry development in the EC. The forest in the Community has a variety of functions (soil protection, water supply and regulation, recreation, nature conservation) which, in addition to the traditional wood supply function, is one of high and increasing importance for the health and welfare of the population in the Community.

This social and economic role of the forestry has to be maintained and possibly enhanced in the future through appropriate policy direction and the alignment of research efforts with practical needs.

RECYCLING OF WASTE R&D (REWARD)

Objectives

The objectives of the programme are the following :

- to increase recycling and utilisation of industrial and urban waste,
- to minimise the adverse environmental impact of waste disposal,
- to conserve raw materials and energy from mixed waste streams.

Background

Recycling and utilisation of waste is of major importance in minimising environmental damage resulting from waste disposal or destruction and in the conservation of valuable materials and energy.

The R&D programme was initiated in 1979 for an initial phase of five years, followed by a second phase from 1986 to 1989 and finally REWARD 1989-1992.

The programme is managed jointly with Section 8 of STEP which covers waste research, emission abatement and clean technologies. Close collaboration is maintained with relevant parallel programmes including "Recycling of non-ferrous metals" and "Joule" (energy R&D) with respect to reducing the environmental impact of combustion and pyrolysis of waste fuels and biomass.

The research covers the main subjects :

sampling analyses and classification of wastes
recycling technologies for developing and promoting cost-effective recycling systems
fuel (energy) potential of wastes to improve the technology and process for production and use of fuels derived from wastes

During the period 1986-1989 the programme received a financial allocation of ECU 3 millions so of the 173 submissions only 21 could be accepted for support in the following items : plastics recycling (9 projects), organic wastes (4 projects), thermal treatment (5 projects), other projects (3).

REWARD (1989-1992) received ECU 6 millions so of the 95 submissions only 10 could be accepted for support in the following items : separation and recovery process and process optimisation (2 projects), upgrading and use of the reclaimed products (8 projects). REWARD involves 39 participants with at least one industrial partner per project.

It can be argued that a recycling R&D programme for the EEC of 3 years duration and at a cost so low is not viable. On the other hand there is considerable political and public pressure concerning the environmental impact of waste disposal and recycling is an important aspect of effective waste programme.

Results

Despite some difficulties, there is little doubt that over the years since its inception this programme has made a significant contribution to a better understanding of many of the problems in the recycling, reclamation and management of waste. Progress made has allowed for new R&D approaches and directions be followed.

Results can be grouped into the following categories : Plastics Recycling where degradability is a factor in plastic waste disposal. Whilst one can accept the viability of recycling single polymer wastes doubts were substantiated on mixed systems in particular regarding subsequent recycling. Use of waste plastics as fuel could be preferable but experience confirmed that waste burning in cement kilns should no longer be favoured because of the risks of producing contaminated and possibly unreliable cements. Pyrolysis or hydrolysis of waste plastics to produce chemicals or fuels has emerged as the best route for mixed wastes; Composting whose importance as technology was confirmed as part of integrated management and for cleaning up contaminated land; thermal processing where use of catalytically active bed materials proved to avoid failures or lack of exploitation of pyrolysis systems; in addition pyrolysis can now be considered a valuable technique for the future dealing with complex materials including mixed plastics, shredder wastes, distillation residues etc.; research projects are implemented into the recyclability of demolition of other waste, Phospho-alpha-hemihydrate (gypsum) and collection and sorting of used batteries.

A total of 52 national bodies (15 universities, 15 public/private research centres, 13 large enterprises and 9 SMEs) participated in the implementation of research on 21 types of products (e.g. wastes from mixed plastics, demolition works, thermoplastics...) testing 19 different procedures.

Pilot and demonstration work has been initiated in Sweden on the separation of plastics contaminated with cellulose.

A review of compost standards has been initiated and is performed now with O.R.C.A. (Organic Reclamation and Composting Association) in view of setting up standards for quality assurance criteria for compost. Similar approach is being followed for demolition waste.

Reviews

Progress of research work from 1986 to 1988 was evaluated in the primary and secondary Raw Materials evaluation report (Research Evaluation - Report N:38 - EUR 12.146) following a review by D.V. Jackson, Scientific Adviser for Reward (An Appraisal of the CEC Recycling and Utilisation of Waste (RUW) R&D Programme 1979-1988).

From the beginning of 1986 changes occurred in the management of the recycling programme. The only contact group that has continued to meet has been that devoted to compost thus reducing the scale of the concerted-type of actions. Also the COST 84 project on the use of lignocellulose-containing byproducts and other plant residues has continued as part of the project.

Commission proposal to combine management of the second programme with the appropriate sector of the environment R&D programme proved fruitful.

APPLIED METROLOGY AND CHEMICAL ANALYSES (BCR)

Objectives

The objectives of the programme are :

- to promote collaboration between laboratories of all Member States to eliminate causes of disagreements over the results of a particular test or measurement

- to provide the test laboratories with means of calibration to verify if their measurements are correct

- to develop testing methods recognized at Community level and which can be adopted in Community legislation or in the European Standards which are essential for the internal market.

Background

At the beginning of the eighties, while the European Community was developing the approximation of national legislations and the harmonisation of technical regulation in view of the future internal market, a new challenge was recognized at international level, namely that the laboratories in charge of verifying the quality of products and their conformity to regulations were not necessarily reliable. It was recommended that mechanisms be developed to ensure and verify the quality of the laboratories themselves (accreditation). Essential requirements were laid down in international standards, later transposed as CEN standards.

There are probably as many as 100 000 laboratories of all kinds in the Community making many millions of measurements per day.

When the results of several laboratories are in disagreement, considerable effort may be required to determine what was the accurate value. It is therefore understandable that the laboratories would not embark upon such a quest unless there is driving force behind them.

This was the role of the BCR programme which was conceived in order to provide a service to industry, to testing laboratories, to official laboratories (food control, agriculture, environment) and to the services of the Commission. This service consisted of:

- establishing collaboration between laboratories of all Member States where disputes arose out of discrepancies in test results ; such collaboration should lead to improving methods of measurement and thereby eliminating sources of errors and discrepancy

- establishing means of calibration (reference materials) which should make it possible for any motivated laboratory to verify if its testing procedure is correct

- improving existing or developing new testing methods which could be adopted at Community level in Directives (e.g. on Agriculture) or in European standards (CEN/CENELEC) (prenormative research).

The programme was organized to provide a service at any time for essential Community issues. One of the recent example was a request of DG VI for immediate action in a dispute between the Community and the USA over the tolerable lead content in wines. Within a few weeks all major official laboratories in the Member States will participate in a preliminary collaborative exercise before being compared with American laboratories.

The basic principle followed to maximize harmonisation is to open the projects to laboratories of all Member States. For matters of public concern (food, environment), the Commission encourages official laboratories to participate together with expert laboratories from universities or industry.

The measurement projects which are supported are related to four broad sectors : agriculture and food, environment, health, industrial products.

Results

Since 1980, the BCR programme has supported about 500 collaborative projects involving about 800 organisations or 2000 researchers.

Projects were continued until satisfactory results and agreement were achieved. Projects originated from requests submitted by other Commission services or from laboratories in the Member States who had observed serious discrepancies in their results and were not able to resolve them alone.

A number of methods developed in the programme have been introduced into Council Directives or into international Standards.

The programme also issued 300 certified reference materials, samples of which are sold all over the world (80 % in the Community, 20 % outside : USA, Japan, Australia, Switzerland, etc). This activity is second only to that of the National Institute for Standards and Technology (NIST) in Washington. About 8000 samples are sold per year to some 2800 laboratories. The BCR reference materials related to environment analyses are used by more than 900 laboratories in Europe.

Finally collaborative work organized by the BCR programme has led to mutual recognition agreements in particular in the field of metrology.

Reviews

Previous reviews (Evaluation of the Community Bureau of Reference, Report No EUR 11358, 1988) have shown the essential importance of the wide collaboration engendered by the BCR programme as a means of cross fertilisation, know-how transfer, technical improvement, and the development of mutual appreciation between laboratories which had previously not met.

It was also recommended that publicity should be intensified to promote the sales of reference materials. However the Commission is now confronted with selling rates which are too high. This should be solved by giving responsibility to laboratories in the Member States to reproduce reference materials before they become exhausted. Previous attempts to do this were, however, not very successful.

One of the reviews pointed out that the programme had developed a high level of competence recognized worldwide.

A review made in 1990 (Evaluation of BCR programme by independent experts, 1990) considered that the BCR programme was essential for European harmonization and for trade with third countries. It indicated that only the Commission could carry out this task because of its neutrality. It recommended that the programme be amplified along the same spirit and with adequate means.

However it must be pointed out that the type of service provided by the BCR programme requires considerable staff but limited research expenditure. Hence the programme has high staff costs in relation to the total budget. This is in line with the Council Decision of 1988 but appeared less acceptable to the Member States during the discussions of the following programme Measurements and Testing.

BIOTECHNOLOGY
(BAP and BRIDGE)

Objectives

The objectives of the Biotechnology Action Programme (BAP, Council decision of 12 March 1985) and BRIDGE (Council decision of 27 November 1989) were:

- the establishment of a supportive infrastructure for biotechnology research in Europe
- the elimination, through research and training, of bottlenecks resulting from gaps in basic knowledge or from structural and scale constraints, which prevent the exploitation by industry and agriculture of the materials and methods originating from modern biology
- the monitoring and analysis of developments in biotechnology and the promotion of the necessary concertation between Community and Member States in matters affecting such developments.

Background

Ten years ago, the European Commission came forward with an initiative, the Biomolecular Engineering Programme (BEP), which was quite a novelty when public support to biotechnology R&D was not even organised in most Member States.

The preparation and launching, in 1982, of this programme were carried through by the Biology Directorate of DG XII after intensive studies and consultations during the period 1976–81. During 1980–83, the FAST programme established a broadly based assessment of needs for the optimum development of biotechnology in Europe.

In 1985, the Biotechnology Action Programme (BAP) was launched, as a follow-up of BEP, and was continued in 1990 by BRIDGE. Both BAP and BRIDGE established a supportive infrastructure for data banks and culture collections and organised cooperative research for the elimination of bottlenecks which prevent exploitation by agriculture and industry of genetic, enzymatic and cellular engineering. New elements, risk assessment and protein design, were introduced in BRIDGE.

There is a major need to improve Europe's competitiveness by maintaining a sound basic biological knowledge upon which either normative activities or commercial technologies can be developed by the actors themselves in their regulatory and economic environments. European firms need a portfolio of products and these should be chosen in such a way that they are best supplied from Europe. The Community effort should explore options, not available by traditional routes, such as those giving researchers access to genes and pathways never before available. Quality of the product in the supply chain is also of prime importance in meeting consumer demand, as is compatibility with preserving the environment. In this respect, biotechnology must be seen as a source of alternative processes rather than a justification for existing ones. This will be achieved, in part, through an expansion of the goals of the present BRIDGE programme, and through the inclusion of new priority areas likely to promote an understanding of the properties of living matter.

Results

The reviews and evaluations (see next heading) to which the programmes were submitted:

- underlined the quality and the density of the work carried out which rendered possible the characterisation of more than a hundred important genes in cultivated plants, industrial microorganisms and animal cells, the identification of their products and the domestication of many enzymes for the production of substance with high added value. Significant contributions were made for the assessment of risks associated to genetic engineering.

- revealed the utility of the structures (European Laboratories Without Walls : ELWWs) which the Commission created for fostering transnational cooperation around key problems for the Community. One hundred and twenty ELWWs were conceived as research fora to optimise and regulate cooperation on a specific problem, or for a common target, between laboratories having accepted to share methods, materials, staff and results during the time of programme execution. They cover a wide diversity of subjects ranging from the fermentation of fruit juices to the automation of DNA sequencing, the molecular biology of the soft rot disease or genes active in the lactose-fermentation pathway. For instance, it was through ELWWs organised in networks that, for the first time in the world, an entire chromosome was sequenced (chromosome 3 of yeast) or that MINE (Microbial Information Network for Europe) was established. In all cases, training was closely associated to research and the first decentralised network for Community training in biotechnology was organised with the Carlsberg Laboratory for the improvement of plant seed.

- calculated the interest of transnationality. The benefits of close collaboration were demonstrated in a bibliometric study which examined the transnationality and scientific impact of published results. Papers supported by the CEC were shown to be more multinational in their authorship than other papers and more highly cited than single nation papers by 75%. Further analysis by General Technology System and PREST suggested that "CEC papers" were not only being cited more than other biotechnology papers but that the citations were occurring earlier.

- showed industrial interest. Although there have been more than 120 expressions of industrial interest, only few firms have actually participated directly in BAP as contractors. One of the obstacles was related to the limited amount of funds allocated per project. In view of the small size of contracts, potential private partners found the application process too slow and cumbersome. The research activities seen as too scattered in BAP were modified in the targeted projects of BRIDGE to overcome scale and structural constraints. In addition, special efforts to associate industries to the activities of the ELWWs proved to be successful (for an independent evaluation, see Biofutur 1989).

- demonstrated the usefulness of the tasks implemented in the programme for the concertation of biotechnology in Europe. Examples of achievements in the concertation action are numerous (information of the public, dialogue with national policies, launching of EBIS : European Biotechnology Information Service).

Reviews

Biotechnology R&D at Community level started slowly with an initial budget of 8 MECU in 1982 (adoption of BEP), to reach 75 MECU in BAP and 100 MECU and BRIDGE.

These programmes, implemented with the help of advisory committees meeting twice a year, gave rise to contractual agreements with 250 laboratories in BAP and 570 in BRIDGE and to a wide spectrum of concertation activities.

An independent evaluation of the results obtained in BEP and in BAP was carried out in 1988 (Report EUR 11833) and, for BAP only, by nine leading experts in 1990 (see catalogue of BAP achievements, Elsevier, 1990). The evaluators stressed the enthusiasm of Commission staff and the intensity of their work and the success of the way they manage transnational consortia.

A review of the programmes shows that their content expanded together with a regular adaptation of the strategies followed for their implementation. This evolution can be summarised as follows:

- It shifted from research on methods (immobilisation and transfer techniques, control of regeneration ...) to research on processes and pathways (on biological models, in situ, or with organisms important for man) and toward large collective ventures with industrial partners (sequencing, risk assessment, gene mapping ...) which no Member State could carry out alone.

- The disproportion between demand for participation and funding possibilities was such that selection pressure at the time of evaluating proposals was always high. Such severity, coupled to the efficiency of the peer review system adopted for the assessment of projects, led to a partnership of very high quality.

- These evolved progressively towards the coherent integration of initially dispersed work. The ELWWs proved their efficiency for the promotion of transnational cooperation in basic research; the multi-partite projects of BRIDGE, specially created for the transfer of technology to European industries, are now on their rails and appear to be successful. Each involves a team of contractors, a monitoring unit responsible for the proper implementation of the project and, in practically all instances, a platform of industries created by enterprises interested by the project. Larger targeted projects, centred around new technologies essential for the Community, are being prepared.

EUROPEAN COLLABORATIVE LINKAGE OF AGRICULTURE AND INDUSTRY THROUGH RESEARCH (ECLAIR)

Objectives

Conceived as a five year programme, ECLAIR was launched in 1988 with the objective to promote in Europe the useful application of recent developments in the life sciences and biotechnology thorough :

- research, adaptation and development of agricultural products destined for industrial use, as well as the research and promotion of new industrial techniques for processing and transforming agricultural raw materials with a view to obtaining, under viable economic conditions, industrial products which meet the needs of the market;

- research and development of industrial inputs in agriculture, such as pesticides and fertilizers, and of eradication and disease control systems less harmful or better adapted to the environment; the reduction and elimination of by-products of processing by recovering resources and reducing waste.

Background

The agro-industrial complex involves a number of components - farmers and cooperatives, input industries and processing industries - which are dependent on each other but for which the links have to be fostered. This complex is evolving rapidly and the change is such that emphasis is shifting from quantity to quality, and from a supply driven system to a market or user driven system.

The approach of ECLAIR is to provide an environment in which the agro-industrial complex and research participants can benefit from sharing R&D resources, risks and costs. The Commission encourages the cooperation process through a set of actions where the agro-industries take a leading role. Since its start, the ECLAIR programme has coupled basic research work to work suitable for short term exploitation, and within the precompetitive stage, projects with a clear market potential are encouraged.

The total budget of the ECLAIR programme is of 80 million ecu. The actions undertaken involve a substantial agro-industrial participation.

Organizations from 11 Member States are participating in the Programme. Besides national and private research institutes and universities, the main industries concerned by the programme are:

- the primary sector (Agriculture, Horticulture, Forestry)

- the input industries (seeds, machinery, chemicals, fertilizers, feed) including world leaders and numerous SMEs, and

- the processing industries (wood, paper, sugar and starch industries etc.) including also the leading food and chemical companies.

Results

A major initial outcome is that ECLAIR has succeeded in eliciting proposals, with commitments to co-finance from industry and agriculture, for development projects on a scale commensurate with the Community resources proposed. The 220 proposals submitted included 1410 participants as follows : agricultural enterprises : 4.1%, cooperatives :4.1%, industry : 26.8%, public research institutes : 26.5%, private research institutes : 7.1%, education other than universities : 1.6%, universities : 25.7%, other : 3.7%.

The selection of the proposals received has led to 46 selected proposals, some of which were merged into joint projects, resulting in a final total of 42 research projects. The total budget is 130 million ecu, with an EC contribution of 63 million.

It is too early to quantify results as the Programme is only approximately 50% completed; however, the projects complement and support the many new industrial applications increasingly available in the agro-industrial sector. Results to date include the testing and modification of agriculturally useful species and the promotion of the use of biotechnology and genetic technologies in agriculture. Novel products, e.g. bioplastics, are being developed.

Reviews

The ECLAIR programme has been designed in close consultation of all interested parties in the agro-industrial sector. Besides consultation of IRDAC, CODEST, and CREST, in the preparation of the Commission's proposal the following consultations were carried out :

- call for expression of interest after which 856 replies have been analyzed, classified and formed the base for the technical annex of the ECLAIR programme;
- 15 organizations representative of agricultural and industrial interests among which CEFIC, COPA-COGECA, CIAA, EFPIA and GIFAP;
- the Advisory Committee for Biotechnology (BAP and BEP); and
- the Standing Committee on Agricultural Research.

A first interim review of the ECLAIR Programme is currently in progress. A relative weakness of participation by Germany has been noted, as well as a poor link with other national or international programmes. Other comments concern the high level of industrial involvement and private financing achieved and the strong link to other Community research programmes and to the Common Agricultural Policy.

The agro-industrial sector is of great economic importance for the Community. The goal is to is to provide the science and technology necessary for the maintenance and creation of competitive and efficient bio-based food and non-food industries.

Cooperative research and development is a formula which has now established its effectiveness, and should be retained. Basic research, instrumental in providing the underlying expertise needed to create future breakthroughs, must continue.

It will not be possible for Europe to promote equally all areas. In the light of the CAP reform, research in primary production needs to concentrate on economic activities for rural and coastal development, the greater use of new technologies and the development of new sources for chemicals and materials. In respect to inputs to primary production, research should focus on reducing production costs and improve the quality and diversity of the output. To maintain European competitiveness, the processing and utilization of the products from primary production must be improved. Quality of food and non-food products, ability to process raw material of variable quality (bioenergy and timber) and further non-food uses of agricultural products are some of the research goals.

In addition to the broadly based agro-industrial programme, emphasis needs to be put on a few ambitious, structured, target-oriented projects centred on topics which are of particular promise to the European agro-industrial competitive prospects.

FOOD LINKED AGRO-INDUSTRIAL RESEARCH (FLAIR)

Objectives

The FLAIR programme, which runs from 1989 to 1993, has the following objectives :

- to promote food industry efficiency and competitiveness
- to improve food safety and quality for the consumer
- to reinforce the scientific and technical infrastructure serving the European food industry.

The call for proposals was published on 29 June 1989, following a Council Decision of 20 June 1989.

Background

The food industry is a significant industry in Europe, employing some 2.2 million people. It is a major user of agricultural raw materials - especially in countries where agricultural production is a significant part of the economy, and is also an important employer in these countries. Food processing covers processing of a broad range of raw materials - milk, meat, grains, vegetables, fruits. From a consumer standpoint, food is the largest single item of household expenditure. Consumers are now more selective and critical of safety, quality, convenience and nutritional aspects of food.

FLAIR concentrates on the processing-distribution-consumer end of the food chain and aims to encourage research in :

- food quality,
- food hygiene, safety and toxicology
- nutrition and wholesomeness.

The budget is 25 MECU and principal means of support are by shared-cost projects and concerted actions, as well as supporting measures (training grants, workshops, studies).

Results

Following the call for proposals 57 applications for concerted actions (508 participants) and 106 shared-cost proposals (635 participants) were received.

FLAIR is comprised of 22 shared-cost projects (123 participants) and 11 concerted actions (391 participants), spread across the three key areas of food safety, food quality and nutrition.

Projects range from basic science underpinning new technologies (eg. : microwave, heating, sensors, new drying technologies, endogenous enzymes and flavour deterioration) to safety and consumer issues (eg. safety of cheeses from raw milk, transgenic food crops, poultry meat safety, food allergies), to nutritional projects (vitamin intake, resistant starch, functional fibre).

FLAIR is a new programme and as such many valuable scientific networks have been established throughout food science and industry, particularly by concerted actions. Shared-cost, and more especially concerted actions ensure that infrastructures of the food industry are reinforced. New networks of scientists from universities, research institutes, industry, consumers are now in place projects and these will have long term beneficial effects.

It is difficult at this stage to quantify results from the programme as the projects are only now approaching their midway stage. All projects are active and working well and results are now forthcoming.

In the field of science in which FLAIR operates, the programme should have a significant impact. Some of the projects are very novel and no other coordinated European groups are working on these areas eg. sensory analysis, food lectins, micro-nutrient bio-availability, transgenic food crops.

A number of projects within FLAIR are directly related to the development of European standards (pre-normative research in collaboration with BCR) eg. quality standards for virgin oil, quality determination of fruit juice, establishment of a compatible European system of high quality date on food consumption and food composition.

One of the concerted action, FLAIR-FLOW, is totally devoted to dissemination of results from FLAIR to the food industry (SMEs) and consumers. This has established dissemination networks in every Member State and 4 non EC states and already there is a very high level of interest in this means of dissemination.

Universities, consumer groups, public and private research institutes are well represented in the programme. Large food companies are participating in a reasonable number of projects but increased participation from food SMEs in the future would be desirable. Concerted actions in particular are providing very useful forums for research coordination and some valuable networks are now in place from these. Cooperation with other programmes, eg. BCR, VALUE, COST is important in many of the projects.

Reviews

FLAIR has been designed in close consultation with the CAN-EF which provided advice on the implementation of the programme and the selection of projects.

On scientific content of the programme advice was also sought from IRDAC, CREST, SCAR. A preliminary study on the structural and social effects of the FLAIR programme has recently been commissioned but to date no independent review of FLAIR has been carried out.

For the future, increased industrial participation would be desirable, especially from food SMEs who are very numerous, specialised in particular products but more concerned with immediate R&D needs (eg. product development). Participants come from all Member States but German participation is rather modest and should be encouraged in future.

Cooperation in research between the larger food multi-nationals on such areas as basic food science, quality measurement and nutrition via EC R&D projects, as well as increased interface with other industrial technologies (eg. information technologies) should also be considered in future.

Further work on the basic science and chemistry of food and especially of emerging technologies will be required.

COMPETITIVENESS OF AGRICULTURE AND MANAGEMENT OF AGRICULTURAL RESOURCES (CAMAR)

Objectives

The research actions are to contribute solutions to problems which relate to the common agricultural policy and rural development.

The programme was launched in March 1990 for a 5 year period with the following objectives:

- To help farmers to adapt to the new situation created by overproduction and a restrictive policy on prices and markets;
- To maintain the incomes from holdings and encourage structural reform whilst controlling output and reducing production costs;
- To care for and improve the agricultural situation, in line with the market situation, in all regions with weak agricultural structure and which have been slow to develop, thus promoting greater economic and social cohesion in the Community;
- To conserve natural resources and the countryside, ensuring that an improved environment will result from the application of the technologies to be developed and from changes in production systems;
- To develop agricultural information services and infrastructures to improve the dissemination of research results within and between Member States.

Background

Agriculture and rural development are enormously important for the Community. Over the years the common agricultural policy has benefitted from agricultural research, technological development and demonstration. At this time with the reform of the common agricultural policy, and a changing international scene, there are even more prospects for research to be directed to certain priorities.

The problems are well known. Some production is in surplus, output is tending to rise and the cost of support is seen by many as excessive. A control of production and a shift of price nearer to the world market will mean much adjustment. There are evident difficulties for continuing rural development and signs of serious abandonment of land and desertification in the most difficult regions. Agriculture and rural development are in need of care and attention and Community research must be environment friendly and aim for:

- Extensification
- Lower production costs
- Quality improvement
- Non-food production.

There has been coordination of Community agricultural research in the Directorate General for Agriculture since 1975 and many brochures and publications promote the promising results. Over the years with training and mobility grants, scientists in the Community have been drawn closer together and there is no doubt a healthy transnational cooperation is growing. The successes, and a few shortcomings of the Community agricultural research programmes, up to and including 1988, were assessed by an independent evaluation panel. These programmes were all well received by the agricultural research community and the recommendations to expand such work were clearly presented in the evaluation. Indeed lack of funds and uncertain timing had been the major problems.

Results

Agricultural shared cost research contracts will use 75% of the budget of 55 MECU. The work progresses well following selection of submissions received after a "call for proposals" in October 1989. The list of projects supported from the selection which, in three waves, was completed in late 1991, is a good blend in the key sectors of the programme:

1. Conversion, diversification, including extensification of production, reduction of costs and protection of the rural environment.

2. Product quality, new uses for traditional products, and aspects of plant and animal health.

3. Socio-economic aspects and specific actions for regions lagging behind in development.

4. Methods and services to disseminate agricultural research information particularly from this programme.

A large number of proposals were received and the successful, on the basis of the first reports, are progressing well. Over 80 major projects were supported but many proposers were disappointed that only about 1 in 10 resulted in contracts. Shortage of funds means that a number of very good scientific plans could not be included. Certainly many will apply again and are encouraged to do so.

Conferences, training and mobility of scientists and technicians, are being organised by the Commission in a number of key areas close to the preoccupations of the common agricultural policy and rural development.

The programme interacts with other Community research programmes such as those on agro-industrial (ECLAIR and FLAIR) biotechnology and the environment.

Reviews

The Community Agricultural Research Programmes since 1975 have tackled essentially applied problems. In solving these there is a need for multidisciplinary and basic research. Increasingly this must be the approach for the future so that the Community funds available are directed more specifically to solving problems facing the common agricultural policy and rural development as the next century fixes on the horizon.

DECOMMISSIONING OF NUCLEAR INSTALLATIONS

Objectives

Under the provisions of the EAEC Treaty the Commission is conducting, since 1979, successive five-year R&D programmes on nuclear decommissioning (Council Decisions 79/344/Euratom, 84/60/Euratom and 89/234/Euratom). The main objective of these programmes are:

- to improve the scientific and technological basis for the safety and health protection aspects related to nuclear decommissioning;
- to make scientific knowledge and practical technical experience decommissioning available to interested parties in all Member States;
- to ensure that cost-effective techniques for the decommissioning are being developed.

Background

Many of Europe's first experimental reactors, nuclear power plants and fuel cycle facilities built in the fifties and sixties are not longer in operation. At present, 37 of the 150 nuclear power plants in the EC and 53 experimental reactors are more than 20 years old. About a third of these reactors were already operating 30 years ago.
The Community, aware of the need to ultimately decommission the disused facilities, launched a first cost-sharing R&D programme in 1979 which carried out a series of evaluations and identified priority approaches and research areas. Due to this early start, the programme has been able to keep abreast of the rapidly increasing R&D requirements in the field of nuclear decommissioning. The rising need for research is reflected in the programme's 5-year budgets: 1979-1983: 4.7 MECU, 1984-1988: 12.1 MECU, 1989-1993: 33.8 MECU.
The general trend in the nature of R&D activities has undergone a gradual evolution from the initial scoping studies and laboratory-scale experiments of the first programme (1979-1983) to the extensive range of assessment studies, technological development and large-scale practical testing and demonstration in pilot projects, which characterize the third programme (1989-1993).
Among the general and conceptual issues, to which the R&D activities contribute are

- as the dominant radionuclide in disused, defuelled reactors (Co-60, half-life 5.28 a) decays at a significant rate, the optimum duration and conditions for the safe storage of closed down reactors must be investigated;

- most of the dismantled components and debris or scrap from demolished structures of a nuclear power plant are not radioactive or contain only minute traces of contamination. Such materials can be released from regulatory control if accurate and reliable measurement techniques can assure that the activity of the released material is below regulatory limits.
  The justification of such limits and the development of appropriate assaying techniques is among the priority actions of the programme.

  the minimization of occupational exposure to radiation being an overriding objective, technologies for the effective decontamination of structures and components prior to handling are being developed. For the dismantling of activated core structures remotely

controlled dismantling tools are necessary to avoid worker exposure.

Since 1979, 207 research contracts with national and private research establishments, universities and industrial R&D laboratories were concluded. During the earlier programme, these projects were mostly carried out by individual contractors, whereas a majority of the contracts awarded after the latest call for proposals (1991) are held by multi-national associates, a large number of which are SMEs. Organizations from eight EC countries actively participate in the programme. The largest projects in the present programme are the four pilot dismantling projects in which new techniques developed in the R&D actions are tested and demonstrated under authentic industrial conditions: reactors BR-3 (Mol), WAGR (Windscale), KRB-A (Gundremmingen) and the pilot reprocessing plant AT-1 (La Hague).

Results

The results of the second R&D programme (1984-1988) have in general provided the basis for the larger technological projects of the current third programme (1989-1993); for the latter however, only a few provisional results are available at this early stage.

- In the field 'technical and strategic assessments' a special project collecting specific data on occupational doses, costs, waste arisings and working times has been set up to provide a data base for future radiological and economical assessments.

- The techniques for decontamination, release measurement and melting of metal scraps developed under the second programme are presently being applied in large-scale tests. The successful dismantling of the KRB-Obrigheim turbine and equipment during the preceding programme resulted in the recovery of 98 % of the 4000 tons of scrap and debris for recycle. This record performance has lead to wide-spread application of the decontamination, sentencing and melting techniques, e.g. at the G2/G3 reactor site in Marcoule, where 700 tons of steel piping are currently being melted.

- The remote handling techniques developed by 1989 have been applied successfully to the dismantling of the reprocessing equipment in the hot cells of the AT-1 pilot plant in La Hague and the WAGR reactor internals. The remote underwater segmentation of the massive BR-3 thermal shield, completed at the end of 1991, is also a pioneering performance which proved the feasibility of cutting up the heavily activated reactor pressure vessels by mechanical cutting.

- The cutting of large metallic components by shaped linear explosive charges demonstrated in La Hague and Marcoule reduces the doses to the dismantling workers considerably in comparison with the conventional segmenting techniques.

The technology developed under the present programme will enable decommissioning operators to carry out (IAEA) Stage 1 and Stage 2 decommissioning without exceeding the new low dose limits (20 mSv/gr.). The means and feasibility of Phase 3, in particular the dismantling of large reactor pressure vessels, remain to be demonstrated in a future 4th programme.

Reviews

A first evaluation of the programme covering the period 1979-1985 was concluded in 1986 by a panel of independent high-level experts (Evaluation of the Community's Research Programme on Decommissioning of Nuclear Facilities - Research Evaluation Report N° 26e, DG XII, July 1986). The general conclusions of the report drawn up by this group were:

- "The research programme conducted under the heading: 'Decommissioning of Nuclear Installations' makes up a well structured, technically sound and highly practice-related programme with broad industrial participation. It is Community-wide the leading and trendsetting programme in this field, addressing all important questions relating to the feasibility and safety of decommissioning, and comprising a great number of research topics which are considered as priority topics at national level too."

More recently, a mid-term review of the current third programme (1989-1993) was carried out by the programme management (Draft Communication from the Commission to the European Parliament, the Council and the Economic and Social Committee, CGC6/91-20 revised): the conformity of the programme with the objectives set by the Council decision was examined and the adequacy of the programme for the present requirements was investigated. This review concluded that, although the start of certain activities was delayed by contractual procedures and funding problems, the available results showed a steady progress on all relevant issues. The main shortcoming of the programme was that, the industry had not taken sufficient advantage of the opportunities to gain practical decommissioning experience by seconding staff to the Community pilot dismantling projects under the co-funding scheme specifically introduced for this purpose.

The Management and Coordination Advisory Committee (CGC-6) supported the results of the review in the following terms:

- "The Committee considers that the programme has been carried out so far in a very satisfactory manner and in agreement with the Council Decision; judging by the state of advancement reached at the end of 1991, it is convinced that the main objectives of the 1989-1993 programme will be attained during the following two years, bearing in mind that the implementation of decommissioning policies and the pursuit of pilot dismantling projects require a continuation of R&D efforts beyond 1993.

  The Committee stresses the importance of producing representative data on costs, operational exposure and waste arisings as well as of recording the specific difficulties encountered in decommissioning operations. It recommends that the Commission maintains a special effort on these issues.

  The Committee agrees with the findings of the review report (CGC6/91-20) and endorses its conclusions".

The essential reason for a Community R&D action on decommissioning of nuclear installations is that, as 10 out of 12 Member States will in the foreseeable future have to deal with some disaffected nuclear installations, a Community-wide co-operation in the development of the appropriate strategy and technology is of considerable mutual benefit. The main advantages are:

- the establishment of safe decommissioning practices based on a common approach to radiation protection issues;

- the enhanced cost effectiveness of developing advanced technology, e.g. remote handling equipment on a European basis;
- the provision of practical experience and knowledge to decommissioning operators in all EC countries, in particular data on costs, occupational exposure and waste arisings collected in special databases and accessible to those European bodies which have to plan and organize decommissioning actions.

As the results of the present research cannot satisfy all the future R&D requirements presently identified or anticipated, the programme should be extended in time and expanded in scope:

- to allow testing and demonstration of advanced methods resulting from current studies;
- to provide solutions to new problems arising in the course of the later stages of dismantling and to adjust decommissioning practices to the available waste management system;
- to enlarge the scope of R&D activities to the restoration of disused mining, milling and fuel processing sites;
- to make full use of the results of the current programme by extensive collection and analysis of radiological, technical and economic data with a view to establish a European expert system.

MANAGEMENT AND STORAGE OF RADIOACTIVE WASTE

Objectives

The programme, which is the fourth of consecutive five year programmes, is composed of two parts :

Part A : Waste management and associated R&D actions

Part B : Construction and/or operation of underground facilities open to Community joint activities

It has the following objectives :

- to contribute to the demonstration and to bring to maturity a complete system for radioactive waste management, which ensures the safety of the population and the protection of the environment during all the handling phases, and in particular during the final disposal phase. International cooperation is in particular promoted in the projects under Part B.

- to be a framework for exchange of information and reflections between the different researchers in the Community, permitting, among other things, the search for a european consensus on common approaches and to harmonize practices if needed.

- to promote the scientific and technological co-operation between Member States, a source of efficiency and economy in time and money.

Priority is given to ensuring the safety of the population and the protection of the environment.

Background

"Even if nuclear power programmes were to be cut back or even abandoned, or if decision were taken to stop using radioactive isotopes for medical treatment and in industrial facilities, countries still have the residue of radioactive waste. Therefore society must solve the problem of radioactive waste management now and for the future. That is not a matter of opinion but a matter of fact, which applies to people all over the world, including the European Community" (Foreword of the Evaluation Report).

Nuclear energy provides a substantial proportion (approx. 33%) of the electricity production in the European Community throughout which exists a policy of diversification of energy sources. The generation of radioactive waste is an inevitable consequence of this policy and it has been acknowledged that the Community as a whole has, therefore, a responsibility for ensuring that any problems associated with the waste are solved.

Only disposal of low and medium level short lived waste has been practised up to now, long lived waste and high level waste (vitrified waste resulting from reprocessing of spent nuclear fuel of those fuels themselves if not reprocessed) are stored awaiting the development of disposal

options. The ongoing works in the Member States, to a large extent integrated in the Community programme (thus avoiding duplications and sharing costly results and difficulties), show that the deep geological disposal concept is feasible and safe in its various options (saliferous, argillaceous, crystalline formation, etc.) if the site is well chosen and if the design and the construction of the underground repository are based on sound practises. It is thus advisable to develop and to verify the concept in a concrete manner, namely by means of the experimental facilities which take profit of the different geological formations available in the Community.

Treatment and conditioning of radioactive waste have been practised for a number of years for most of the wastes; it is however advisable to complement the range of available processes in the Community and to benefit from the technological progress in general, in order to further reduce radioactive releases in the environment, releases which do not recognise borders.

The current Shared-Cost Action programme follows three earlier programmes and benefits from experience gained over a long period. The two later programmes differ substantially from their predecessors in that they contain activities related to underground facilities (part B). Each successive programme has taken into account and built upon the results and progress achieved in the preceding programmes.

The launching of specific coordinated research projects within the programme has promoted the co-operation between various teams within the Member States. In the previous (third) programme some 70 bodies within the Community were involved, 43% national bodies and research centres, 36% private industries, 21% universities and institutes.

Results

The current on-going programme has been running for a relatively short time with many of the projects only starting up in the last six months. Therefore it would seem to be appropriate to also insert in this review the main results of the previous programme, the successive programmes constituting actually a single continuous effort to master the problem. These included results of basic research as well as results of a more applied nature and solutions proposed for practical problems including technical development and feasibility studies. Most of them were worked out in the frame of projects, many of which involved supranational collaboration. They concern mainly improvements in reducing waste volume and radioactivity, waste package behaviour in repository conditions, feasibility and safety of deep geological disposal in salt, granite and clay the highlights of which are summarized hereafter.

With regard to waste treatment and conditioning, the application of advanced processes for the treatment of liquid waste, namely those arising at nuclear power plants and reprocessing plants, should enable the reduction by several tenths of the release of radioactive effluents into rivers or seas. Volume reduction factors up to five seem also feasible for waste concentrates.

With respect to the behaviour of conditioned waste, studies on the retention of radionuclides in the embedding matrices have shown that long lived radionuclides remain immobilized in cementised waste for several hundred years, even after mechanical degradation of the cement. The results of a testing campaign with 15 international laboratories participating in the examination of the reaction of waste glass with surrounding repository materials and leachants show close agreement of measured data and a wide consensus on corrosion and release models.

Concerning research on the feasibility of deep repositories, works performed on deep rock formations enable the understanding and prediction of their behaviour and show that adapted excavations are needed : drilling of large diameter holes in granite, excavation and backfilling of large caverns in salt and excavation and support, at reasonable costs, of representative galleries in plastic clay. The underground test drift realised at Mol (Belgium) at 220 m depth was the first of its kind in the world.

In the context of looking at safety of deep disposal the MIRAGE (Migration of Radionuclides through the Geosphere) project has provided valuable experimental data on the migration of radionuclides through the geosphere. In parallel, scientists from different Member States who have worked together during the last two programmes in the Community project PAGIS (Performance Assessment of Geological Isolation Systems) have shown that, during thousands of years no radioactivity would escape from underground repositories for vitrified high level waste if these installations are well designed and the sites well chosen. This conclusion, drawn on the basis of existing technology and scientific knowledge in Europe, confirms those obtained previously outside the Community on different bases, namely in Sweden and Switzerland.

Finally, in the framework of a study on waste management practices and policies, a certain number of areas have been identified, in which a common approach and/or harmonization should be developed.

Reviews

The exchange of fresh scientific information on the progress and results of the work carried out in the framework of the programme was assured at the operational level by periodical progress meetings of working groups, for the various tasks and projects.

The results of the research contracts are published in final reports and frequently presented at international seminars and conferences. The Commission itself organizes or cosponsors several of them.
The overall results of the programm, the third of its kind, was presented to the worldwide scientific community, at the third European Conference on Radioactive Waste Management held in September 1990 in Luxembourg.

Exchange of information with non EC-countries has been assured by means of co-operative agreements.

The third (1985-89) programme was evaluated by a panel of independent experts in accordance with the Community research and development activities. In the summary conclusions, the panel judged that the programme 1985-1989 is a logical and fruitful follow-up of previous Community activities in the field of radioactive waste R&D. Those activities resulted in a significant increase in scientific and technical knowledge which will contribute to future decision-making.

The panel also noted that the programme created an appropriate European context where most of the problems relevant for waste management have been dealt with in common. It supported the extension of the Community programme, stressing that the nature of the research involved requires an effort spread over long periods of time, including in situ research, inter-comparisons, reviews and public information. This programme should have spin-off in other sectors. The panel stressed the importance of maintaining the expertise in the teams engaged in the programme and the consequent need for continuity of funding.

Public acceptance is a major component in managing radioactive waste because it conditions the political decision-making process. When the panel addressed this problem it came to the conclusion that there was very little research as such that was worth carrying out in this field. However it concluded that the CEC could play a responsible role by publishing clear, easy to read, factually accurate, status reports on major aspects of waste management technology. In setting up such a task, it should not forget that scientists and technical staff are not normally the best spokesmen in this context.

REMOTE HANDLING IN HAZARDOUS OR DISORDERED NUCLEAR ENVIRONMENTS (TELEMAN)

Objectives

The overall objectives of the programme are improvements in the safety and profitability of man and plant in the nuclear power industry through the development of advanced robotic teleoperators. Cooperation at the European level reinforces the scientific and technical base necessary for such developments.

This development responds to the needs of the nuclear industry, from mining through plant operation to decommissioning. It covers nuclear power plants, fuel reprocessing plants and fusion machines. Benefits appear across the range from routine inspection, monitoring and maintenance to repair, replacement and accident management, where the environment may be highly hazardous and unpredictable.

Background

The R+D policy of the European Community started as far back as 1967 and focussed mainly on basic resources (steel and coal, nuclear energy). The safe operation of nuclear power plants, decommissioning and more lately fusion, all require remote handling. The industrial robotisation and space industries have led to major progress in remote handling technology. The concern for managing major nuclear accidents (Three Mile Island, Chernobyl) has been an extra incentive for integrating into a single programme the knowledge in this technology now available and relevant experience and needs of nuclear plant operators and operators. One must keep in mind that as high as 30% of electricity is generated from nuclear power stations in Europe (peaking to 70% in France).

TELEMAN is aimed at helping the nuclear industry to comply with the requirements that workers will be exposed to the minimum practicable amount of radiation, without compromising inspections, maintenance and repair operations. Also the increased quality of such operations must reduce the probabilities of failures and accident situations and indeed lead to the large cost-benefits brought about by plant life extension.

TELEMAN is a "User led" programme to ensure the usefulness of research projects. A Users Group has been formed to advise the Commission on all aspects of the programme, from planning of projects, functional specifications of Calls for Proposals to testing and evaluations of the projects.

The main areas of the research programme are :

- Teleoperator component and sub-system development
- Environmental tolerance, including radiation resistance
- Research machine projects to demonstrate the integration of the above
- Product evaluation and studies

The first 2 areas were the subject of the first Call for Proposals (September 1989) and the last 2 are covered by the second Call for Proposals which had a deadline of 14 February 1992.

Results

In response to the first call 41 proposals were received, with a total requested Community funding 3 times the available funding of about 8 MECU.

By carrying out a highly detailed analysis of each recommended proposal in cooperation with the external evaluators, the TELEMAN management was able to negotiate reductions in the EC funding required for the 16 contracts from 13.3 MECU to 8.1 MECU (40% reduction) while at the same time improving the focus of the research on all the key technical areas identified by the TELEMAN Users Group, thus maximising the value for money of the contracts.

The involvement of the Users Group which is a unique characteristic of the programme, is not only highly praised by the "Comité de Gestion et Coordination" (CGC), but does make the management and monitoring more realistic and highly efficient (the contract selection process was considered highly rigorous and professional, and a model for wider applications by the Commission in the future).

16 multi-partner shared cost research contracts were started in the winter of 1990/91 as a result of the 1st Call for Proposals. These range from one-year feasibility studies to four-year coordination projects, with all of the key technologies for TELEMAN covered : dexterity, mobility, observation, control, communication, and environmental tolerance. The projects are aimed at developing modular components and sub-systems which can go towards providing the functions and capabilities required of teleoperated robotics systems for the nuclear industry.

The projects have now been running on average for about 1 year and are for the most part now in the research and prototype phases, while some of the shorter duration projects are nearing the testing phase. Within the limits of the available budget, it has in some cases been possible to fund research into alternative solutions to problems such as sensor-based control, or principles of locomotion for cluttered and obstructed environments. These alternatives have gone forward to compete with other, independently funded, solutions in submissions to the 2nd Call for Proposals as building blocks for integration into demonstration research machines for on-site nuclear industry user testing.

This second Call is now just finished and indications are that a good response has been achieved with far more good proposals than can be supported (by about a factor of 4).

A good level of participation from SMEs and Universities has been achieved. Percentages for the first and second calls for proposals, respectively, are 33% and 32% for large industry, 35% and 22% for research centres, 15% and 21% for SMEs and 17% and 24% for universities etc.

20% of 1st Call contractors are completely new to CEC R&D programmes.

A TELEMAN Open Day was held in Brussels in October 1991 at the time of the launch of the 2nd Call for Proposals. It was judged very successful and achieved all objectives, a major one being a cost efficient way of bringing together at the same time as many experts as possible interested in TELEMAN. Very favourable comments have been received, including from User Group members.

Reviews

TELEMAN is producing good collaboration with many institutes gaining confidence in each other's activities. It shows what can be achieved with limited funding.

Cooperation with other R&D programmes of EC (ESPRIT, Brite, Decommissioning, JRC) and with R&D national/international bodies (Eureka, ESA, CERN, ...) is producing a successful networking effect.

De facto standardisation around TELEMAN projects, due to generic type of "building blocks" is required in the terms of reference of the 1st Call for Proposals. This is encouraging the beneficial move towards standard interfaces.

This programme meets clearly the needs in the field as proved by the large response to the Calls for Proposals and stated by the CGC-5T (Opinions of CGC-5T meetings, April 1990 and July 1991). The TELEMAN Users Group also expressed an opinion on 25 October 1991. Both emphasised that adequate funding should be ensured in the 2nd phase of the programme for adequate exploitation of results from phase 1, but this has not been completely possible.

A follow-on programme and budget (1994 onwards) with comprehensive demonstration projects, would allow full and proper exploitation of good results now being produced and to build on the collaboration and real enthusiasm now apparent in relevant European organisations.

Interesting prospects for the exploitation of the results of TELEMAN, or for the extension of its research can be found in two areas. It will continue to contribute to the reduction in the total radiation dose to man and improve the quality of working conditions and job satisfaction of nuclear workers. It will also produce better inspection, maintenance and repair procedures so improving quality in these areas. This will, in association with the prospect of more replacement of significant plant items, will lead to existing plant life extension. Consequences of this can be substantial cost savings as well as a reduction in the need for new plants.

In hazardous and disordered non-nuclear incidents e.g. fires, chemical plants, underwater, earthquakes, ...) where the environment may have changed unpredictably, advanced remote handling equipment, as a spin-off of TELEMAN, can contribute significantly to safety in the area (for instance the nuclear intervention teams being set up in France and Germany could be utilised in the event of such severe non-nuclear accidents).

CONTROLLED THERMONUCLEAR FUSION

Objectives

The long-term objective of the Community Fusion Programme, embracing all activities undertaken in the Member States (+ Sweden and Switzerland) in the field of controlled thermonuclear fusion by magnetic confinement, is to open a new way of power generation, having potentially a moderate impact on the environment and using a practically inexhaustible fuel. The Programme is designed to lead in due course to the joint construction of reactor prototypes with a view to their industrial production and marketing. A step by step strategy towards the prototype commercial reactor has been envisaged, including after JET[1], an experimental reactor (the Next Step). The main objectives for the period 1987 to March 1992 were the following (Council Decision 88/448/Euratom):

- to establish the physics and technology basis necessary for the detailed design of the Next Step; in the field of physics and plasma engineering, this implies the full exploitation of JET and of several specialized Tokamaks in existence or in construction, and in the field of technology the strengthening of the fusion technology programme,
- to embark on the detailed design of the Next Step before the end of the programme period (March 1992), if the necessary database exists at that time,
- to explore the reactor potential of some alternative lines, akin to the Tokamak.

Background

The ultimate aim of all 4 large world Fusion Programmes (European Community, Japan, ex USSR, USA), which is the creation of prototype power reactors, has a time-horizon measured in decades. Unlike fission, self-sustained fusion reactions require very large devices with the result that experimental fusion machines are not much different in size from full scale power reactors. Steps forward are costly and separated by long time intervals; maintaining the necessary continuity requires therefore special care, in particular regarding the management of scientific staff, the transfer of experience and skills, and the involvement of industry.

Integration of all european magnetic fusion research into one Community Programme has been essential for optimum use of the available human and financial resources. Individually, none of the Member States would have had the resources for a project of the size of JET and would be recognized as an equal partner in a world-wide collaboration on a Mega-project such as ITER(1). On the contrary, the Community Fusion Programme occupies a vanguard position in fusion research; early concentration on toroidal magnetic configurations was undoubtedly, also a reason of the Community's success.

The European Fusion Programme is implemented principally through contracts of association with organizations in the Member States (and Sweden and Switzerland), the JET Joint Undertaking, the NET[1] and ITER[1] Agreements covering the Next Step activities, and in industry. In addition,

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[1] JET:Joint European Torus
NET:Next European Torus, the European version of the Next Step
ITER:International Thermonuclear Experimental Reactor, the international version of the Next Step

the Community's Joint Research Centre (JRC) conducts research on specific aspects of fusion technology. The annual overall European expenditure on Fusion has settled since the late 1980s at about 450 MioECU. At the present rates of support (25 % for general expenditure, 45 % for priority actions, 75% on average for Next Step design, 80 % for JET, 100 % for the JRC) the Community finances about 45 % of the overall expenditure in the Programme, the balance being found from national means. In terms of man-years, about 1750 professionals work directly for the Programme. A high mobility of scientists within the tight network of the Fusion Programme's laboratories contributes to the cohesion of the Programme, allowing the smaller Associations (or researchers from the 3 countries having no Association) to access large facilities and to participate to state-of-the-art research. Each year, between 15 and 20 % of the professionals work for a substantial period of time outside their home laboratories. The decentralized structure of the management, with less than 1% of the total staffing steering the Programme from Brussels, is recognized as efficient.

The scientific, managerial and financial expertise acquired within the Programme in long term international scientific collaboration represents a unique know-how vis-à-vis the other ITER partners, supporting the Community's strong position in ITER. The sustained commitment of the Community to a clearly defined long term objective is an essential element in the strength of the Fusion Programme and makes the Community a recognized reliable partner for international collaboration in this domain.

Results

Tokamaks. JET, the world's most performing Tokamak, has provided outstanding contributions to progress in Tokamak Physics. By using a mixture of deuterium and tritium, the appropriate fuel for a reactor, the fusion power in JET has reached the Megawatt level for the first time ever in a magnetic fusion device. At present, the main parameters of the Next Step can be confidently chosen, enabling the ITER-Engineering Design Activities (EDA) to start. Nevertheless, plasma purity has been found more difficult to control than anticipated, and a reliable solution to this problem needs to be validated, in particular in JET and in ASDEX-U, before finalizing the design of the relevant ITER subsystems.

The Conceptual Design Activities (CDA) of ITER were carried out in 1988-90 jointly by four Parties -the European Atomic Energy Community, Japan, USSR and the USA. The results of the CDA have been accepted as a basis for the forthcoming EDA, a proposal to conclude the Agreement of which was transmitted to Council in January 1992. The NET Team has been the focus of the European participation in ITER and has also managed the execution, by the Associations, the JRC and industry, of the programme of Technology R&D aimed at the Next Step. The Community made a leading contribution to the ITER-CDA and is presently in a position to do so for the forthcoming ITER-EDA: for example the Community has obtained to provide the ITER-Director and to host that part of the quadripartite team in charge of designing the core of the device (In-Vessel Components).

Together with JET, the specialized Tokamaks (TORE-SUPRA, ASDEX, FT, TEXTOR, COMPASS, TCA and RTP) have contributed to establish the basis for the design of the Next Step and have investigated fusion relevant Physics and Technology. Considerable progress has been achieved regarding the performance and the reliability of the various systems required to operate Tokamaks, such as magnets, power supplies, additional heating and non-inductive current drive, plasma fuelling and exhaust, plasma control, diagnostics and data handling. New Tokamaks (ASDEX-U, FTU, TCV, ISTTOK) have been built and are starting to produce data. The

Community possesses the only Fusion Programme which has a coherent set of up-to-date devices and technical facilities that are expected to provide a major part of the data in support of the ITER-EDA, thus enabling the Community to influence strongly the design.

Alternative lines in magnetic confinement. W VII-AS has provided proof of the feasibility of the modular Stellarator concept; on this basis the engineering design of an advanced superconducting Stellarator (W VII-X) is under way. TJ-II is being constructed to study different Stellarator configurations. RFX, the largest Reversed Field Pinch in the world, was commissioned in 1991 and is starting studies on plasma confinement and plasma purity at high current; the smaller Pinch EXTRAP-T2, near completion, will investigate methods for plasma control.

Safety and Environment. The Research Programme on safety and environmental aspects of fusion has been mostly in support of the Next Step design: quantification of radio-activity sources, analysis of accident sequences, waste produced and path ways for the dispersion of tritium and activation products. An International Energy Agency (IEA) implementing agreement in this field is under preparation (see below).

International Collaboration. Besides the ITER activities, undertaken under the auspices of the International Atomic Energy Agency, multilateral cooperation is conducted under seven implementing agreements within the OECD-IEA. A bilateral collaboration agreement, similar to those already existing with Canada (which was formally involved in the Community contribution to ITER) and the United States, was signed with Japan in 1989.

In summary, the objectives of the 1988 - March 1992 programme have been reached, and the Community is in good position to play an outstanding role in the engineering design of the Next Step which is ready to start, within the frame of the quadripartite ITER collaboration, subject to formal approval by the Parties.

Reviews

By Council Decision of 16 December 1980, a Consultative Committee for the Fusion Programme (CCFP) was set up with the task of, inter alia, watching over the ongoing activities of the Programme and evaluating the results obtained. The CCFP has recently assessed the Conceptual Design of ITER { Ref: CCFP 47/6.1, June 1991 }.

A Fusion Programme Evaluation Board was set up by the Commission to conduct an independent evaluation of the programme {Research evaluation report No.45, EUR 13104, 1990, Luxembourg}.

A Study on Thermonuclear Fusion was performed by STOA (Scientific and Technological Options Assessment of the European Parliament) {Report PE 153 635, July 1991, Luxembourg}.

The Court of Auditors has undertaken a Special Study on the scientific and administrative management of JET, annexed to its report on the 1990 Accounts of the JET Joint Undertaking {to be published in the O.J., February 92}.

From these various assessments, the following recommendations have emerged:

- The Community should retain fusion as high priority in its R&D strategies.
- A stepwise strategy towards the prototype reactor should include, after JET, an

experimental reactor (Next Step).

- The Associations will remain important, but the balance of their activities should change in the context of the evolution of the Programme. The links Associations-Universities should be strengthened.
- The programme of JET should include a new phase devoted to plasma purity control, before full power tritium operation in 1995/96.
- The Community should express its full commitment to the ITER initiative but should preserve its capability to proceed with NET, if the collaboration fails. All efforts should therefore be made to reach a convergence between the detailed technical objectives of ITER and of NET.
- The Community should begin procedures to identify suitable European sites for the construction of the Next Step.
- A broadening of the scope of the ITER collaboration should be sought, in particular regarding a powerful neutron source for materials testing.
- Environment and safety must assume high priority in the Fusion Programme.
- Research on decommissioning of fusion plants should become an element of the Programme.
- A watching brief on other approaches to fusion should be maintained.
- Organization and management of the Programme will need changes to cope with the construction of the Next Step and a larger involvement of industry.
- Global expenditure in the frame of the Community Fusion Programme does not need substantial increase above the current level (450 Mio ECU in 1990 money), until start of construction of the Next Step device after 1996.
- A further Evaluation Board should report before a firm decision on the construction of the Next Step.

NON-NUCLEAR ENERGIES
(JOULE)

Objectives

The objectives of the programme are to contribute to:

- increasing the long-term security of energy supply and reducing energy imports, through the diversification of sources and better efficiency of energy use, thus providing a technical support for the achievement of the energy objectives defined for 1995 by the Community;

- improving EC industrial competitiveness through a) a reduction in energy cost and b) the development of energy technologies;

- alleviating environmental problems related to energy conversion and use;

- establishing the large internal market of 1992 in the energy sector, inter alia through research leading to norms and standards;

- solving technical problems in energy supply and use in developing countries.

Background

The programme contains four subprogrammes: Models for energy and environment; Rational use of energy; Energy from fossil sources; Renewable energy and geothermal energy.

Within the Community, gross energy consumption is likely to increase by 1 % during the decade 1990-2000. Moreover, the Community still imports about 44 % of its primary energy (31 % of its oil, 7 % of its natural gas and 6 % of its coal) and several countries of the Community remain dependent on short-term energy imports. Security of supply must be achieved through an efficient and diversified energy system characterized by the importance of the investments (about 70 billion ECU per year for the EC).

The competitiveness of Community industry may be stimulated and improved by developing advanced energy technologies. Community industry must be capable of responding to the needs arising from energy innovation if the Community is to avoid becoming dependent upon imported technologies as well as on imported sources of energy, should there be another rise in oil prices. It must be ready to capture a substantial share of the markets for advanced energy technology products within the Community, in other industrialized countries and in developing countries.

It is also becoming increasingly important to integrate environmental aspects in energy strategy. Environmental constraints, especially reduction of air pollution, affect energy costs and the competitive position of the various energy sources. The balanced pursuit of environmental and energy objectives is therefore of particular importance.

The programme ensures continuity of the efforts undertaken since 1975 and guarantees that optimum benefit will be gained from the results acquired and progress made in energy technologies up to now. There is still substantial scope for energy conservation. New and renewable energy sources are only just starting to make a useful contribution to the Community's

energy demand. Improvement is still needed in the clean use of fossil fuels in order to reduce pollutant emission significantly at a reasonable cost. The Community industries working on energy technologies need to be encouraged by innovation and the development and use of these technologies. The matching of requirements to resources in the developing countries calls for the availability of suitable technological facilities. The JOULE programme also includes the elaboration and application of energy and environment models for the Community. Finally, it helps to the establishment of consistent norms and standards of performance and quality for the large internal market of 1992.

Up to now, 249 projects have been launched representing a total amount of 232 MECU and a Community contribution of 128 MECU, involving about 700 organisations from industry (including SMEs), research centres and universities.

Difficulties in planning the financial commitments for the programme were encountered near the end of the programme's life as a result of the European Parliament adding a significant sum (40 MECU) to the programme budget.

Results

The *models for energy and environment sub-programme* has realised a large study relative to the evaluation of the "CO_2 emission reduction strategies for Europe". A European network of economists and engineers has been established for such a study. The results have been largely used by the Commission for the preparation of its communication to the Council and the discussions within the Member States.

Another major study covers the design and elaboration of an accounting framework for the external costs of fuel cycles with the US.DOE.

The *rational use of energy sub-programme* is characterized by "subsidiarity" which is brought about by collaborative R&D in projects and by bringing together industrial and national programmes. It has pioneered and initiated new technologies (e.g. fuel cells and Li batteries).

EC combustion research brought about collaboration between 50 laboratories including the major part of the European car industry. This research lead to the development of diagnostic equipment to study in situ pollution formation and of a computer simulation model which is presently used by European car manufactureres for the design of clean and energy efficient petrol and Diesel engines. A new advanced Li polymer battery was developed which has the promise to be cheap and give electrical vehicles a range of 300 to 400 km on one charge.

The sub-programme played a major role in the European development of highly efficient and clean fuel cells for power production, cogeneration and road traction and triggered a strong interest in fuel cells in Europe. R&D energy savings in buildings and industry made much progress in the fields such as heat exchangers, separation methods, process intensification, heat pumps and passive solar energy.

Energy from fossil sources research is carried out under two complementary headings: Hydrocarbons and Solid Fuels. Competent multipartner teams have been established in both areas and the practical work of the programme is actively underway. In the Solid Fuels area the programme is strongly directed towards reduction of emissions from coal utilization.

As intermediate achievements, progress has been made in better understanding coal characteristics and their relation to combustion behaviour, in improving the aerodynamics of powder coal burners to reduce NO_x formation and in the development of materials for coals combustion systems. A pilot plant for the microbial desulphurization of coal will start operation in June 1992, and an 8 MWt pilot pressurized circulating fluidized bed combustion plant has been designed and is presently being built.

In the hydrocarbons area, a vigorous R&D effort has been established to develop improved and advanced technologies for improving energy supply and for reducing environmental impact (e.g. research into geoscience, heavy oil and gas conversion and diesel particulates).

The *renewable energy sub-programme* has achieved important progress in the renewable energy technologies through the creation of large European networks of research centres, universities and industry, particularly SMEs.

In the field of solar photovoltaic important production cost reductions have been achieved; research in wind energy has been focused on research in the MW-sized large turbines, on the exploration of alternative sites and on the contribution to the development of European standards; the biomass sub-programme was developed of energy-industry technologies which can have an important impact on the CAP.

The *geothermal energy sub-programme* has drilled the first well and installed seismic network at the European Hot Dry Rock experiment, site at Soultz. The work on corrosion and scaling has progressed and the mechanisms have been elucidated. The deep geology programme has started with a seismic study of the lower crust in the Baltic Sea.

Reviews

Models for energy and environment have been realised in close collaboration with the General Directorates of the Commission, associated with the CO_2 Communication to the Council (DG II, III, XI, XVII and Cellule de Prospective) and with the European network of national teams in charge of the model applications. The results have been assessed and discussed in the framework of the interservices group of the Commission. They have also been reviewed during workshops, organised by international institutions (IEA, IIASA). They were reported in scientific publications or newspapers. The limits of the study which have been identified have formed the basis of the definition of the new programme.

The European and U.S. experts involved in the project participate in regular meetings, held for the definition of harmonised methodologies. The Commission services which will be involved in the application of such a framework in the future, participate in the meetings, to ensure that such a research will answer the questions to be taken into consideration in the definition of policies.

Rational use of energy evaluation of progress is carried out by experts and in contractors meetings. In a number of fields market studies have been carried out.

Energy from fossil sources-projects are monitored by external experts under contract.
The first results of the hydrocarbons studies were presented at the European Oil and Gas Conference, organized in Sicily by the Commission in 1990.

Renewable energies research has been subject since 1975, to three evaluations, which have generally underscored the importance and positive results of the renewable energy programme.

Routine evaluation of the research contracts is implicitly carried out in the programme at three different levels (external experts, contractors meetings, international conferences).

The *Geothermal energy sub-programme* has been constantly followed by internationally recognised experts who advise the Commission services.

SCIENCE AND TECHNOLOGY FOR DEVELOPMENT (STD)

Objectives

The primary aim of the programme is to strengthen the endogenous research capacities in developing countries in order to build up and develop the indispensable basis for the generation of knowledge and technology. This objective should be achieved in relation to the specific conditions or environments of tropical countries, in areas of priority interest for these countries, and those associated to the transfer and adaptation of technology developed in the Member States.

Background

STD is a specific programme of cooperation in the field of scientific research and technological development between the EC Member States and developing countries regardless of whether or not they are party to economic cooperation agreements with the EC. It is concerned with two areas of vital importance to Third World countries, namely agriculture (including forestry and fisheries) and medicine, health and nutrition, taking into account the environmental aspects (preservation and regeneration) linked to these areas.

STD's objectives are attained essentially through the funding and implementation of joint research projects of relevance to the socio-economic problems of developing countries and compatible with their strategies for solving them. Projects must contain genuine collaboration between research institutions in the EC and those in developing countries with a real and complementary involvement of all partners in the conception, execution and management of each integrated project.

This is a different strategy from the ones followed traditionally by international funding agencies for tropical research in general. For the EC Member States it also represents the possibility to significantly strengthen the scientific and technological cooperation in tropical science, increase its own human capital with competence on tropical problems, intensify the links and coordination between the different research structures in Member States and between these and institutions in developing countries. Also, an understanding of the tropical world could be important in finding solutions for certain problems which occur in Community countries as well as for problems of global importance. The tropical world has resources and biological models which are vital to the development of modern agriculture (genetics, microbiology, animal and plant physiology), has essential natural resources which need to be preserved for environmental reasons and as far as public health is concerned, certain important diseases are common to tropical and temperate countries.

The first STD programme was implemented between 1983-1986 with a budget of 40 MECU; it was adopted by the Council in 1982, in recognition of both the importance of research and, in particular, of the role of scientific cooperation in the development process. Moreover, the Council recognized the need to reactivate the EC Member States' traditional but declining competence in the areas of tropical agriculture and health. The second phase of this programme (STD2) started at the end of 1987 (Council Decision 87/590/EEC of 14.12.1987, OJ L 355 of 17.12.1987 p. 41) and ran until the end of 1991 with an initial budget of 80 MECU (55 MECU for the subprogramme "Tropical and Subtropical Agriculture" and 25 MECU for the subprogramme "Medicine, Health and Nutrition in Tropical and Subtropical Areas". This budget was

supplemented with an additional 5 MECU through an amendment to the budget of 1991 adopted by the European Parliament.

Results

A call for proposals was announced on 16.12.1987 (OJ C 337 16.12.87 p. 3) and remained open for two years until 31.12.1989, allowing the continuous submission of proposals. For evaluation and selection purposes this call was divided into five tranches. The total number of proposals received and evaluated was 1872 (1154 for tropical agriculture and 718 for tropical health). A total of 339 projects were selected (180 for tropical agriculture and 159 for tropical health). Thus, the selection rate for STD2 was about 18%.

An important mobilization of research institutes both from Member States and developing countries took place under STD2. The analysis of the programme implementation confirms the development of an intra-European collaboration with a significant participation of those institutes not traditionally involved in tropical agriculture and medicine, the reinforcement of N-S relations and the emergence of a regional and/or transnational approach to certain problems on the part of several developing country teams. A total of 630 different institutions (303 from Member States, 188 from Africa, 70 from Latin America, 66 from Asia and 3 from Oceania) are currently participating in the STD2 programme. 75% of the research contracts have more than 3 partners and 25% have 5 or more.

In addition to the research contracts, which include an important component of advanced training of young scientists in Europe and in developing countries, a total number of 38 specific conferences and seminars, workshops and contractors meetings received a total financial EC participation of 893.770 ECU. The STD2 programme has also contributed to the creation and/or development of research networks in the field of small ruminants, tropical perennial oil plants, tropical forests, schistosomiasis, malaria and leishmaniasis.

STD's financing of marginal costs promotes a cost-effective use of scarce research funding when compared to traditional international agriculture and health research centres. The STD programme plays a leading role in supporting certain areas of research which are now largely dependent of this programme for scientific progress, such as schistosomiasis, malaria, trypanosomiasis, genetic improvement of banana, Sesbania, high altitude rice and trypanosome diseases of plants.

Some examples of results with a direct impact on developing countries:

Agriculture

- The development of high altitude rice culture in Burundi and Rwanda (where famine is currently widespread) has been able to take place only as a result of rice varieties created under an STD contract.

- The transfer of technologies for in vitro multiplication and for production of pathogen-free potato material in Rwanda has been an outstanding success and has provided support to the seed potato multiplication programme of PNAP (National Programme for Potato Improvement) in Rwanda.

- As a result of several STD contracts drought risks can now be mapped for certain important food crops (maize, rice) according to the length of the growing cycle of the varieties used and their sowing dates.

- Also the mapping criteria of the risks concerning the further spread of black leaf streak disease, which destroys bananas/plantains, have been established following epidemiological studies carried out in STD.

- The development of an ELISA test has enabled not only a study of the persistence and the efficacy of the most widely used trypanocide but also the control of the emergence of resistant trypanosome races.

- The work carried out by five laboratories from the EC and four from developing countries should lead to the production of a vaccine against tropical theileriosis, an important disease affecting cattle in India, the Middle East and the Southern Mediterranean area.

- The development of feedstuffs from local raw materials for the production of the fresh water prawn (Macrobrachium rosenbergii) in South-East Asia should enable an extension of this production to small producers under conditions which are economically more satisfactory.

- The study of Sesbania rostrata as a model for symbiotic nitrogen fixation could result in very significant yield increases in rice cropping while avoiding the cost and the pollution risks from inorganic nitrogenous fertilizers.

Medicine, Health and Nutrition

- Malaria research

  An EC/STD contract has provided for the development of a simple and specific ELISA test which measures chloroquine and its metabolites in urine specimens. Research is underway to further develop this test into a dipstick test and to include other anti-malaria drugs. This test has already proven a valuable tool in the strategy to control malaria.

  Genetic methods for identification of malaria vectors not recognizable with conventional morphological criteria were developed and made available to African scientists. Important advances were made with the discovery of new taxa in the Anopheles gambiae complex and progress was obtained in the knowledge of distribution, bionomics and vectorial status of the various members of the complex. New strategies of vector control were tested and one based on the use of impregnated curtains has given very promising results. New techniques were developed which increase both the quantity and the quality of information on malaria transmission.

- Schistosomiasis research

  The research activities in this field are carried out through 11 research contracts involving 26 research teams linking scientists from 7 EC Member States with scientists from 12 developing countries, building a research network.

  The research on the development of a vaccine against Schistosomiasis has achieved remarkable results and this is reflected in the award of the internationally recognized King Faisal prize (1989) to two of the senior scientists, Prof. Capron of Lille and Dr. Butterworth of Cambridge. Vaccine trials are now being initiated at the Primate Centre

in Nairobi, Kenya. Consequently, millions of unnecessary treatment courses have been dispensed with at vast expense.

- River Blindness research
  Several tests for River Blindness, based on the most advanced methods in molecular bilogy, which have been developed through STD programme grants and the STD sponsored functional research network are currently being applied in the field. The onchocercose functional research network has established a "bank" of reference sera and an exchange of Onchocerca volvulus gene clones.

Reviews

An ex-post external evaluation was carried out for the STD1 programme (1983-1986) the report of which was published in October 1988. The STD management team considered this report very positive (evaluation report No. 34 p. VI) and very valuable for the improvement of the programme operations. However, even before the expert panel had formulated its 18 recommendations, 9 of them had already been taken into consideration in the elaboration of the second phase of the STD programme. The remaining 9 were subjected to a deeper reflexion by the Commission and the CGC No. 8 and later considered in the preparation of the new specific programme in the field of Life Sciences and Technologies for Developing Countries (1990-1994).

STD2 consolidated the achievements of the launching phase of STD while still focusing dominantly on disciplinary research on agriculture and health. The multidisciplinary as well as the interdisciplinary nature of research projects has already been emphasized in the STD2 programme with the mobilization of research teams to work in the field of production systems, post-harvest technology, conservation and better use of the environment (use of water resources and soil management and protection), health services research, environmental health and nutrition.

In the implementation of STD2 attention was paid to achieving an adequate balance between food and non-food crops which are important to the economies of developing countries. STD2 stimulated actively the presentation of proposals involving its two key areas, in anticipation of the explicit interdisciplinary approach adopted in STD3.

STD3, with its marked interdisciplinary orientation, will continue to reinforce considerably the interface between agriculture and medicine by looking at the implications of farming systems on public health and at the biological interactions between man and animals leading to disease and malnutrition in humans and depressed productivity in animals. Projects supported under STD2 can be grouped into two main areas: Zoonoses (i.e. infections or parasitic diseases affecting man and animals) and nutrition research contracts. A third group of projects includes environmentally dependent diseases such as malaria and schistosomiasis which are closely interrelated with irrigation-based agricultural development schemes and to a lesser extent trypanosomiasis. The prevalence of the latter, transmitted by tse-tse flies, is also dependent on population pressure on land and the resulting deforestation in humid and sub-humid areas of Africa.

During the implementation of STD2 significant political and economic changes occurred in the developing world as a result of the end of the cold war and the structural adjustment/debt rescheduling processes adopted by many DC's. This reappraisal of development priorities by DC's and also donors such as the European Community led to adjustments in the STD content in phase 3 and is taken into account in the current preparation of its phase 4. Specifically, STD3 emphasized a holistic, integrated approach to the solution of problems in the agriculture and health sectors while introducing a major component, environmental sustainability. Plans for STD4, currently on the drawing board, reflect the increased demand being put on STD3 in terms of

international requests for support and the perceived need to expand STD's scientific content to other critical areas for development, namely the conservation of natural resources and the production and use of environmentally friendly renewable energies.

MARINE SCIENCE AND TECHNOLOGY (MAST)

Objectives

The MAST programme was adopted in June 1989 for a period of 3 years, with a budget of 50 MECU. Its main objectives were: to contribute to better knowledge of the marine environment in order to improve its management and protection and to predict change; to encourage the development of new technologies for the exploration, protection and exploitation of marine resources; to improve coordination and cooperation and the exchange of information amongst national marine R&D programmes in the member states, and to help increase the effectiveness of these programmes through better use of research facilities. Additional criteria were pertaining to industrial competitiveness, economic and social cohesion, provision for common norms or standards, and training.

Research areas: (I) Marine Science (30-35% of the funds), (II) Coastal Zone Science and Engineering (15-20%), (III) Marine Technology (30-35%), (IV) Supporting Initiatives (10-15%).

Background

Europe has one of the largest coastlines of all continents in relation to the land mass. Due to population pressure in coastal areas, nowhere in the world, except perhaps in the USA and in Japan, are the issues of protection, exploitation, and management of regional and coastal waters felt more acutely.

Europe is surrounded by continental shelf seas as well as by deep waters. In their diversity, the seas around Europe are part of the global Earth system and contribute in an important - although as yet unquantified - proportion to the overall biogeochemical balance of the planet. They play a role in controlling global and local climate. Research, leading ultimately to operational forecasting of oceans and shelf seas, must address the fundamental processes - physical, biological, chemical - that may control the behaviour of the system.

Given the many and economically important uses of the sea, some of which are mutually conflicting (e.g. exploitation and tourism), it is essential to have a good knowledge base and reliable predictive techniques so that long term management strategies can be developed. In addition, large scale transboundary problems which are typical of the marine environment (e.g. the movement of substances from one area to the other) require multinational research.

It is estimated that the member states together currently invest at least as much per year on civilian R&D in this area as the USA. However, while several European countries hold the lead in some aspects of marine science and technology, this is being threatened because the research effort is often dispersed, piecemeal or insufficiently coordinated. The second Framework Programme recognised this and suggested that an EC marine science and technology initiative would help to introduce the necessary European dimension into the various on-going research activities and thereby help develop a European "critical mass".

The scope for R&D activities in the marine environment is huge, and yet the MAST budget is limited. In view of this, MAST 1989-92 was conceived as a pilot programme, under which research could be initiated in a large number of fields, albeit at reduced costs, and in the hope that a follow-up under a successor programme would allow for topping up where necessary. Broad and diversified as it is, MAST does not include marine research topics which are covered by other EC programmes: STEP-EPOCH (Environment), Fisheries and Aquaculture, BCR and JRC activities.

Over 1000 expressions of interest (about 40% from universities, 37% from research centres and 22% from the private sector) were received prior to the launch of the programme, in reply to a call published in 1988 in the Official Journal. 46 research contracts have been signed between end 1989 and end 1990: 19 in area I, 10 in area II, 17 in area III. Breakdown by type of organisation is shown in annex. There are 255 participating laboratories from the Community. 4 are from EFTA countries, on a project per project basis. 15 study contracts have been placed for consultancies and feasibility studies, under the supporting initiatives (area IV) of the programme.

Results

None of the 46 projects supported has ended yet. From the progress of work so far, it is clear nevertheless that transnational collaboration has produced useful synergies. In the North Sea, fluxes of matter have been assessed with far more details than before, and MAST has set up the first international group on ecosystem modelling: due to the very high complexity of biological systems, this kind of modelling cannot be done on a national level, not even for small geographical areas. In the Mediterranean, the study of water masses circulation has made a qualitative step forward.

Results of studies on the production, transport and fate of particular material in coastal seas explain the functioning of ecosystems and could provide the basis for local environmental management. Progress is also being made on controlling factors of biological communities in estuaries and in the deep sea, for the prediction of natural or man-induced variability.

On coastal morphodynamics (interaction of waves, currents, sediment transport and deposition), 6 leading institutes, who are normally competitors on the world market of consultants, and 14 associated partners, representing in all 9 member states, have united efforts to develop advanced models of physical processes at the leading edge of sophistication worldwide.

In technology, the main focus is on acoustics, with successes scored on such topics as innovative imaging and measurement techniques, and acoustic tomography to determine the 3D structure of the oceans. MAST is organising for September 1992 a major international conference on underwater acoustics. Other subjects are related to the design of underwater vehicles, to in-situ probes for geophysical measurements, and the testing of behaviour of advanced materials under water.

As part of the supporting initiatives, steps have been taken to improve ocean data management and exchange across Europe, coordinate the use of research vessels by creating a database (EUROSHIP) of their cruise schedules, intercalibrate instruments. Feasibility studies have been launched on the design of major research facilities (a vessel, a benthic abyssal laboratory, a facility for calibration of large acoustic instrumentation). 30 fellowships have been granted and 7 advanced courses supported.

Reviews

The positive role played by MAST in bringing European researchers together is freely and widely acknowledged. Nevertheless there is a feeling in southern Europe that the Mediterranean receives proportionately less attention than North European seas. Any such judgement should be compounded however by taking into account the achievements of other programmes, sponsored by the EC (e.g. STEP-Environment, MEDSPA) or under other international schemes (UNEP, World Bank).

In MAST, the imbalance partly reflects a relative paucity of proposals from Mediterranean countries. There are signs of an improvement in MAST-II 1991-94, and the improvement should be confirmed with a planned large scale targeted MAST-II project on the Mediterranean.

It is sometimes claimed that MAST is not enough industry-lead. A partial answer to this remark is that a programme which focuses on processes in the sea, and on the technologies needed to study these processes, is not essentially tuned to meet the requirements of industrialists who exploit marine resources. The market of "marine instrumentation for scientific research" is necessarily limited. In time however, some of these instruments may be developed for the purpose of monitoring the marine environment. While the potential market in this latter sector appears to be more promising, it seems that industry still needs to be made fully aware of future opportunities.

At present, liaison with industry in marine environmental studies is ensured by participation of MAST in the EUREKA-EUROMAR steering committee. The follow-up of MAST projects as EUROMAR initiatives is encouraged.

While research has been initiated in all topics of the work-plan (according to the philosophy of a "pilot" programme), the magnitude of cost reductions on successful applications - particularly in area I, the most heavily oversubscribed - has sometimes put unduly severe constraints on researchers and on their administrations. Cost reductions will generally be less drastic in MAST-II, even if it means supporting a smaller proportion of applications.

Problems encountered in managing the programme relate primarily to various forms of delays: on contracts negotiation and signature, on the availability of funds for advance payments, etc...

FISHERIES AND AQUACULTURE RESEARCH (FAR)

Objectives

The main objective of the FAR programme is to provide a scientific basis for the effective implementation of the Common Fisheries Policy by coordinating and supplementing the national fisheries research programmes and initiating research in the fields of fisheries management, fishing methods, aquaculture and upgrading of fishery products.

The programme was adopted in 1987 for the period 1988 to 1992 and takes into account:

- The implementation of a Community policy of conservation and management of fisheries resources;
- The necessity to facilitate the adaption of Community fleets to the new conditions of fishing;
- The possibility of benefiting from the increased demand for fishery products;
- The development of aquaculture production in order to increase the overall fish supply in the Community, and stimulate employment in coastal areas;
- The need for integration of production and processing to promote the optimum utilisation of fishery resources and improve the quality of the products.

Background

Fisheries research is an integral part of the Community fishery strategy and must contribute to meeting the needs of the market, preventing the over exploitation of the fish resources and promoting a better utilization of the catches.

Over the years one observes, inside and outside Community waters, an increasing pressure on the exploited fish stocks, which results in an ever tighter fishery management. In the light of the increasing need for restrictions in the fishery it is necessary to acquire a detailed and comprehensive scientific basis in order to be able to give pertinent advice which is recognised by the professionals and the administration as reliable and a sound basis for fishery management.

The necessary research can only be done effectively at the European level. This is not only because the research takes place in a difficult environment and is therefore expensive, but, more important, because the natural resources, including the environment cannot be managed within one Member State.

Furthermore, the increasing demand on the internal market for fish and fish products and the limited production capacity of the natural resources result in the ever increasing important of the aquaculture. Considerable progress has been made in this field. The increase in production has, however, also revealed problems which can only be solved by further research, like for example

in the field of genetics and pathology. During recent years it has been clearly demonstrated that there is a lack of knowledge of marine animals suitable for aquaculture; significantly less is known about them than their terrestrial counterparts.

The research needed in aquaculture is too expensive and too wide ranging to be undertaken by individual Member States in isolation. Therefore, a well coordinated research effort in the field of aquaculture is required.

To achieve the coordination of research at European level, the FAR programme cooperates in two ways, by providing financial support for specific research projects and by coordination activities facilitating the exchange of results, ideas, techniques and researchers.

Results

Since the beginning of the programme, three calls for proposals were launched and a total of 128 transnational projects, involving 236 institutes have been selected for financing for a total amount of 31.3 MECU. These cooperative research projects cover the four fields of interest: fishery management, techniques, aquaculture and upgrading of fishery products.

Thirty coordination activities have also been selected for finance, including support for conferences, seminars, construction of databases and the preparation of publications. Furthermore 12 grants for bursaries and scientific exchanges have been allocated.

Reviews

Although an internal review of the programme started in 1991, it is too early to draw any conclusion on the programme, especially since only very few projects have been completed.

Under the third Framework Programme, fisheries and aquaculture research is incorporated in a broader programme AIR (Agriculture and Agro-Industry including Fisheries), underlining the growing importance of aquaculture with respect to off-shore fishing and adding more transparency and integration to the EC R&D programmes.

PROGRAMME TO STIMULATE THE INTERNATIONAL COOPERATION AND INTERCHANGE NEEDED BY EUROPEAN RESEARCH SCIENTISTS (SCIENCE)

Objectives

The Community's actions for the stimulation of scientific and technical cooperation and interchange among the Member States started in 1983, with the launching of an Experimental Phase. The following years saw the actions develop in size, under the Stimulation Plan (1985-1988) and the SCIENCE Programme (1988-1992), while keeping to the overall objectives of development of international cooperation and interchange among European scientists.

The purpose of the SCIENCE Programme was to "develop and support intra-European scientific and technical cooperation on high quality projects". Its specific goals were to improve the mobility of research scientists within the Community, to set up intra-European cooperative and interchange networks and to strengthen communication and exchange of information within the European scientific and technical system. In addition, the programme was to contribute to reducing the disparities still existing between different Member States, strengthening the economic and social cohesion of the Community.

Background

Mobility of researchers, cross-fertilisation of ideas across disciplines and sectors and transnational collaboration of teams are considered today as indispensable elements for the advancement of science and technology. As far as the Community is concerned, the existing barriers between disciplines, sectors and nations create obstacles to the realisation of Europe's full scientific potential; they leave unexploited its diversity in scientific skills and traditions; and they certainly do not help bring together the critical mass required for successfully achieving specific targets and goals.

The SCIENCE Programme and its predecessors were conceived as the Community's response to a manifest need for the breaking down of these barriers. They provided a variety of measures in order to be able to accommodate a broad range of requests; they had a flexible management for quick response; they were open to all disciplines and sectors, without fixed priorities and with a bottom-up approach in order to be able to pick up new and innovative ideas in any field; finally, they were given a system of evaluation (peer review) appropriate to the bottom-up approach of the Programme.

The SCIENCE Programme (with a budget of 167 MECU) has covered all the fields of the exact and natural sciences: Mathematics, Physics, Chemistry, Life Sciences, Earth and Ocean Sciences, Scientific Instrumentation and Engineering Sciences. These areas were also covered by the previous two programmes: the Experimental Phase (with a budget of 7 MECU) and the Stimulation Plan (with a budget of 60 MECU).

Since 1988, over 570 projects have been launched involving more than 1150 participants. Organisations from all 12 Member States and the EFTA countries (associated as full members since 1989) have taken part in the Programme.

Methods of support include grants for the mobility of individual scientists, shared-cost contracts for targeted projects and marginal-cost contracts for the support of twinnings and networks of laboratories.

Results

A major outcome of the SCIENCE and Stimulation Programmes has been, in the words of the Evaluation Panel, "the remarkable intra-European collaboration it has made possible"... "The projects have strengthened the links between research teams and many European scientists have found new partners and forged new links. All the nations of the Community have benefitted from the Programme, but in different ways, and this in spite of the absence of any formal requirements concerning the national distribution. SCIENCE is very small compared to the national programmes but is complementary to them in a very popular and successful way".

The evaluation of completed contracts has shown that the programme has produced a flow of ideas and results. Among these, one can find results of outstanding significance on a world-wide scale, as for example the results produced in the fields of spin glasses, chaotic behaviour or combustion.

Each project has produced, on average 25 publications in scientific journals and has generated major conferences and several workshops.

Many successfully completed contracts have been turned into major projects under technology-oriented Community programmes: the EJOB (optical computing) project is been now carried out under ESPRIT and the CEAM (Concerted European Action on Magnets) under BRITE-EURAM.

The SCIENCE Programme has also been able to respond promptly to new ideas, as in the case of the BRAIN (Basic Research in Adaptive Intelligence and Neurocomputing) and the High Tc Superconductivity initiatives; both initiatives are currently pursued under joint DG XII-DG XIII actions.

Reviews

The SCIENCE and Stimulation Plans have been evaluated by an independent panel, and all the completed contracts have been examined by independent senior scientists who have presented their conclusions to the panel.

The panel believes that "there is a great demand in Europe for scientific cooperation between the scientists of the nations, and in particular for a programme governed by new scientific ideas, in addition to other programmes of the EC which follow technological demand". They emphasize that science is part of the cultural life of Europe and underlies its technological future. Their fundamental recommendation is that "the European Community recognize this situation by having a programme dedicated to the collaboration of the scientists of European nations. In view of the success of the programme and the strong demand for what it offers, there is a strong case for its

continuation and expansion to a point where the desire for cooperation is matched by the support offered".

Among the Panel's more specific recommendations, one can list the following:

- The need for a European scheme that offers scientists the possibility of spending time in another European country after their doctorate. The existing scheme should be extended and improved to make it sufficiently attractive to the best European scientists to do their post-doctoral work in Europe.

- A part of the fellowship programme should be to award fellowships to major centres of high quality which can then swiftly make awards to scientists of their choice.

- A successful fellowship programme will lead to the need for stronger infrastructure among those nations whose scientific strength is enhanced by returning fellows; such people should receive support to continue collaborating in networks.

- Twinning programmes are very useful in creating networks of scientific activities and could be made much more substantial and numerous.

- As a new element of the programme, a small number of major multinational programmes should be inaugurated to create networks of centres of high quality in Europe.

- A programme of collaboration between scientists both of different nations and of different disciplines should be started with a separate budget for interdisciplinary research.

- Although the interaction between science and industry within the SCIENCE Programme has up to now been poor, there is still a need to accommodate such interaction.

LARGE INSTALLATIONS PLAN

Objectives

The Large Installations Plan was launched in March 1989 (89/238/EEC) for a period of 4 years (commencing 1 January 1989), with the following objectives:

- to encourage access by researchers who are nationals of Member States to major scientific and technical installations within the Community to which they would not normally enjoy access,

- to increase training opportunities available to European researchers so as to enable them to make better use of major scientific and technical installations,

- to develop the use of large-scale scientific and technical facilities within the Community, where necessary by adaptation and/or the addition of special features.

Background

Over the years the EC Member States have invested large sums of money in experimental equipment for the natural sciences. Where the size of each installation surpasses the national limits, international cooperation and the sharing of costs and benefits have taken many forms. High energy physics and astronomy are the best known examples of long standing international cooperation involving most Member States and other countries as well. However, other domains of physics and related equipment dependent sciences are also moving rapidly into the range where single country efforts are no longer feasible.

Following the Call for Tenders, in 1989, 165 "Preliminary Proposals" were received, of which 23 were pre-selected and re-submitted as "Final Proposals" jointly by the installations and their respective groups of potential new users. Of these 23 joint proposals, which represented a total financial request of more than 65 MECU, the Commission, in agreement with the Advisory Committee for the Large Installations Plan, finally selected 17, for which a total of about 28 MECU is now being funded through the Community and which involve more than 400 groups of potential new users from all Community Member States.

Several "Study Panels" have also been set-up, in the context of the programme and in cooperation with the Advisory Committee, in order to investigate the main needs and future developments in various fields of Science and Technology where large facilities play a significant role. The areas which have been analysed are: Synchrotron Radiation Sources; Neutron Beam Sources; Very High Power Lasers; High Magnetic Fields; Combustion Technology; Hydraulics; Oceanography; Earthquake Engineering.

Results

The scientific and technical achievements that are beginning to emerge, appear to meet the objectives of the plan. The launching of the Large Installations Plan in 1989 by the EC to

support European research at large installations, reflected the needs of the scientific community. The funds available for an experimental action were necessarily limited and after less than 3 years it is, therefore, to be expected that only some of goals have been achieved. Scientific results and the impact of training opportunities as well as spin-offs and economic impact have longer lead times. However, the launch itself and the selection of 17 proposals for awards in the order of 1-2 MECU each, are tangible results. The fact that the Large Installations Plan has now upgraded and opened these facilities to a wider community of European scientists is itself a success. Important characteristics of the selection process are:

- The awards have been given to places where effective use is made of them in the spirit of the objectives of the programme.

- All of the contracts have gone to leading facilities in Europe, some of which are among the world leaders.

- In cases where awards were given for substantial upgrading, this will elevate the centres to an international level.

- The selection procedure supervised by CODEST and the Advisory Committee and the follow-up by subject specialised Study Panels contributed to the necessary continuous dialogue between the scientific community and the EC.

Reviews

An external evaluation is now in progress. Although the work of the Evaluation Panel is not completed, the following statements are mainly based on their findings.

The overall objective, namely to give European researchers in some research areas access to large-scale equipment which they do not have in their own countries, has been achieved. For reasons particular to the areas of research and nature of experiments, the situation is quite distinct for the different contracts. For example, the number of new users varies by a factor of 20. One of the reasons is that some of the facilities were well established as user facilities and others were upgraded to higher capability to start user programmes.

During the selection procedure in 1989, it was an important consideration that proposing facilities should indicate their prospective new users to provide an estimate of the demand. In the early part of running the programme some of these indicated user lists are seen to contain an element of wishful thinking. In future selection rounds such estimates should be supplemented by an assessment of how the proposers serve existing and potential new users and by a peer review of proposed experiments. Moreover, the relevance of any estimated demand would certainly be higher if the time that elapsed from proposal to contract negotiation could be reduced.

The awards of the Large Installations Plan contained three components: one for paying the users' travel and direct costs, a second for covering "user fees" at the installation and a third for financing one-off investments in order to bring the equipment up to international level. The last two contribute to long term investment and constitute a substantial part of each contract, thereby giving the Commission an important role in supporting the long term interests of the European scientists.

Although the centres operating the contracts appear to have made good progress in implementing the investment, there will be an increasing need to coordinate such investments with national funds, when extending the programme in future.

The contracts have been awarded to centres of high quality, of which some are unique at the leading front of science. These centres serve well established user communities across Europe. They need Community support to secure the "critical mass" of equipment for attracting scientists from all over Europe. The first two years of the running programme (the first contracts started only in 1990) have confirmed that a great number of scientists are eager to use such unique facilities. It is particularly important - from a European viewpoint - that the best of the young scientists find leading scientific partners in Europe. At the same time the contracts represent an opportunity for the centres to welcome scientists who can contribute to the knowledge at the forefront.

The first two years of operational experience show sufficient evidence to suggest that the responsibility for selection of user proposals is best executed by visible structures of international peers involved in selection and by active users advising in solving practical problems. The Large Installations Plan has helped such procedures and where their use is weak or not well developed, it should be strengthened in future.

The growing need of collaboration between more and more specialised installations is generally accepted. To achieve leading edge results, centres will need to cooperate with others in, e.g. the design of experiments and peripheral equipment. The centres are also able to benefit from the sharing of management experience so that all take up the best practices for operating internationally with their user communities. Perhaps the field of synchrotron radiation research presently provides one of the most vivid examples of how useful the Community funds can be in this respect, by furthering a cooperation or networking that involves both a division of labour among the large facilities and the stimulation of home based research in other countries.

The objective of stimulating the mobility of researchers has been attained by the Large Installations Plan, in particular through the support to short term visits. The need for sustaining such support will continue to exist after the completion of the LIP contracts. Of particular relevance for promoting long lasting effects would be the possibilities for the centres to allocate fellowships and to employ young researchers in addition to financing users from other countries.

Whereas the Evaluation Panel has concentrated on the assessment of the work carried out at the installations supported by the programme, the Study Panels have also taken up additional research areas which depend on large scale equipment. Some of these fields are strong and internationally leading, like synchrotron radiation and neutron research. Here the goals should be to retain this position. There are other areas where European scientists lack effective access to large scale equipment, e.g. in oceanography and climatology, and EC initiatives may provide an incentive to Member States to invest in such areas.

STIMULATION PLAN FOR ECONOMIC SCIENCES (SPES)

Objectives

The four basic goals of SPES are to:

- strengthen cooperation on research projects and networks and increase the mobility of Community economists;
- improve the training of economists at the doctoral and post-doctoral level through studies and research in Member States other than their own;
- encourage the repatriation of young economists to the Community; and
- increase the exchange of knowledge and information between Community economic researchers.

Background

Although there are more than 30 years of experience with support to research, this had not before included the economic sciences. The Single European Act of 1987, which revised the EC Treaty, gave the explicit status to the research and development policy and the legal basis for the Framework Programme to include the economic sciences.

The progress of economic integration among the Member States during the 1980s drew attention to the growing needs for "European economics" and the lack of means devoted in the Member States. It became therefore the objective of SPES to take on three different problems of structure and content in European economic research:

- the predominance of scientific orientation towards the USA,

- the inadequate funding for Community cooperation,

- the need for more research into the issues of Community economic integration.

The objectives are reflected in a list of suggested research topics which include: internal market, European integration, economic growth, monetary issues, employment, modelling and microeconomics. Later, further topics were announced relating to Eastern Europe and environment.

At the scientific level the content is determined via a bottom up approach relying upon the initiatives of the researchers themselves. The awards are given according to the quality of the proposals with regard to scientific excellence, multinational involvement and the European interest of the subject.

Results

The criteria that proposals should involve highly qualified researchers from several countries seems to give a better assurance of a European perspective of a particular project than a conformity with a short list of European issues.

The support of research projects and networks has been the most important activity of SPES. Out of the 86 projects granted in the first three years of the programme, 62 were joint research projects or networks which absorbed a total of 6.5 MECU.

The joint research projects and networks have strengthened cooperation between economic researchers in the Community, have stimulated mobility and have raised the quality of economic research in general and especially on issues of European interest. Moreover, the financial resources available through the SPES programme have been critical in supporting many projects that otherwise would not have started or would have ended prematurely. Participating researchers who have stated that their research in certain areas would have continued even in the absence of SPES funding have also agreed that this would have been done at a diminished scale. The SPES programme has succeeded in stimulating economic research beyond the level that could have been achieved on the bias of national resources. A large majority of the participants in these activities have found that SPES funded projects have improved the overall quality of their research and have enhanced their professionals contacts in other EC Member States. It is worth noting that improved research quality has been related to mobility and the joint undertaking of projects. Since the number of completed projects is but a small fraction of those funded, the assessment of the degree to which the criteria of quality and European interest have been satisfied has relied primarily on an evaluation of the accepted projects. It is considered, that the criterion of scientific excellence has been fulfilled, while a majority of the funded projects focus on topics related to the EC integration process or issues of special interest to the Community. The 9 courses and workshops financed are likely to advance the objectives of SPES including cohesion. 61 scholarships have been granted during the 1989-1991 period.

The training of economists and joint research activities at centres of scientific excellence will also contribute to reducing scientific disparities between Member States thus strengthening economic and social cohesion. Improving the quality of economists' training and broadening their research experience is an effective means of stimulating economic science in peripheral countries.

Evidence can be found in the projects and their involvement of partners that the traditional orientation of many good European economists towards the USA is now being complemented by new links within Europe. Thus, SPES has encouraged the specialisation in Europe among economists who are partners in cross-border teams. SPES has not been able to finance the build-up of home bases in institutes or regions needing basic upgrading. However, the possibility for good scientists from such institutes to become involved in high quality projects represents a very important step towards cohesion.

Since scientific excellence should be viewed not as competing but as parallel and independent goals, cohesion should be achieved by means and measures which can improve the quality of economic research in peripheral countries thus increasing the potential for contributions to European science and the probability of participation in SPES projects.

Reviews

The programme has been operating for a relatively brief period (from mid 1989 to end 1991), it is not possible to reach a complete (full) assessment of the extent to which these objectives and criteria have been met. Nevertheless, the evidence available from surveys involving researchers and students who received support, from discussions with participating researchers and with potential users of the projects output and the Panel's evaluation of the selection process and of available final and interim reports has allowed the Panel to reach an overall positive assessment of SPES.

The scientific achievements are beginning to emerge and the high quality of selected projects will undoubtedly be confirmed in due course.

The selection procedure has been of high quality based upon scientific criteria of excellence.

The cohesion among Member States has been improved in the economic science through the involvement of top researchers from all countries in fundamental research projects, through fellowships and, to a lesser extent through courses and international workshops.

The value added or importance of the EC being the financer of economic research projects has been to put emphasis on the fruitful options for competition among the best of European scientists and for their cooperation at a larger scale than is possible individually.

Since the SPES programme has shown the ability of economic scientists to come forward with research projects that will contribute to basic knowledge of European political economy which is important in the long term, the EC should continue its support.

The budget should be less erratic than in the experimental plan.

Support should be available to proposals in all topics of economic research. The value added of giving the support at EC level should be ensured by requirements of cross border cooperation in joint projects and networks.

Increasing support should be given to fellowships, at a level that meets, but does not outpace, the growing demand.

The selection procedure should continue to comprise of the scientific evaluation by recognised referees and a group of highly esteemed scientists.

The decision to grant awards should be followed up by a less time consuming procedure for the setting up of contracts, because the quality of projects can be jeopardised by long time delays.

The results of the research must be published through normal scientific journals to ensure an ex post critique and evaluation, but immediate transfer of knowledge is also necessary in the form of discussion meetings and dissemination of non-technical summaries to politicians and other users outside academia.

MONITOR

Objectives

In the MONITOR Council Decision (89/414/EEC-O.J. L 200), Annex I states the general aims of the programme as follows :

- the purpose of the programme is to be instrumental in identifying new directions and priorities for EC research and technological development policy and to help show more clearly the relationships between R&D and other common policies;

- the programme involves factual and strategic analysis and forecasting relating to the scientific and technological environment and its interaction with economic and social developments. It also has the task of providing methodological support and guidelines for the evaluation of R&D programmes.

Background

MONITOR has received its heritage from previous FAST I and FAST II programmes, the activities in R&D programme evaluations which have existed for more than 10 years, and the decentralised and informal strategic thinking which has always existed in the Directorates concerned with R&D.

The evaluation of the FAST II programme (1983-1987) and a study on the organization of R&D evaluation recommended the creation of an integrated system for the assessment, strategic analysis, forecasting and evaluation of the development of S&T. This should include analyses on the implications and effects on the economic and social development of the Member States.

In view of these reports and the Commissions's own experience, and with the aim of providing EC R&D policy with an integrated set of accurate tools to back the definition of R&D priorities, the MONITOR Programme was adopted.

The main question facing MONITOR is how EC R&D policy can have a significant impact with a relatively low amount of resources. This problem can only be solved by means of designing a strategy with carefully selected objectives, encompassing more than the mere scientific and technical value.

Unlike other programmes financed under the second F.P., MONITOR is not focused on any specific industry or research area. The client for the output of MONITOR is the whole of scientific research, more specifically the research policy makers, programme managers, researchers and administrators not only in the Commission but also in Member States.

Research is a significant industry in itself. In 1990 total financing of civil R&D in the EC amounted to some 34 BECU of which the CEC programmes contributed 1.6 BECU or 4.7%. Numbers of people employed in research activities are similarly significant. Over 1% of the active labour force of the EC is involved in higher education research sector alone and approximately 0.8 million scientists are employed in the business sector.

MONITOR represents only 0.4% (22 MECU) of the budget of the second F.P. yet should provide a vital service. It is designed to provide long range scoping studies (FAST - Forecasting and Assessment of Science and Technology), mid to short-term strategic analyses (SAST - Strategic Analyses in Science and Technology) and a means to improve validation and feedback derived from existing programmes (SPEAR - Support Programme for Evaluation Activities on Research) for the Commission while at the same time stimulating and advising about the impact and future of research in the Member States.

Results

One of the major results of MONITOR is that it has opened up new lines of thought and, at the same time, has tried to satisfy demands by means of finding responses to the actual problems that EC R&D policy faces, with a multidisciplinary approach. One of the specific merits of MONITOR is also to highlight possible S&T responses in order to meet objectives in other areas of Community policies.

MONITOR activities cover a great range of subjects, fields and issues, recurrent themes being :

- Science and Technology and the European Industry;
- Science and Technology and socio-economic cohesion;
- Globalisation of Science and Technology;
- Strategic issues for R&D policy;
- Development of R&D evaluation methodologies.

Here we will be concentrating on those major MONITOR findings relevant to the future R&D policy.

Five major trends arise from the whole range of MONITOR analyses :

a. Complexity of issues : Science and Technology are confronted with global science, economic and social problems. In order to solve them, more cooperation along multidisciplinary approaches as well as an increased synergy between research and other instruments such as regulations, standards, actions, etc. is needed.

b. Need to change the approach to competitiveness : since science and technology inputs do not lead directly and automatically to improving competitiveness, a less simplistic approach is needed. Strategic and forward-looking thinking has to be on the basis of the choices to be made.
These should include not only purely scientific parameters, but take on-board both the constraints and possibilities of the organization of companies and the human and social factors which intervene in the economic development. Science and technology strategies must be supported and accompanied by training, policies encouraging investment and diffusion of know-how.

c. Emergence of new actors of science, technology and innovation : towns, regions, social groups, public opinion become more and more potential users and/or operators of R&D. This implies that there are new patterns of social demand for research. To respond, EC R&D policy needs to develop research activities taking into account local and regional needs, as well as a better involvement with other present and future EC policies.

d. New European geography : the present European situation, where the completion of the Single Market is a reality, where socio-economic cohesion is still a driving force, where relations with EFTA and Eastern European countries are on the political agenda, suffers from the existence of conflicting logics and patterns of organisations within the European territory. These circumstances require a reinforced European integration, a far better coherence between R&D and regional policies, supported by stronger networks of local capabilities in science, technology and innovation.

e. Growing tendency for short-term approach : companies and Member State governments are faced with short-term imperatives which may, and in fact do, threaten long-term investment such as research. This implies an increased need to safeguard long-term approaches and strategies, continuity of investment in R&D and an appropriate balance between industrial and basic research.

These trends appear simultaneously in time, and R&D policy, amongst other, is confronted to all of them. This implies that a future R&D policy should be based on the following :

i More demand pull in the definition of contents and priorities, involving users, customers social demand, local and regional actors;
ii Broader concertation with all actors (both users and suppliers), leading to consensus on needs, objectives S/T requirements and implying commitments from all parties interested.
iii Coherence with other EC policies (such as transport, environment, industrial) and other EC instruments.

Some specific results from each subprogramme are given below as an example :

- The SAST project on NICs (New Industrialized Countries) has provided background information to DG I's negotiations with some of these countries, while the project on standard-setting and observance has contributed to the discussion on prenormative research and the EC industrial policy. SAST analysis in relation to agrobiotechnology is being used in devising future activities in the BRIDGE and AIR programmes.
- FAST has made proposals for the implementation of new programmes such as Anthropocentric production systems and organisational dimension of manufacturing; the future of technologies and cities, and a better understanding of the process of globalisation of society and economy.
- SPEAR has provided considerable support to the evaluation of specific R&D programmes as well as to the organisation of evaluation in some Member States. It has also contributed to stimulating the debate on evaluation within other Commission services.
- MONITOR has also given input to CREST and IRDAC for their discussions in the 4th F.P.

Reviews

Within the Commission, MONITOR has been useful in providing a multidisciplinary approach to research issues, has sometimes played a role in "building the bridge" between natural and social sciences and has certainly provided input at different stages of the R&D policy-making, although there is still a lot of room to do more.

Even if there is still much work to be done, it has involved quite a good deal of its potential clients in the preparation and implementation of its activities. The broad systematic consultations

have usually yielded a good result.

Through the networks, both formal and informal, it has been possible to associate a large number of partners to the programme, who otherwise would have been excluded, acting as a sort of concerted action.

The MONITOR activities are driven by the need to provide a Community perspective in the RTD policy area and are therefore of a genuine Community interest (Re : subsidiarity principle).

From this experience, some recommendations can be drawn for the future:

- The functions fulfilled by MONITOR are, by its very nature, permanent. In a future phase, closer to the decision makers, a more flexible modus operandi should be designed so that real requirements of S/T policy makers are, first, well expressed and, second, appropriately met.
- A greater effort should be devoted to translate MONITOR results into operational recommendations for policy action, and thus a better impact on the decision-making process.
- Regular evaluations of specific R&D programmes should be fully integrated with the methodological aspects of evaluations which are currently under MONITOR (SPEAR). This would also improve synergy with forecasting, technology assessment and strategic analyses carried out under MONITOR.
- The EC R&D policy needs an integrated "technology watching" function and a better organisation capability to utilize the contribution from human and social sciences.

DEVELOPMENT OF STATISTICAL EXPERT SYSTEMS
DOSES

Objectives

The objectives are:

- To promote research and coordinated development of tools in the field of statistics in the EC;

- To enhance capacity to produce and use statistical information employing advanced data processing techniques.

Background

Statistical information has become an essential resource in the running of modern economies. The growing complexity of the financial, social and physical environment and the increasing pace of economic life mean that statistical tools designed in the different climate of some decades ago may soon be obsolete in the face of modern requirements. It is therefore essential to ensure that the tools of measurement, monitoring, control and planning undergo constant development.

The creation of a single European market will lead to a growing need for statistics for many sectors of economics, which must be comparable, trustworthy and timely. This situation makes it natural that Europe should play an active role in developing new statistical tools.

Some new methods growing out of research into Artificial Intelligence are becoming available. We must try to profit from them in order to improve the quality of our data, to make the data more readily accessible and to extend the range of services offered to the user.

The DOSES programme aims to stimulate and coordinate European initiatives in statistical expert system development. It forms part of a series of Community actions aimed at promoting research and development in the field of information technology and developing a market for information services.

Designed in collaboration with the governments of the Member States, it will act as a catalyst in creating the Community "synergy" which will contribute to the building of Europe.

Results

Since 1989, the DOSES programme is supporting 16 collaborative projects involving organisations.

The 7 shared-cost projects have not yet been completed; only progress reports are available. However 7 coordinated projects led to the realization of 7 reports to date.

Reviews

In accordance with Article 4 of the Council Decision, a mid-term review was carried out in June 1991. An independent expert, Mr W Molenaar from the Rijksuniversiteit in Groningen, was selected for his experience in this field and produced an evaluation report. From this the Commission prepared a Communication to the Council and Parliament in March 1992.

EUROTRA

Objectives

The main objective of the programme was to create a prototype of a machine translation system capable of dealing with all official languages in the EC.

This objective was formulated under the 2nd Framework Programme in terms of two consecutive specific programmes:

a) Council Decision of 20 June 1989 on a specific programme for the completion of a machine translation system of advanced design (Eurotra). An amount of 7 Mecu was decided for a period of eighteen months.

b) Council Decision of 26 November 1990 adopting a specific programme concerning the preparation of the development of an operational Eurotra system. An amount of 10 Mecu was decided for a period of two years. This aim was refined within the preamble to the Programme: "Whereas this programme should lead to the development of a high-level scientific prototype".

At the technical level, the programme aimed at creating a suitable climate for the transition of Eurotra from a theoretical to an operational system. This included upgrading the research environment to support large-scale system development, testing and research prototype implementation, the advancement of work on lexicography and terminology and, maybe most important, the setting up of cooperation schemes between research institutes and industry.

A number of accompanying measures were also initiated (standards, education and training).

Background

The Eurotra research programme was integrated into the 2nd Framework Programme after a series of preparatory actions dating from 1982. Its aim was to carry out research and development into a machine translation system of advanced design.

At that time, only a few machine translation systems existed, for limited language couples and often for very limited types of text. There were no systems, of European or other origin, which addressed all official Community languages.

Eurotra highlighted the basic political problem of respect of diversity of national identities and cultures in the building of Europe, as well as the increasing practical problems of trans-border communications in European science and technology, trade and industry and between administrations.

The programme was based on a network of national research centres in each Member State, coordinated by a central team in Luxembourg. It involved over 200 researchers.

The Community budget for the programme was 20.5 Mecu between the periods 1982-1989, and 17 Mecu within the 2nd Framework Programme for the period 1989-1992. In addition, the Member States contributed funds under a joint financing scheme.

Results and Reviews

The programme has so far been evaluated twice by independent experts.

a) The 1988 Pannenborg report (COM (88) 270 final. The panel comprised Dr. Pannenborg (ex Vice-Chairman of Philips), Prof. S.Allen (Permanent Secretary of the Swedish Academy), H. Steusslof (Director at the Fraunhofer Institute), and A.Danzin.

b) The 1990 Danzin report (COM (90) 236 final). The panel comprised A. Danzin (ex-Director IRIA and Vice-President of Thomson-CSF), Prof. Allen, H.Coltof (Senior Consultant, van de Bunt), H.Steusloff, and A. Recoque (Head of artificial intelligence group, Bull).

The Danzin report concluded that Eurotra will not lead to an industrial machine translation system by 1992, but to a scientific prototype, imperfect and incomplete. The original expectations of the mid 1980s were over-ambitious. However, genuine progress had been made in the project since the Pannenborg evaluation, and it was felt out of the question to abandon the project.

By the very fact of its existence, Eurotra has laid the foundations for a Community achievement in the field of language technologies, and this is very important since it corresponds top a need which has become clear in the course of the past decade.

The main conclusion of the Danzin panel was that during the past decade, new requirements have emerged for a broad Community approach to language engineering and the so-called language industries. A global Community strategy is required, setting out ways of promoting European schemes and stimulating cooperation, action to encourage cross-fertilization of knowledge, synergy with other Community programmes, the introduction of policies on standards and legal aspects and the launching of selected pilot projects.

The Danzin report therefore recommends that the project should be re-oriented:

- the positive spin-offs in terms of basic research and specialist training should be maintained and enhanced
- monolingual applications should be addressed
- industry should become more closely involved in the programme, for example in finding industrial applications for the spin-offs from Eurotra software work
- organisational restructuring should be considered in order split the functions of maitre d'oeuvre and maitre d'ouvrage within the project.

Since the Danzin report, work has continued on Eurotra. The findings of the report have been taken into account both in the specific programme approved in November 1990 where an important portion of the resources have been reserved for shared cost projects with industrial participation, and in the LRE programme (area 6 of the specific programme "Telematics systems of general interest" in the 3rd Framework Programme.

c) The Council Decision of 26 November 1990 calls for an independent evaluation at the end of the specific programme, namely in 1992.

However, as explained below, the Commission feels, in line with the Danzin report, that the general activity in the field of machine translation should continue,albeit on a much broader basis.

With the conclusion of the specific programme 1990-1992, the Eurotra programme in its present form will come to an end. The LRE (Linguistic Research and Engineering) programme builds explicitly on the results and the experience on Eurotra, ESPRIT and national programmes in the domain of natural language processing.

LRE overlaps in time with Eurotra and is designed as a transition from a programme aiming at a single application to a first strategic programme aiming at the creation of a linguistic technology and infrastructure. Consequently, LRE has been articulated along five action lines. It concerns research into linguistic technology, the stimulation of common tools, methods and resources for linguistic systems, the promotion of standards, applications in machine translation and other areas, and training.

Beyond LRE, in the perspective of the revision of the 3rd Framework Programme and the preparation of the 4th Framework Programme, it is intended - in line with the evaluation results - to draw up a new Community strategy for language engineering. This strategy will address the serious need for a linguistics infrastructure for communications in science and technology, trade and industry, and between public administrations, with the advent of the Single Market.

DISSEMINATION AND VALORIZATION (VALUE)

Objectives

The Value programme contributes to the general objective of the Framework Programme, as defined in Article 130-F of the CEC Treaty. In addition to this, and at a second level, it contributes to the establishment of the internal market, as well as to the economic and social cohesion of the Community.

This general objective is reflected in the objectives allocated to its two subprogrammes.

The object of subprogramme I is the dissemination, through the appropriate channels, of the results obtained by the specific programmes, in order to improve the competitiveness of European industry, and special consideration being given to the interests of SMEs.

The aim of subprogramme II is to promote an integrated common communications system and associated services which are accessible to research centres in Europe, while complying with the requirements of confidentiality and integrity of the information.

Background

On 20 June 1989, the Council adopted the decision concerning the implementation of a specific programme for the dissemination and utilization of scientific and technological research results, namely the Value programme. The duration of the programme is 4 years.

The resources available to the Value programme distinguish it from other RTD programmes. The call for proposals constitutes only one of the means of its setting up.

In the field of valorization, a call for tender was published in 1990 and 1991. This allowed for, after selection, assistance in valorizing 80 results originating from Community research. The requests made for the financing of prototypes have been relatively high since the last selection exercise, the Programme has only been able to grant financial assistance to requests in a ratio of 1 in 10.

Similarly, a call for proposals "dissemination" attracted a high number of proposals representing a sum 30 times higher than that of the available budget.

Amongst other means of its implementation note should be taken of the launch of the call for tender for the selection of contractors to set up the information system CORDIS, in addition to that for experts and consultants contributing to valorization activities.

Results

The Value programme, being the first of its kind adopted by the Council, is largely, in view of this fact, of a pilot nature and a variety of possible directions in activity in the areas of dissemination and valorization were explored.

Amongst the achievements of the Value programme, the following should be noted:

- The launch of the experimental information service CORDIS. This service now comprises of 6 databases (programmes, projects, publications, results, partners and acronyms) and has some 2000 users listed

- The publication of reports and works on the activities of Community RTD (approximately 350)

- The carrying out of strategic studies on valorization and dissemination

- The identification and evaluation of the results of completed projects (the BRITE-VALUE study involving 200 results)

- The protection of results belonging to the (parents) stemming from research of the Joint Research Centres

- Joint activities with DG XXIII aimed at SMEs, to encourage them to use the results stemming from Community RTD activities

- The launch of 2 pilot projects in Greece and Portugal with a view to the setting up of relay centres for dissemination and valorization in this countries

- Assistance for the valorization of approximately 80 results stemming from Community research, including the financing of prototypes (18 in the course of the first 2 years of the programme)

- The organisation of awareness seminars on dissemination and valorization and additionally, participation in specialist fairs for the promotion of Community RTD results

- Support given to the EUREKA "Cosine" project, and to the RARE association (réseaux associés pour la recherche européenne)

- Assistance given to the development and adaptation of national R&D networks

- Support for studies on the confidentiality and integrity of Community RTD information.

These activities allow an increase in the level of dissemination and utilization of RTD results. As yet, their impact is difficult to measure, especially with regard to exploitation due to the time limits necessary in order to place a precompetitive R&D result on the market.

The information service CORDIS did not exist before the setting up of the VALUE programme. It has been set up under very short time limits, in an experimental form. It has yet to be completed and improved with regard to data collection and the user interface.

The work of evaluation of the R&D results carried out in conjunction with the specific programmes has given rise to useful information which, in the future, should allow for better selection of RTD projects destined for industry.

In accordance with the mid-term review panel, unless the budget is increased at least tenfold, the "prototypes" activity will be unable to make a significant impact. It should be noted, nevertheless, that it has given rise to interest on the part of contractors, and that the demand is strong.

Reviews

The following reviews have been carried out:

- Public measures in leading industrialised countries for promoting the exploitation of R&D results - Segal Quince Wicksteed Limited - [March 1992]

- Study of approaches and practice in the exploitation of RTD results - Bossard consultant - 1990
- Mid-term Review - Review Panel - February 1992

The interest in the activities of dissemination and valorization is growing. The Court of Auditors carried out a special report on the exploitation activities of Community research priori to the programme being put into action and the European Parliament adopted a report on the same subject during the course of the July 1991 session.

These reports, in addition to the mid-term evaluation report on the Value programme, established by a panel of independent experts, will serve to direct the programme in the future thus:

- A global follow-up system of utilization, made up of Community RTD results should be set up, in order to better monitor the social and economic impact

- The setting up of a Community network on dissemination and utilization, built around the Relay Centres chosen int he Member States, constitutes one of the priorities for the coming years

- The central action of dissemination and utilization, in the course of being adopted, should continue the fundamental activities implemented by the Value programme, and by studying the interfaces between research and society, to put particular accent on the infrastructures such as the relay centres or the CORDIS information service, and making available the specialised knowledge necessary for the dissemination, protection and utilization of the results

- A better awareness of the different components in the application of dissemination (publications etc)

- The recourse to experts and consultants should be followed up, a growing importance should be accorded to strategic studies, market studies, technical/economic feasibility studies which will allow a good exploitation of results

- The synergies with Community initiatives such as Spring and Stride, in addition to intergovernmental programmes such as Eureka should be developed

- The specific programmes should devote an increasing amount of their resources to dissemination and utilization

- New means of financial assistance should be put at the disposal of contractors participating in RTD activities, in order to help them exploit their results. These should, in particular, involve venture capital associations.

These reports underline the insufficiency of the resources available for dissemination and utilization and the necessity of strengthening these so that this activity has a significant impact on the competitiveness of European industry.

JOINT RESEARCH CENTRE MULTIANNUAL RESEARCH PROGRAMME 1988-1991

Background

The Joint Research Centre of the European Communities is a European scientific and technical research centre. Its four sites in Belgium, Germany, Italy and the Netherlands house eight different institutes, each with its own focus of expertise. The JRC performs scientific research and technology development for the Commission of the European Communities, national agencies, universities and corporate clients from Community Member States and other countries.

The scientific, regulatory and administrative bodies of the Community are the JRC's main users. They seek to increase the competitiveness of European industry within an open market, and for this they need prenormative and pre-competitive research. The Community also carries out science that must be done on a European scale: provision of reference materials and measurement techniques, database services, environmental observations, research on safety, all of which depend on the transfer of scientific capabilities throughout Europe.

Increasingly, national governments and private corporations also utilize the considerable resources of the JRC to carry out contract research. With facilities and areas of expertise unique in Europe, the JRC serves a special role as a resource for organizations whose research needs exceed their own internal capacity, or who wish to benefit from the availability of specific JRC facilities and talent.

The following institutes comprise the JRC:

- The Central Bureau for Nuclear Measurements;
- The Institute for Transuranium Elements;
- The Institute for Advanced Materials;
- The Institute for Systems Engineering and Informatics;
- The Environment Institute;
- The Institute for Remote Sensing Applications;
- The Institute for Safety Technology;
- The Institute for Prospective Technological Studies.

Objectives of the JRC's Research Activities

General

These are defined in Council Resolution 88/C/197/03 of 29 June 1988 concerning the activities to be undertaken by the Joint Research Centre which confirms the Community character of the JRC and considers that the distribution of activities should be as follows:

A. Implementation of the Framework Programme (FWP) by means of specific research programmes and preparatory research:

	Breakdown of JRC Contribution to FWP	Percentage of JRC Resources 1988-1991
EEC research programmes	40%	74%
EAEC research programmes	60%	

B. Work for third parties (including support to the Commission):

	Breakdown of JRC Work for Third Parties	Percentage of JRC Resources 1988-1991
scientific and technological support for the Commission	48%	26%
work for external private and public bodies	52%	

JRC Objectives under the Framework Programme Specific Activities

These activities are executed under Council Decisions 88/521/EEC and 88/522/EURATOM, both of 14 October 1988.

JRC Specific Research Programmes Related to the EEC Treaty

The JRC specific research programmes related to the EEC Treaty are concentrated on two main lines of action of the framework programme for Community activities in the field of research and technological development.

These lines are:

- quality of life (environment);
- modernization of industrial sectors (science and technology of advanced materials, technical standards, measurement methods and reference materials).

The specific research programmes contribute to:

- the generation of scientific knowledge in the fields of environmental protection and industrial safety as necessary for the implementation of the Community environment policy and of the Community consumer protection policy and for their further development. This will be implemented through research on environmental protection, on industrial hazards and on the application of remote sensing techniques. This research will

be conducted through the joint drawing up of reference measurement methods and analysis techniques, the collection and dissemination of data, the conduct of several collaborative Community-wide projects and the operation of both existing and new experimental facilities of Community interest;

- ensuring that the manufacturing industries of the Community have better access to a range of advanced materials and that these materials are produced by cost-effective means and incorporated in high-performance components and in particular by establishing improved methods for the characterization of advanced materials, by performance assessment techniques, by data collection and dissemination, including a data bank to be made publicly available, and through the operation of experimental facilities of Community-wide interest;

- the scientific and technical knowledge necessary for further harmonization and standardization, notably in the industrial and energy fields by research on reference methods, reliability of structures and reference methods in non-nuclear energies. This will include the construction of a new facility for examining the reliability of structures and the operation of this and existing experimental facilities of Community-wide interest, establishment of common methods and codes for testing, and common models for describing the behaviour of structures, mechanical systems and common methods for assessing the performance of non-nuclear systems;

- the strengthening of the economic and social cohesion of the Community. This will be achieved through exchange schemes for scientific and technical personnel from the public and private sectors in all Member States to the JRC and vice-versa for at least 120 persons, and through a scheme of associated laboratories fostering a close and permanent collaboration between these laboratories and the JRC, in particular with laboratories in Member States and their regions most interested in this scheme;

- the enhancement of the relevance of the JRC scientific venture in ensuring specific users for its expected results;

- increasing the scientific consensus on environmental and safety issues, in associating national laboratories, universities and industry to the JRC specific research programmes through technical meetings, exchange of personnel and, where possible, through the drawing-up of common studies and common projects;

- increasing industrial competitivity in accelerating technology transfer from JRC specific research programmes to industry, notably in implementing these programmes, when possible, in the framework of industrial cooperation, where exchange of personnel will be a vital component of the association.

JRC Specific Research Programmes Related to the EAEC Treaty

The JRC specific research programmes related to the EAEC Treaty are concentrated on three main lines of action of the framework programme for Community activities in the field of research and technological development.

These lines are:

- quality of life (radiation protection);

- modernization of industrial sectors (technical standards, measurement methods and reference materials);

- energy (fission: nuclear safety, controlled thermonuclear fusion).

The specific research programmes contribute to:

- providing data and methods needed for the prevention of harmful effects of ionizing radiation and radioactivity through research on radiation, evaluation and monitoring with emphasis on a Community-wide databank with a public service from early 1989;

- enhancing the scientific an technical knowledge related to fission: nuclear safety by the conduct of several large-scale experiments, by joint studies of the observed behaviour of operating plants, by the setting of common models of hypothetical accident situations and of common models for the safe management and control of nuclear materials and waste as well as by research on special nuclear elements;

- Community efforts in the area of research on controlled thermonuclear fusion with emphasis on safety-oriented technological aspects focusing on work planned for NET (Next European Torus) as required by that project as well as fusion safety assessments, including the accomplishment of the construction and operation of the tritium handling laboratory;

- the establishment of reference methods and measurements in the nuclear area by the determination of nuclear data for standardization in the field of fission and fusion technology, by research on nuclear metrology, and by the provision of reference materials to calibrate analytical equipment and assess analytical methods through work in the Treaty-based Central Bureau for Nuclear Measurements and the organization of inter-laboratory comparisons;

- the strengthening of the economic and social cohesion of the Community. This will be achieved through exchange schemes for scientific and technical personnel from the public and private sectors in all Member States to the JRC and vice-versa for at least 120 persons, and through a scheme of associated laboratories fostering a close and permanent collaboration between these laboratories and the JRC, in particular with laboratories in Member States and their regions most interested in this scheme;

- increasing the scientific consensus on safety issues, in associating national laboratories, universities and industry to the JRC specific research programmes through technical meetings, exchange of personnel and, where possible, through the drawing-up of common studies and common projects;

- increasing industrial competitivity in accelerating technology transfer from JRC specific research programmes to industry, notably in implementing these programmes, when possible, in the framework of industrial cooperation, where exchange of personnel will be a vital component of the association.

Results

These appear in annual reports of the Joint Research Centre and of individual institutes and in topical reports, contributions to journals, international conferences, etc. An annual Publications Bulletin is published by the Centre.

JRC results also contribute to an increasing number of actions undertaken by other Commission Directorates General in which there is a significant scientific or technological content. These include the provision of scientific-technical support for policy formulation or proposals for regulations, standards, etc.. At the same time, analytical and laboratory support services are provided to give expert and neutral help as requested.

Laboratory services, existing large-scale facilities and consultancy are also made available to public and private bodies against payment where relevant facilities or competences are available at the JRC.

Evaluations

During the period from 1988 to 1992, a mid-term and and end of term evaluation have been carried out by panels of high level scientists under the respective Chairmanships of Dr. H.L. Beckers of Shell Research and Sir Hermann Bondi. As stipulated in the Council Decisions, these evaluations were performed by outside experts nominated after consultation with the JRC Board of Governors.

Mid-Term Evaluation

The Panel felt that good progress had been made in implementing earlier recommendations for improved efficiency of the JRC. The quality of the work itself, and the communication of results deserved praise.

The Panel recommended that the number of Institutes should be reduced, and in particular that the Centre for Information Technology and the Institute for Systems Engineering should be merged. Strategic planning should be strengthened throughout the JRC and its customers. The customer/contractor principle should be extended and intensified, especially as it applied to infrastructure services, and the relationship between the JRC and other Directorates General for whom it acted as a contractor.

The composition of the Board of Governors should be reassessed to include additional persons with industrial experience. Its method of operation should be reassessed to focus on more strategic issues.

Current recruitment procedures were unacceptable for an efficient research organization. The Institute Directors must be able to hire staff directly and rapidly. The JRC needed more flexibility in operation than was permitted by current constraints to act as an efficient research organization.

Upon advice from the JRC Board of Governors, the Commission has implemented these recommendations as far as possible within existing regulations for Community Institutions.

End of Term Evaluation

The Panel examined the work of the JRC from two points of view: its quality and its relevance. It also considered the administrative structure and the future programme proposals.

The Panel found the quality to be generally good, rising to excellent in some places.

The efforts of the JRC were relevant to the work of the Commission, a fact which was becoming recognized more and more. This was clear in the draft of the JRC Programme Proposal 1992-1994, but it was felt that this could be further enhanced in a significant way by certain adjustments. A general difficulty encountered in assessing relevance was the absence of an unambiguously defined mission for the JRC. In practice, however, an implicit understanding of the JRC's role was present among staff and management.

Linkages between the Institutes of the Centre and the international academic and technical Community both in universities and in industry were of outstanding importance. In this respect, every effort should be made to encourage visiting scientists, particularly senior ones, to work at the Institutes.

All the Panel noted with pleasure the level of enthusiasm and interest shown by the staff, the quality of the work done and the excellent equipment. Those members of the Panel who had known the JRC in previous times were much impressed by the progress made since their last visit. This applied particularly to one of the members who had been involved in the two previous evaluations.

Further progress along the same lines was highly desirable and required that the Commission established clearer goals. The management team had come far since the evaluation of the Panel of Senior Industrialists in 1987, but had reached limiting conditions under the present personnel regime. This should be rectified so that further substantial gains could be achieved.

Upon advice from the JRC Board of Governors, the Commission has taken into account those recommendations concerning the JRC Programme Proposal 1992-1994 and the longer-term planning for JRC activities.

Data on JRC programmes

Total budget allocation for work to be carried out under JRC Specific Programmes (Framework Programme)	700.00 MECU
Total committed	699.59 MECU
Programme Implementation:	
Date of Council Resolution (88/C/197/03)	29 June 1988
Date of Council Decisions (88/521/EEC; 88/522/EURATOM)	14 October 1988
Evaluations:	
Mid-Term Evaluation (SEC(90)35 final)	16 January 1990
End of Programme Evaluation (SEC(92)45 final)	17 January 1992

LIST OF EVALUATIONS, REVIEWS AND IMPACT STUDIES

The following list details the principal evaluations, reviews and studies used in the preparation of this Communication. Details of other reports used are given in the technical fiches on individual programmes. In each category, the reports are listed in the order of the Framework Programme, preceded by reports of a more general/horizontal nature.

i) Reports prepared for the Commission by an independent panel

Evaluation of the EC Research Training Fellowship Scheme (1968-1989) and of the ISC Fellowship Scheme (1985-1989). June 1990. EUR 12931

Report of the Framework Programme Review Board, June 1989

Inquiry on COST Efficiency and Mechanisms. September 1991. EUR 13992

Evaluation of the effects of the EC Framework Programme of Research and Technological Development on Economic and Social Cohesion in the Community. Forthcoming publication

Evaluation of the Fourth Medical and Health Research Programme (1987-1991). July 1990. EUR 13001

Radioprotection: Synopsis of results 1985-1989. 1990, EUR 13200

Radiation protection in the European Community, Evaluation and Suggestions. 1988, EUR 11449

Evaluation of the Radiation Protection Research Programmes (1980-1984 and 1985-1989). July 1989. EUR 12145

Evaluation of the Research and Development Programmes in the Field of the Environment (1981-1985 and 1986-1990). November 1988. EUR 11953

Communication from the Commission to the Council and the Parliament concerning a review to asssess the performance and results of the ESPRIT programme. SEC(89)1348 final

ESPRIT: Mid-term Review (in progress)

RACE: Programme management Audit: GEO180, October 1989

Establishing Advanced Communications in Europe: IBC Strategic Audit: February 1989

Perspectives for advanced communications in Europe: 1990

DRIVE Strategic Consultative Committee Report: June 1990

DRIVE Strategic audit report: November 1989

DRIVE: Final evaluation report (in preparation)

Final report on the DELTA exploratory action: May 1991

DELTA: Final Report on Performance and Results, March 1992, SEC(92)396 final

Final report on AIM. July 1991. SEC(91)1420 final

Final technical report on the AIM Exploratory Action: November 1990

Evaluation of specific activities relating to Aeronautics - BRITE/EURAM Area 5 (1990-1991) Final Report. June 1991. EUR 13524

Evaluation of the European Advanced Materials Research Programme - EURAM (1986-1989). November 1988. EUR 11950

Evaluation of the R&D Community Programme in Primary and Secondary Raw Materials (1982-1985). May 1989. EUR 12146

Evaluation of the Raw Materials Research Programmes on Wood and Cork (1982-1985 and 1986-1989). November 1988. EUR 11952

Evaluation of the Community Bureau of Reference cost shared research (1983-1987). December 1986. EUR 11358

Evaluation of the Biomolecular Engineering Programme BEP (1982-86) and the Biotechnology Action Programme BAP (1985-89). June 1988. EUR 11833

Evaluation of Agricultural Research Programmes. June 1989. EUR 12147

Evaluation of the Third Community Programme Radioactive Waste Management and Storage (1985-89). July 1989. EUR 12264

Evaluation of the Community Fusion Programme (1984-1990). July 1990. EUR 13104

Evaluation of the R&D Programme in the field of Non-Nuclear Energy. June 1988. EUR 11834

Evaluation of the Community Programme on Science and Technology for Development STD. October 1988. EUR 11951

Evaluation of the Science/Stimulation Plans. July 1990. EUR 12854

SPES: Evaluation Report 1992 (unpublished)

Large Installations Plan: Interim Evaluation Report 1992 (unpublished)

Evaluation Report of the EUROTRA Programme. July 1990. COM(90)289 final

EUROTRA assessment panel - Final report, October 1987

VALUE: Mid-term Review - Review Panel - February 1992

Mid-term evaluation of the JRC. JRC Evaluation Panel, December 1989. SEC(90)35

Evaluation of the 1988-1991 mutiannual research programme. JRC evaluation panel, 1991. SEC(92)45

ii) Commission reports based on work of outside experts/independent panels

Post-Chernobyl actions, Executive Summaries. 1990. EUR 13199

Progress report and 30 month review of RACE. December 1989. SEC(89)2050 final

DRIVE: Progress report and mid-term review. December 1989 SEC(89)1990 final

DELTA: Progress report and mid-term review: SEC(89)1989

AIM: Progress report and mid-term review: SEC(89)1989

Catalogue of BAP achievements, Elsevier 1990

Decommissioning: 1991 Programme Review Report

iii) Consultants' reports prepared for the Commission

Assessment of the impact of Community S&T policy upon Danish S&T policy, Copenhagen School of Economics, 1987

An overall evaluation of the state of R&D in Spain, CSIC, 1989

The impact of the EC's R&D policies on the R&D policies of the Federal Republic of Germany, ERA, 1988

Review of the EC R&D Framework Programme in Ireland, Fitzpatrick, 1990

Impact of EC S&T policy on Greek S&T policy, Paterakis, 1988

L'impact des programmes communautaires sur le tissu scientifique et technique Français, Armines, 1989

The impact of Community R&D programmes on S&T research in Italy, BGP Consulting, 1990

Evaluation du potentiel R&D du Grand-Duché de Luxembourg, J.P. Biname, 1991

Strategic effects of EC R&D programmes in The Netherlands, Andersen Consulting, 1989

Dutch participation in EC Framework Programmes, TNO, 1991

Evaluation of the impact of EC R&D programmes upon the competitiveness of European Industry: Concepts and Approaches.

Patents as indicators of the utility of EC R&D programmes. June 1991. EUR 13661

Key factors for industrial partnerships in EC programmes. September 1991. EUR 13991

The economic effects of strategic partnerships and technology cooperation. September 1991. EUR 13950

Measurement of scientific cooperation and co-authorship in CEC related areas of science. May 1990. EUR 12900

Analysis of the value added due to multinational university-industry partnerships in EC research projects - SPEAR Programme Report (in preparation)

Evaluation of Economic Effects: relevance and impacts of EC programmes promoting industrial R&D with special emphasis on small and medium size enterprises. 1992 (in preparation)

Impact of EC Large Installations and RTD Programmes: Focus on Greece. Unpublished SPEAR Programme Report. 1990

Research networks built up under the MHR programme. Forthcoming MONITOR/SPEAR report

The Greenhouse Effect and its implications for the European Community. 1990. EUR 12707

BRITE/EURAM/VALUE Evaluation Study. Bureau Van Dijk. March 1992

Flying ahead: a view of the future for civil aeronautics. January 1991. EUR 13334

Management Report BRITE/EURAM, Bossard Consultants, 1990

Public measures in leading industrialised countries for promoting the exploitation of R&D results Segal Quince Wicksteed Limited, March 1992

Study of approaches and practice in the exploitation of RTD results. Bossard consultant, 1990

Identification and Analysis of Trends and Objectives of the Information Technology Sector in the Medium and Long-Term and Development of Strategic Policy Options. Booz, Allen & Hamilton Inc., 1986

R&D in Information Technology. BIPE, December 1988

Study of the Impact of Information Technologies on Future Employment and Training Perspectives in the European Community. IFO/MERIT, February 1991.

IT 2000 - A Strategic Study on the Information Technology Industry. Price Waterhouse, July 1990.

iv) Commission reports

Industrial Policy in an Open Competitive Environment - Communication from the Commission to the Council and European Parliament - November 1990. COM(90)556.

The European electronics and information technology industry: state of play, issues at stake and proposals for actions - Communication from the Commission to the Council and European Parliament - April 1991. SEC(91)565.

Promouvoir les conditions de la compétivité des activitiés industrielles baséess sur la biotechnologie dans la Communauté - Communication de la Commission au Conseil et au parlement Européen - April 1991. SEC(91)629.

Radioprotection: 1990-91 Progress Report

ESPRIT 1989 Annual Report

ESPRIT Progress and Results 1990/91

Communication Technologies and Applications in Areas of General Interest: An overview of Direction F programmes and plans: September 1991

RACE'91: The RACE programme and project summaries: March 1991

DRIVE'91: R&D in advanced road transport telematics in Europe: April 1991

DELTA'90: R&D on information and communication based learning technology: July 1990

AIM'89/90: R&D in medical and bio-informatics: October 1989

BRITE/EURAM (1989-92) second year review report. SEC(91)311

BRITE/EURAM: Progress of the Programme (1986-1989)

The BCR Programme: Synopses of current projects 1987-1990. 1991. EUR 13451

ECLAIR-European Collaborative Linkage of Agriculture and Industry through research 1988-1993: Synopsis of R&D projects. August 1991

Large Installations Plan: Interim Evaluation Report 1992 (unpublished)

JRC Annual Report 1989. April 1990. SEC(90)575 final/2

JRC Annual Report 1990. March 1991. SEC(91)494 final

JRC Annual Report 1991. March 1992. SEC(92)527 final

v) Reports prepared by outside bodies

Court of Auditors' Special Report N° 2/91 (91/C 133/01)

Management, utilisation and evaluation of Community research and technological development. PE 153/50/rev

The Report of the EUREKA Assessment Panel, 1991

Controlled thermonuclear fusion. STOA study. PE 149 135