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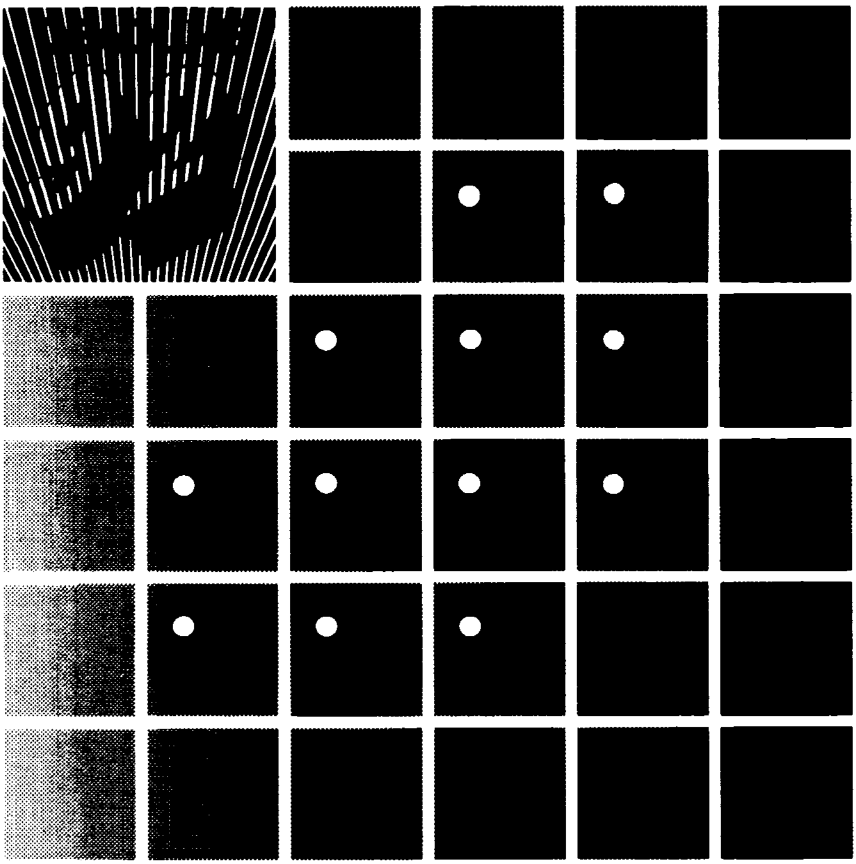
RESEARCH AND TECHNOLOGICAL DEVELOPMENT POLICY



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Research and technological development policy

(Third edition)

Paper drafted by Michel André and completed in December 1987

Contents

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Introduction

Scientific research and technological development are playing an increasingly important role in our societies. Over the years they have become a major focus of effort and investment. In Europe some of these activities are carried out in the framework of the European Community.

In the early days the Community's research activities were confined to coal, steel and nuclear energy, but since 1974 they have gradually been expanded to many other fields. Little by little a Community research and technology policy has evolved and has taken its place alongside the Community's agricultural, industrial and social policies.

The entry into force of the Single European Act in July 1987 was a landmark in this process.

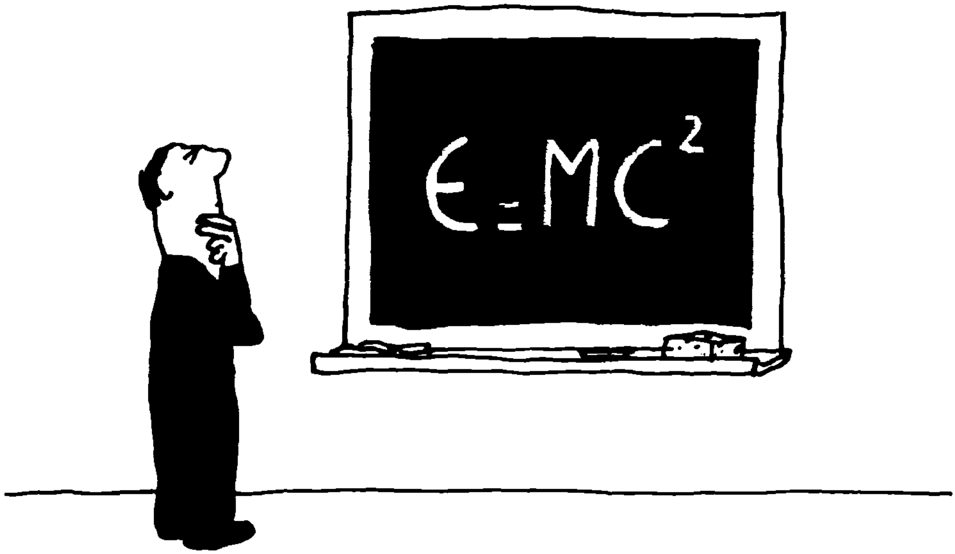
The Single European Act makes extensive amendments to the Rome Treaty. It contains provisions designed to speed up European integration by completing a vast single market by 1992, strengthening economic and social cohesion and cooperation in financial matters, developing the social and environment policies and — the point of interest to us here — establishing a European Research and Technology Community.

The Single Act gives the Community specific powers in the field of scientific and technical cooperation and forms a basis for the framework programme of research and technological development (1987–91), the general instrument for the Community's activities in this field.

The Community's research and technology activities are both diversified and selective. They centre on a few major topics (quality of life, information technology and telecommunications, energy, etc.) and the idea behind them is not to transfer to Community level as much scientific and technical work as possible but to concentrate on those activities in the Member States in which European cooperation offers obvious advantages and will generate a maximum of beneficial effects.

The pages that follow contain a full and clear description of these activities, the principles guiding them, the objectives pursued, the resources used and the results that have been obtained.

This description is organized as follows: the first chapter broadly outlines the European situation in the field of research and technology; it describes the difficulties facing Europe today and also its advantages; it illustrates the features of the current



situation that justify action at Community level and shows in particular that the prospect of completing the single market by 1992 is an important landmark on the R&TD horizon.

The second chapter is technical and institutional. It outlines the history of Community research, describes the legal bases for Community R&TD (research and technological development) activities, the resources available to the Community for these activities, the machinery used and the structures through which they are carried out.

The third chapter reviews field by field all the Community's research and technological development activities. The basis for this review is of course the framework programme (1987–91) which is divided into eight major lines of action.

In an effort to put the Community R&TD effort in perspective, the fourth and last chapter shows both how it dovetails with its immediate environment, i.e. the Community's other activities and policies, and how it fits into the wider context, all the scientific and technical cooperation initiatives organized outside the Community.

Research and technology in Europe

Science and technology in today's world

In modern society, research and technology play an increasingly important and central role. After steadily gathering momentum since the mid-14th century, scientific and technical progress ushered in some years ago in the western world a period of radical change dubbed variously 'the scientific and technical revolution', 'the third industrial revolution', 'the intelligence revolution', etc. Radical it certainly is in quantitative terms: the volume of R&TD activities in the developed countries and their economic importance are several orders of magnitude greater than at the end of the last century. Three million scientific articles are published every year in specialized journals, and at a rough guess more than 90% of all the researchers and scientists who have worked since the beginning of human history are living today.

Nevertheless, today's revolution is essentially qualitative. The second industrial revolution in the 19th century gave man the physical capacity to influence his environment on an unprecedented scale: the steam locomotive and internal combustion engine extended the physical potential of the human body. The fruits of the third industrial revolution are for the most part of a different sort: they allow man to transfer his intellectual capacities to external devices. At the same time, they extend his range of action to an extent unimaginable a hundred years ago by enabling him to influence the very heart of matter and of life: the knowledge on which they are based follows on from the basic discoveries made in these fields since Niels Bohr built the first model of the atom and Watson and Crick discovered the genetic code.

Because of the issues they raise and also because of the historical economic and political conditions that made the scientific and technical revolution possible, research and technology are (probably for a very long time to come) inextricably bound up with the operation of the political, cultural, social and other systems making up our society. Economists realized long since that research and technological development (R&TD) play a vital role in the process of economic development. Used wisely, science and technology can also help enormously to increase general well-being and improve the quality of life for individuals and society: science itself enables us to understand and correct the accidental harm done to the environment and human health by certain technical activities.

Situation of European R&TD

In the plethora of discoveries, developments and innovations generated by the third industrial revolution, what part does European R&TD play? Europe is the cradle of science and technology in the forms in which we know them today: until recently it was the home of all major breakthroughs. Sadly, Europe can no longer claim the lead in most of the major areas of research and technological development. In some fields (such as research on controlled thermonuclear fusion or particles physics), European research still leads the world but on the whole it has clearly lost ground — a situation all the more disastrous in sectors of exceptional economic importance such as electronics, information technology, the life sciences and materials science.

A few figures and examples show the scale of the problem: of the 37 technological sectors of the future that have been identified, 31 are dominated by the United States of America, nine by Japan and only two by Europe: software and electronic switching (some sectors being dominated by two countries equally). In 1986, four out of five patent applications for new materials were filed by US or Japanese companies. Of the 10 leading companies in the world in the computer industry, seven are American and two Japanese while the leading European company is back in 10th place. The picture for biotechnology and many other areas is similar.

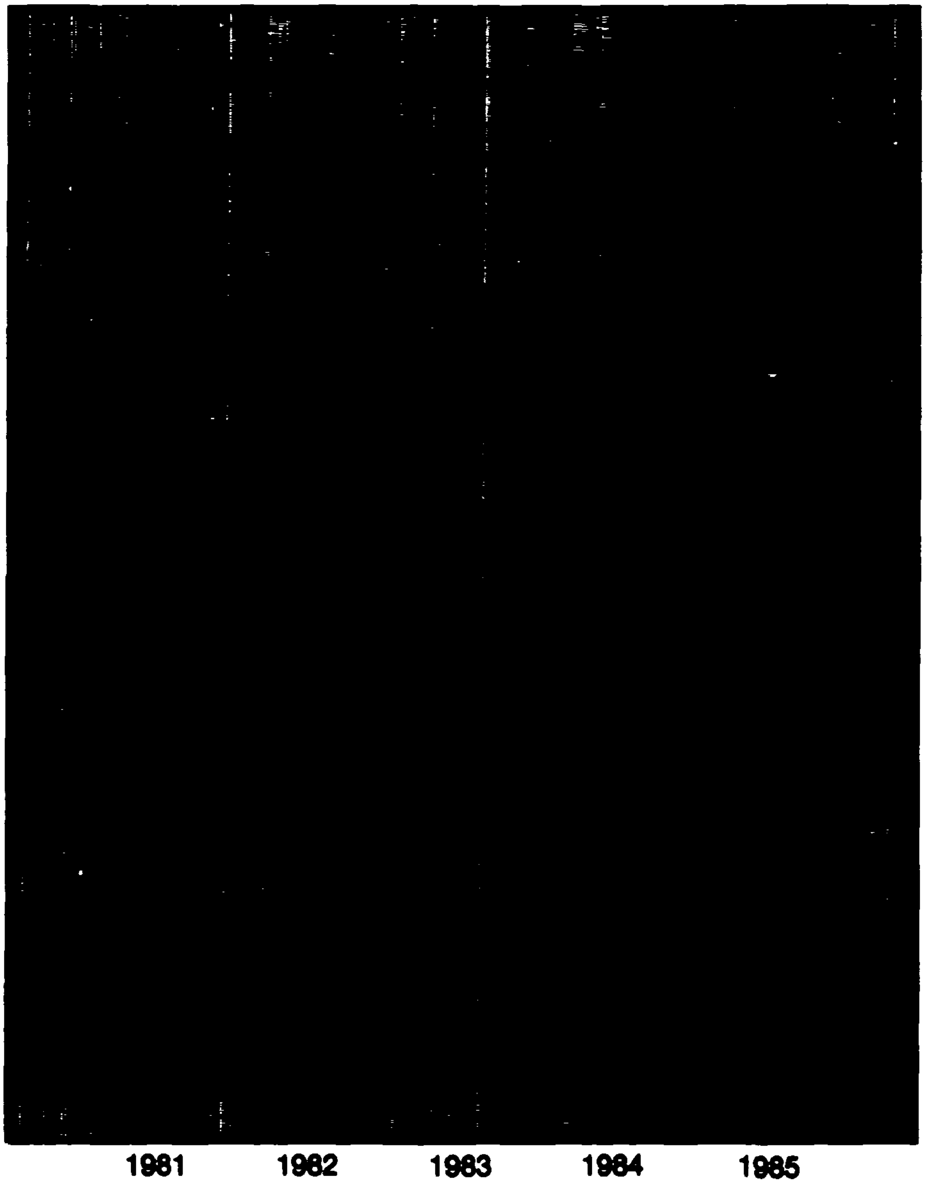
What are the reasons for this state of affairs? Partly the lower level of spending on R&TD: total European expenditure on R&TD in 1985 was 65000 million ECU compared with 146500 million ECU for the United States and 45800 million ECU for Japan (public, private, civil and military funding taken together). An estimate for 1987 to 1992 gives 1 million million ECU for the United States, 330000 million for Japan and 460000 million for Europe of the Twelve. The European research effort as a whole is therefore well below that of the United States in absolute figures and drops behind Japan when related to population.

Obviously this factor is not enough in itself to account for Europe's poor showing. Nor can it be put down to a lack of scientific and technical capacity or intellectual potential: the Community, with its 12 Member States, has more than a million scientists and technicians including 454000 researchers (compared with 723000 and 435000 in the United States and Japan respectively). And the standard of European researchers is also creditable: from 1950 to 1987 Europe claimed 86 Nobel prizes for science compared with 115 for the US and three Japanese laureates. Finally, with a GNP of USD 4 million million in 1985 (slightly higher than that of the United States and well above that of Japan) and a population of 325 million, Europe of the Twelve is today the largest market in the world.

Why then does Europe make such poor use of the immense scientific, human and economic potential that it appears to possess? There are many reasons. Let us try to identify them: insufficient attention to the problems involved in the follow-through

Estimate of gross domestic expenditure on R&TD
(Public and private, civil and military expenditure)
from 1981 to 1985

1 000 million ECU



Source: OECD.

from scientific research to technological development and then on to the market place; poor marketing techniques: the persistence in companies of organizational principles and training methods unsuited to the circumstances of the scientific and technical revolution; the lack of financial instruments to stimulate R&TD and the meagre venture capital available for investment in this field. All these factors will

Estimate of gross domestic expenditure on R&TD
(Public and private, civil and military expenditure)
in 1985

million ECU

FR of Germany	22 009
Belgium	1 542.6
Denmark	963.4
Spain	1 144.4
France	15 587.5
Greece	148.9
Ireland	192.4
Italy	6 307.4
Luxembourg	–
Netherlands	3 287.5
Portugal	111.6
United Kingdom	13 837.5

Source: OECD.

continue to constitute a drag on European R&TD until there has been a radical revolution in attitudes, practices, behaviour, culture and education in the Community.

Alongside these reasons, another group of factors can be identified; funds spread too thinly, research teams working in ivory towers, a lack of coordination, poor dissemination of information, inadequate mobility of research scientists, duplications in national programmes, differing strategies, disparities in standards, the lack of a real single market, etc. All these factors are obviously interrelated and at root they all stem from a single cause that is easy to identify: the division of Europe into many different countries.

European scientific and technical cooperation: necessity and virtues

Whatever might appear advisable in other fields, there is at least one idea that no one disputes today: European cooperation in research and technology is a vital necessity. This idea has gradually gained ground in scientific, industrial and political circles in Europe, all the more readily since modern science is, and is rightly perceived to be, a highly collective venture. It is clear today that in research and technological development Europe's only salvation lies in systematic and purposeful cooperation.

By coordinating their efforts, concentrating their facilities and combining their human and financial resources, the European countries can create the conditions that will enable them to make optimum use of their potential. Scientific and technical cooperation on the scale of the Community of Twelve will in many fields supply the necessary 'critical mass' below which there is little chance of R&TD yielding high-quality results. Through cooperation, full advantage can be taken of the complementary features in know-how, expertise and training found in Europe so that the whole becomes greater than its parts, and a combined research effort can be made in highly interdisciplinary fields, on topics calling for an intersectoral approach, etc. Cooperation will also allow full exploitation of the potential inherent in the large Community market, now close at hand, while at the same time helping to establish it.

Technological cooperation, industrial cooperation and the large market

This theme of the link between Community R&TD and the completion of the large market is sufficiently important to warrant a detailed examination of the aspects involved. The completion by 1992 of a large European market without frontiers, in which people, goods and capital would be able to move without hindrance, is indeed a challenge to the Community; the completion of this large market will be a vital landmark on the road to integration on which the European States took their first steps just after the end of the Second World War and which they have now been following for some 30 years. Obviously the whole of economic life in Europe will be affected by the forthcoming attainment of the large market. Numerous Community policies are therefore involved in this ambitious task. It can be shown, however, that there is a particularly strong link between the theme of the large market and the effort made by the Community to promote scientific and technological cooperation in Europe.

This link is particularly obvious in two areas: technical standardization and the opening-up of public procurement. In both cases, economies of scale are the factor linking up with R&TD. One of the most difficult obstacles that European industry has to overcome is the ever-growing cost of R&TD activities. The best way to cover this cost is to produce and sell each of the products developed in sufficiently large quantities.

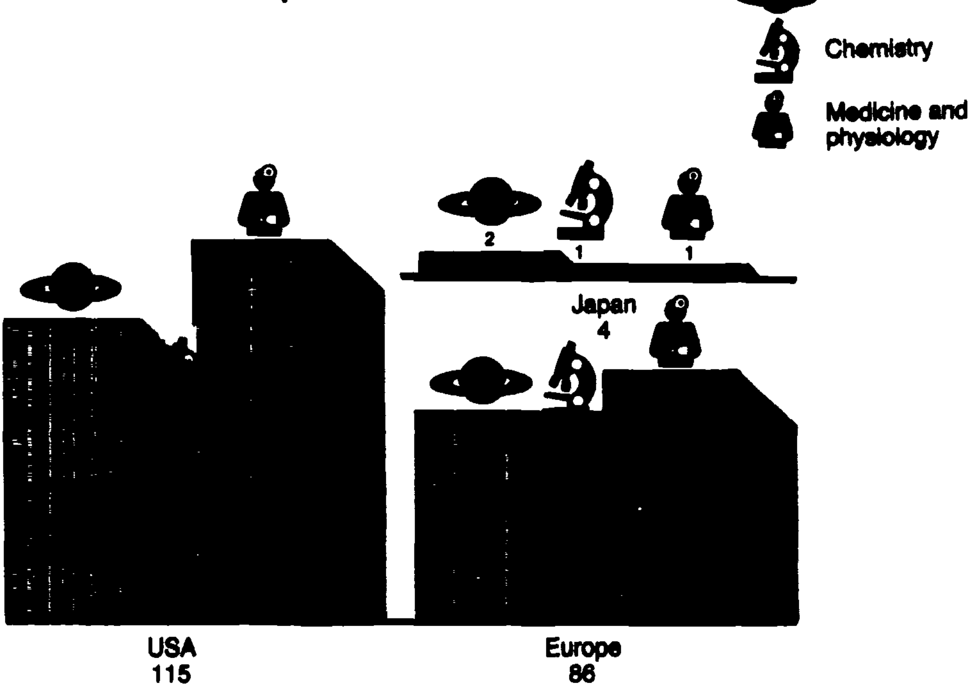
However, technical products in the market place are subject to a tighter system of standards than any other category of goods.

This would not matter if a single system were applied throughout Europe, but that is obviously not the case: the national systems of standards in force differ considerably from each other, thus depriving industry in Community countries of the benefits of economies of scale.

Aware of the importance of this problem, the Community has been working for years to bring differing national regulations closer together. The new approach it worked out in 1986 may be summarized as follows: it is the Community's task to lay down common essential requirements with which products must comply. The technical definition of standards corresponding to these requirements is the responsibility of the European standards institutions (essentially CEN and Cenelec, with which the Community maintains close relations). For example, in 1986 the Council adopted a directive on standards for direct satellite television broadcasting. It has also adopted two decisions on standardization in information technology and telecommunications and on the mutual recognition of terminal systems.

By helping to speed up the European standardization process, this strategy for the completion of the large market obviously creates conditions more conducive to the strengthening of European industrial competitiveness and hence its capacity to invest in R&TD. Reciprocally, the Community's efforts to promote cross-frontier cooperation in R&TD contribute directly to the success of this strategy, since it is obviously easier to draw up common standards on the basis of research carried out jointly, especially as some of this research has the specific aim of facilitating standardization work.

Nobel prizes from 1950 to 1987



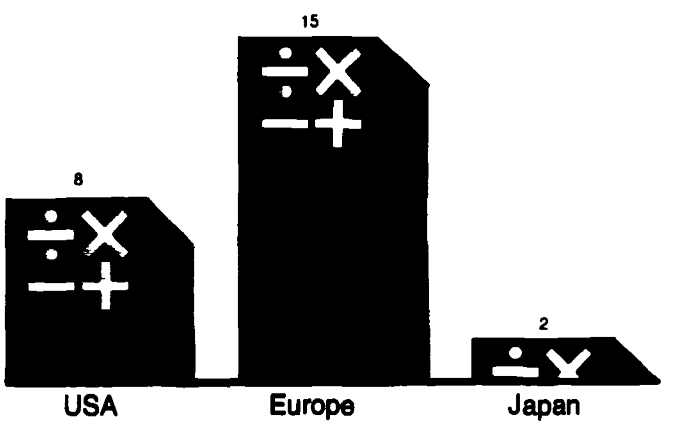
The walling off of public procurement markets is a similar problem. The result obviously is to create as many captive markets as there are Member States and to make it impossible for European manufacturers to extend their activities to all 12 countries. The value of public-sector orders is considerable: procurement by public departments constitutes 10% of the Community GDP, or 20% if public-sector undertakings are included. Of all public contracts, however, only 2% go to companies located in other Member States.

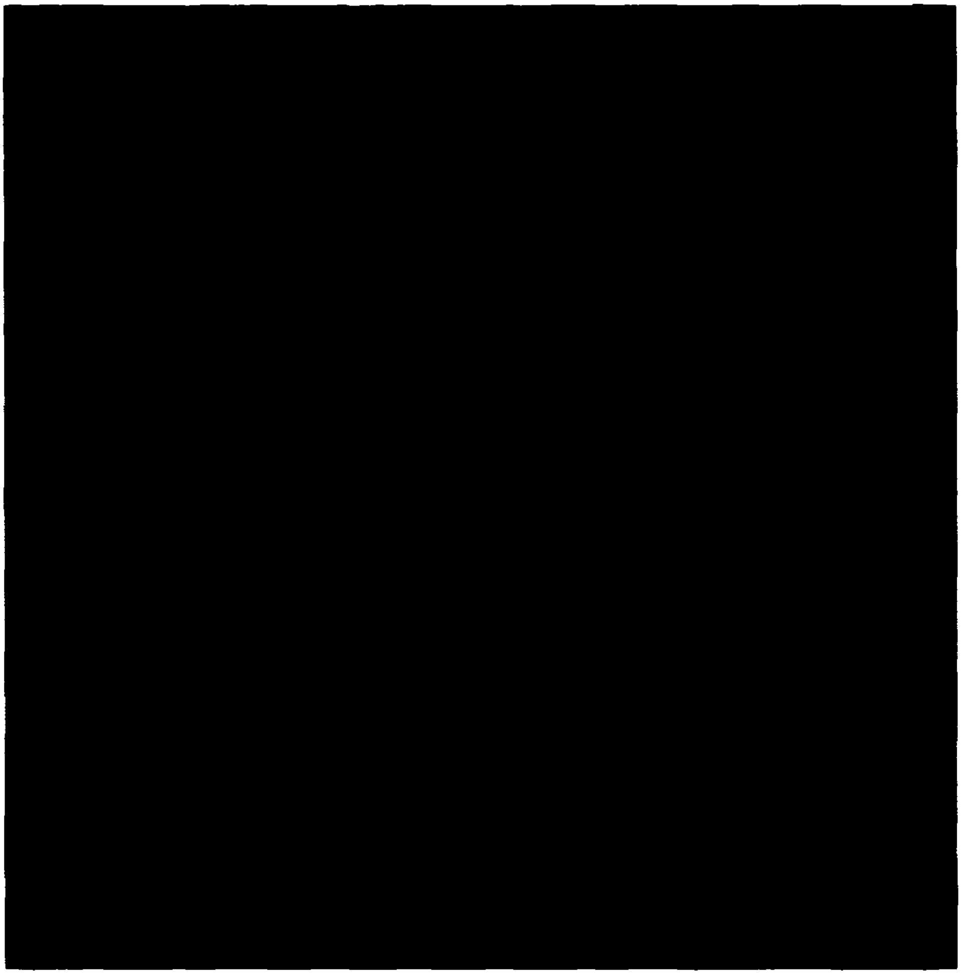
An important point here is that the share of public-sector orders in some technological areas is well above the average: for telecommunications, for example, it is 25%. This shows how important the Community's policy of opening up access to public contracts is for European technological development. Here again the Community's action in the field of R&TD could not be defined without considering the other dimensions involved in the construction of the large market, an important landmark on the horizon.

A parallel may be drawn here between Community initiatives on technological cooperation and recent legal initiatives designed both to promote European industrial cooperation in the widest sense of the term and to create as homogeneous as possible an economic environment in Europe. The former include the concept of 'European economic interest grouping', a legal structure equivalent in Community law to the industrial cooperation arrangements existing in the national laws of certain countries. The latter include all the directives adopted on company law so as to harmonize the rules applicable to mergers and divisions of companies, presentation of annual accounts, etc.

Closer to and strictly complementary with the Community's direct action on R&TD are its initiatives in connection with financial engineering for research and technological development activities. In the technological development process there is an intermediate stage at which the projects are not risky enough to warrant direct public financing, even in part, and yet are too risky for a normal bank loan. Aware of this gap and the need to strengthen European financial engineering capacity for R&TD, the Commission has examined the possibility of creating suitable instruments to finance cross-frontier cooperation projects in advanced technology (for example, the Eurotech Capital companies which would finance projects of this kind by taking a temporary minority holding and the Eurotech Insur guarantee scheme designed to give partial cover for losses resulting from the risk inherent in the investments of Eurotech Capital companies).

Fields medals
('Nobel prize' for mathematics, awarded every four years)
from 1950 to 1987





Testing a hearing aid following implantation (medical research programme).

To give a further illustration of the way in which the impending prospect of the large market constitutes a landmark for Community R&TD, the Community initiatives on research scientist mobility (to be discussed later) will have to be backed up and supplemented by various legal measures to make it easier for scientific equipment to cross frontiers or to overcome welfare problems created by mobility (social security coverage, retirement pensions, etc.). The work done on the related problem of student mobility (briefly touched upon in the last chapter) may be compared with the new approach being promoted by the Commission to the equivalence of qualifications, which should lead to the establishment of a general system for the mutual recognition of qualifications based not on the strict harmonization of curricula but on the comparability of training and mutual confidence between the Member States.

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Community R&TD: history, structure, ways and means

Since the end of the Second World War, alongside the building of an economic and political Europe, there have been many scientific and technical cooperation ventures on a European scale in such fields as particle physics, molecular biology, nuclear fusion, aviation, space and information technology. The European Community, the clearest expression and most powerful instrument of European integration, has over the years steadily strengthened its contribution to this many-dimensioned effort.

To give a better idea of its past and present contribution, some general information on the Community research and technology policy is needed before going on to a line-by-line description of the content of the framework programme for research and technological development (1987–91), the current instrument of that policy. The background to the Community's R&TD policy, its legal bases, the nature and purposes of the framework programme (1987–91) and finally the resources, structures and mechanisms of Community research will all be described in turn.

Background

The idea that the Community offered a natural and particularly appropriate setting for scientific and technical cooperation did not escape the founders of Europe: the history of Community research is as old as that of the Community itself, and like it has gone through a continuous process of growth and maturing leading to the conquest of new fields and the increased dovetailing of its activities. In its current form, the Community's action in the field of research and technology embraces several types of activities that have grown up over the years, as and when new fields emerged in which European cooperation appeared likely to be advantageous and in which the value of new forms of cooperation became evident.

The first area of Community R&TD was also the first field in which there was general Community cooperation: in 1951, the Six signed the ECSC Treaty establishing a European Coal and Steel Community. In 1955 a scheme for aid to research in those two sectors was introduced. It is still working today: the various programmes it covers are regularly renewed.

In 1957 the EEC Treaty establishing the European Economic Community and the Euratom Treaty establishing the European Atomic Energy Community were signed in Rome. The Joint Research Centre (JRC), the European Community's own research centre, was then set up under Euratom. Its task was the joint development of the know-how and techniques required for the industrial use of nuclear fission energy. Because of the difficulties experienced in Euratom at the end of the 1960s (by which time independent nuclear systems had been developed in France and Germany), the JRC gave up its research on new types of reactor. In the early 1970s, while concentrating its nuclear work on safety, the JRC diversified its research by embracing other fields: the environment, solar energy, materials, etc.

This new lease of life for the JRC coincided with a period of more general importance in the history of Community R&TD. Early in 1974 the Council of Ministers decided to extend Community research activities to the whole of science and technology (with the exception of research covered by military secrecy) and instructed the Commission to implement several major sectoral research programmes. The first main areas covered by such programmes were energy, the environment and raw materials, and new programmes have taken over today in all these areas. The 1980s saw the emergence of a whole series of highly integrated second-generation programmes in major technological areas: information technology, biotechnology, materials, etc. The research included in these second-generation programmes has three specific features: it brings together universities, research centres and industry, it combines the resources of different disciplines, and it is generally conducted in the form of transnational projects.

The legal bases

Like all the other Community policies, the Community's R&TD policy (and the activities to which it leads) has its foundation in Community law: it has a number of legal bases in the three Treaties establishing the European Coal and Steel Community (ECSC), the European Atomic Energy Community (Euratom) and the European Economic Community (EEC). The Euratom Treaty provides an explicit legal base for Community research on nuclear energy. Community coal and steel research is based on Article 55 of the ECSC Treaty which promotes technical and scientific research intended to increase efficiency and improve safety in the coal and steel industries. The Community's action in other scientific and technological fields was for a long time based only on a very general article of the EEC Treaty, Article 235 (with the exception of agriculture and fisheries research based on Article 43).

In 1987, however, things changed: the Single European Act which entered into force in July explicitly legitimized the Community dimension of scientific and technical cooperation in Europe by giving the Community formal powers in the field of research and technology. The Single European Act makes substantial amendments to the Treaty of Rome. It contains provisions intended to speed up European integration by completing the large single market by 1992, strengthening economic and social cohesion and cooperation in financial matters, developing the social and environment policies and — the point of greatest interest here — establishing a genuine European Research and Technology Community.

The Single Act adds to Part Three of the EEC Treaty a Title VI, Article 130 F of which reads as follows: 'The Community's aim shall be to strengthen the scientific and technological basis of European industry and to encourage it to become more competitive at international level. In order to achieve this, it shall encourage undertakings, including small and medium-sized undertakings, research centres and universities in their research and technological development activities; it shall support their efforts to cooperation with one another, aiming, in particular, at enabling undertakings to exploit the Community's internal market potential to the full, in particular through the opening-up of national public contracts, the definition of common standards and the removal of legal and fiscal barriers to that cooperation. (...)'.

In the following articles the Single Act sets up a two-part mechanism. First, unanimous adoption by the Member States, after consulting the European Parliament and the Economic and Social Committee, of multiannual research and technological framework programmes which lay down the main scientific and technical objectives, define their respective priorities, and fix the amount deemed necessary for all the planned activities and its breakdown amongst those activities. Secondly, implementation of the framework programme through specific programmes adopted by the Council by a qualified majority (except where they come under Euratom where the rule of unanimity still applies), after consulting the Economic and Social Committee and in cooperation with the European Parliament.

The concept of framework programmes is in fact much older than the Single Act. As the Community's R&TD activities grew and diversified, it became increasingly necessary to coordinate them within a general structure giving an overall strategic view of what was going on. In 1984 the Community therefore decided on the first framework programme (1984–87), but it is the Single Act that has institutionalized this concept and allowed its full potential to be developed. The 1987–91 framework programme of research and technological development is based on the Single Act.

What is this framework programme? The multiannual framework programme is a medium-term instrument for the programming of the European Community's activities in the field of research and technological development. By laying down the objectives, priorities and overall budget for the Community's activities and breaking it down into lines of action, it forms a guide for specific programme decisions to be taken during the five years it covers. Another of its deliberate aims is to familiarize scientific institutions, companies and the Member States with the research opportunities offered by the Community in the medium term. By providing clear information on the specific activities the Community intends to undertake, it helps the European research world to plan its own work better and enables Community research to play its proper part in the panoply of European cooperation projects.

What are the precise aims of the framework programme (1987–91)? What are the motivations behind it? To the Community authorities, this first framework programme based on the Single Act is the Community's response to a challenge facing it today: the need to maintain and strengthen the international competitiveness of its industry in high technological value-added sectors in order to stand up to the United States and Japan. This is a challenge to which it should be equal if it can count on the pooling of the complementary scientific and technical resources available in each of the Member States.

There is a clear link between the framework programme and the first of the six major fields of action covered by the Single Act. In a nutshell the task of the framework programme (1987–91) is to speed up the establishment of a general 'European scientific and technical area', an authentic 'European Research and Technology Community'. And this Community, as we have seen, is an essential component of the 'large Community market' which the Commission has taken as its target for 1992. The thinking behind the framework programme (1987–91) is simple. There is of course no intention of transferring to the Community as much as possible of the research being done in Europe (which would be nonsensical); the basic idea is, from a strategic viewpoint, to carry out at Community level only that research for which one reason or another can more usefully, more economically or more efficiently be done there: research in areas in which the problems are naturally European in scale such as environmental protection or health, research which is beyond the financial and human resources of a single Member State such as controlled thermonuclear fusion, research facilitating the establishment of the internal market by providing bases for common standards and, more commonly, research in areas in which it is essential to make maximum use of the complementary know-how and expertise existing in Europe: it stands to reason that no Member State has at its fingertips all the expertise in every field.

Ways and means

As conducted through the framework programme (1987–91), Community R&TD essentially takes three forms which are traditional to it. The first is in-house research carried out at the JRC. The JRC consists of four different establishments at Ispra in Italy, Karlsruhe in the Federal Republic of Germany, Petten in the Netherlands and Geel in Belgium. It employs 2 260 people, 1 760 of whom are scientific and technical staff. As mentioned earlier, the JRC originally concentrated exclusively on nuclear fission research, but has gradually diversified into other areas: materials, environment, remote sensing, industrial risk, etc. Its nuclear energy research (fission and fusion), which still accounts for a considerable share of its activities, is now concentrated on safety issues in which it has gained widely recognized experience.

The JRC meets the Community's need for an in-house research capacity in key areas relevant to its responsibility. The Centre is currently moving towards an increase in industrially-oriented research (in particular relevant to the completion of the large market), greater flexibility and decentralization of its management, the development of a fairly large volume of research carried out under contracts with outside clients and the strengthening of the Centre's financial independence.

Computer-assisted designing of a component of the NET (Next European Torus), the next experimental thermonuclear fusion machine (JRC, Ispra establishment).

The second form, which accounts for the largest share of Community R&TD, is shared-cost or contract research. This is carried out in research centres, universities and companies in the Community with financial aid from the Commission and under conditions defined by the rules for participation in the various programmes. Community financial aid generally amounts to 50% of the total cost of the research. Most of the specific research programmes are carried out in the form of shared-cost research. This type of research finds its most advanced form in the second-generation programmes for which Esprit served as a pattern (RACE, Brite, Euram, etc.), all programmes with highly integrated projects, the spirit and certain characteristics of which are also now found in the latest versions of older programmes.

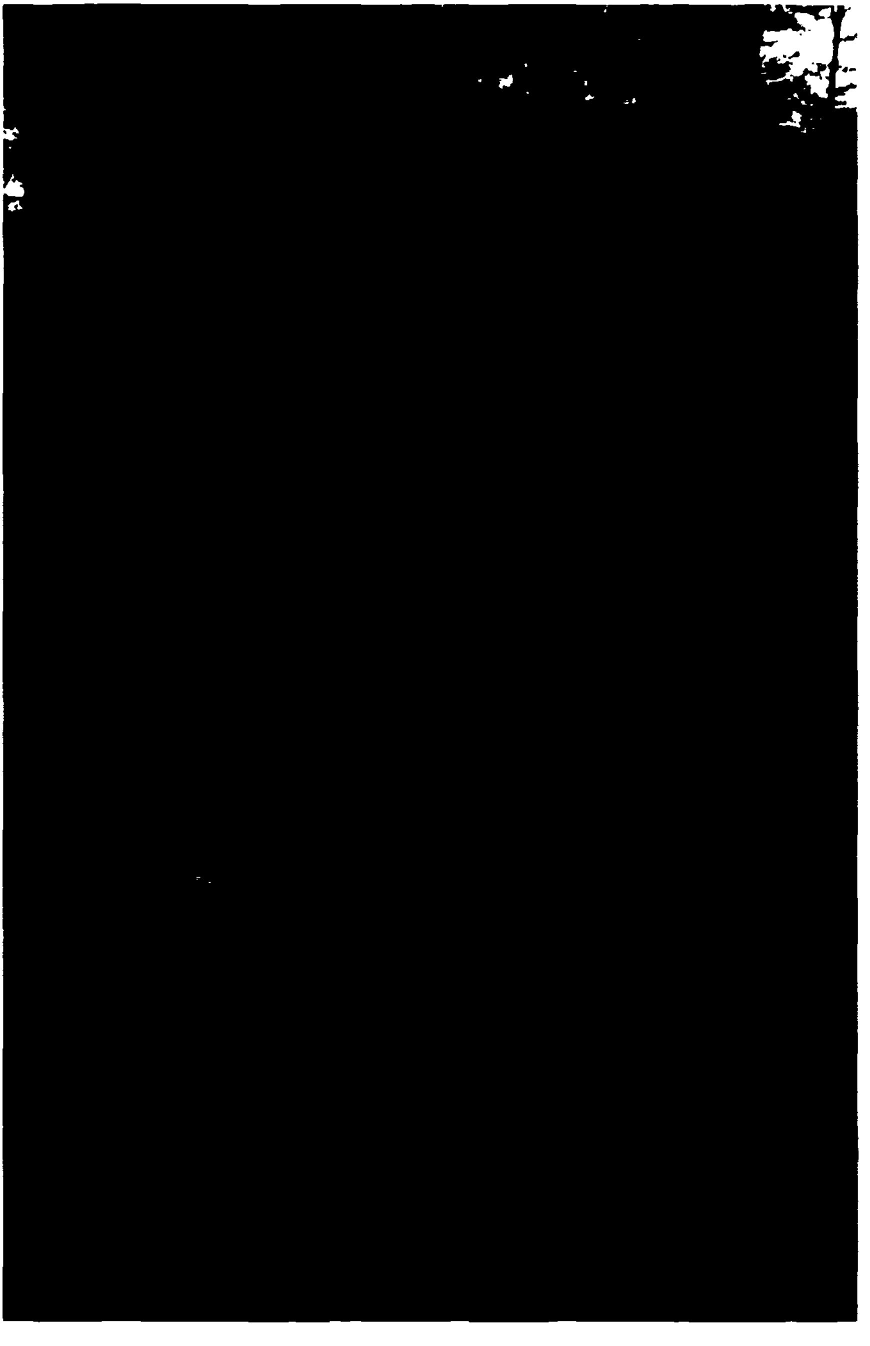
The third form taken by Community R&TD is the concerted-action project. Here the Community does not finance the actual research but ensures close coordination of the work done at national level and pays the costs of coordination: definition of subjects and objectives, exchanges of information, publication, etc. Part of the work (sometimes a substantial part) on certain specific programmes and the whole of the Community medical research programme are carried out in this form.

Community R&TD is not strictly limited to these three conventional forms. It may be carried out under structures such as the 'joint venture' set up for a specific task, for example the JET joint venture for controlled thermonuclear fusion research. This very flexible system also allows complementary programmes in which only those Member States that are interested take part, Community participation in programmes being conducted by certain Member States, cooperation with non-member countries and international organizations, etc.

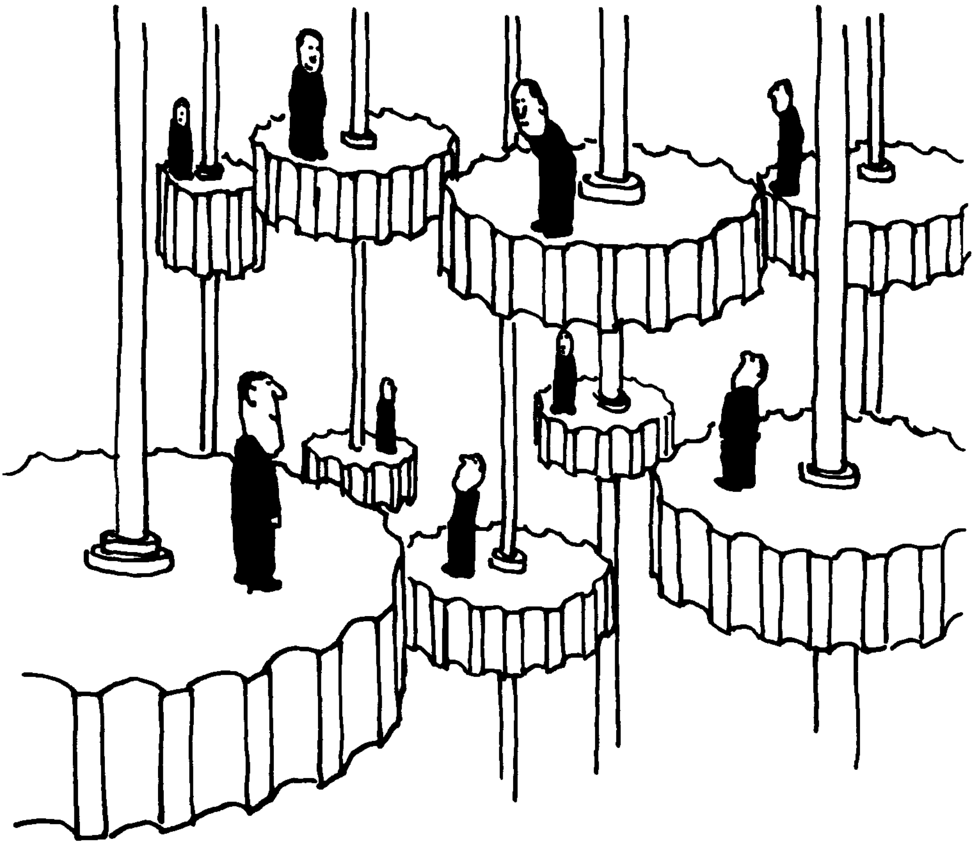
Structures and mechanisms

Finally, a few words about the structures and mechanisms of Community research. In R&TD, as in other Community fields of action, the decision-making machinery is relatively complex. The rules applicable are those governing the functioning and relations of the four main Community institutions: the Council, the Commission, the European Parliament and the Economic and Social Committee. Until recently the respective rules of these institutions could be summarized as follows: the Commission proposes and implements, the Economic and Social Committee and Parliament deliver opinions and the Council decides.

With the entry into force of the Single Act this picture has changed and Parliament now plays a greater part in the decision-making process. In some fields covered by the Single Act (including R&TD) decisions taken by the Council by a qualified majority go through the 'cooperation procedure'. This provides for two readings of the



Device to study changes in the soil due to acid rain (environmental protection research programme).



Commission proposals, by Parliament and by the Council. As a result, while the Commission's power of initiative is maintained, Parliament prerogatives are strengthened to give it a direct influence on Council decisions, even though the Council always has the last word.

In preparing and managing R&TD framework programmes and specific research programmes, the Commission is assisted by a number of committees whose members include senior officials of the Member States together with scientists and experts. Three of the most important committees with general responsibilities are Crest (Committee for Scientific and Technical Research) consisting of senior officials from national ministries responsible for science policy (it advises both the Commission and the Council of Ministers), Codest (Committee for the European Development of Science and Technology), whose 24 members are eminent figures from the scientific world, and Irdac (Industrial Research and Development Advisory Committee) with representatives from European industry.

The individual programmes are prepared and carried out with the help of a number of advisory committees for each of the sectors concerned. Routine management of the Community R&TD programmes is in the hands of various groups of specialized Commission officials. Scientists by training, often coming from university laboratories or industrial research centres, these officials play an active part on the scientific side of the programmes: from their central position, they do much to speed up the circulation of ideas and dissemination of knowledge.

FRAMEWORK PROGRAMME OF COMMUNITY ACTIVITIES IN THE FIELD OF RESEARCH AND TECHNOLOGICAL DEVELOPMENT (1987–91)

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

The framework programme (1987–91) and the Community's principal fields of action

Let us now take a look at the eight main lines of action set out in the framework programme (1987–91). For each of them, the type of research involved will be defined and the programmes embodying it briefly described.

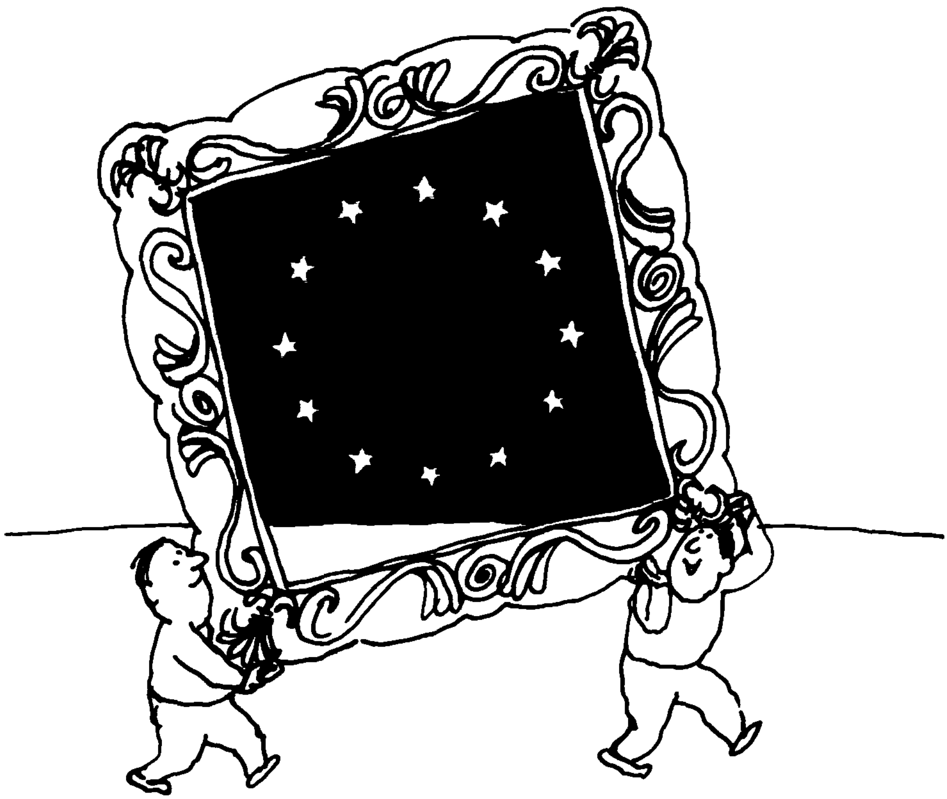
Quality of life

The quality of life covers a vast area. In its research programme the Community has decided to concentrate on three sectors of particular importance in which there are problems which to some extent call for advances in knowledge and technology if they are to be solved. These are health, radiation protection and the environment.

For some years the Community has been engaged in medical research through a European programme coordinating national medical and health research. The programme takes the form of concerted-action projects mentioned earlier.

The fourth medical research programme (1987–90) has two major objectives: cancer and AIDS, two of the most serious health problems of our times. The choice of cancer as a priority for the fourth programme ties in with the wider action programme 'Europe against cancer' adopted by the Community following the European Council meeting in Milan in 1985 and several subsequent meetings of the Council of Ministers. This action programme reflects the determination expressed on both occasions to engage in a common fight against cancer, a disease which, although curable in 40% of cases, is responsible for a growing number of deaths in the Community.

The picture is the same for the Community's work on AIDS. The AIDS section of the medical research programme is also the spearhead of a campaign being waged on a much wider front: exchanges of experience, especially as regards information for the general public and health education, joint examination of the relevance of regulatory measures that might be taken (a notification scheme, more or less systematic screening, etc.).



The scope and gravity of the problems caused by the AIDS epidemic justify support, in Europe as elsewhere in the world, for an extensive and closely coordinated research effort. The main aim of the AIDS section of the Community's medical research programme is to ensure coordination on a European scale. The projects involved cover the various aspects of the medical problems raised by AIDS: epidemiological forecasting and surveillance, study of the interaction between the AIDS virus and the human organism, research on the development of therapeutic substances and vaccines, including *in vitro* testing and the essential animal experiments, etc.

As well as these two aspects the programme covers a range of other topics, some of which have already been studied under previous programmes while others are completely new: age-related health problems (cataract, senile dementia); health services research (assessment of early detection programmes and care delivery systems); medical technology (nuclear magnetic resonance (NMR) imaging or positron emission tomography); computerization of electro-encephalography; medical uses of the laser, etc. In addition to the medical research coordination programme, the framework programme (1987–91) will include specialized activities on predictive medicine and novel therapies.

The second dimension of the quality of life in the framework programme (1987–91) is radiation protection. Radiation protection research includes the study of the effects of radioactivity on the organism, genetic effects and environmental impact, risk evaluation and optimization of protection again ionizing radiation, the development of treatment for radiation, etc. The Community radiation protection programme comes under Euratom. It embraces more than 30% of all research on the subject carried out in the Community countries. Over the many years that it has been in effect the programme has accumulated a vast store of know-how in many fields.

The effects of radiation from natural sources is a good example. Natural radiation accounts on average for about 70% of the radiation to which the population is exposed. Half of this is due to radon, a radioactive gas contained in certain rocks that can be dispersed by the soil and by construction materials. Another set of research

Microelectronics: strip of microprocessor chips (Esprit programme).

projects concentrates on medical uses of radiation, the second largest source of exposure to ionizing radiation. This occurs essentially during radiological examination, the number of which is steadily increasing as the health of the population is more closely monitored. A third section of the programme deals with the risks arising from exposure to ionizing radiation. One question requiring special study, for example, is the determination of the risks inherent in exposure to low levels of radiation.

In the field of radiation protection a whole category of problems was brought spectacularly into the spotlight by the 1986 accident at the Chernobyl nuclear power station: these concern the evaluation of the radiological consequences of nuclear accidents. They have for years been the subject of research under the Community's radiation protection programme. However, the Chernobyl accident clearly demonstrated the need to step up this research while at the same time providing an opportunity to validate existing models for atmospheric, aquatic and terrestrial dispersion of radionuclides and for transfer through the food chain, etc.

The last aspect of the quality of life covered by the first action line in the framework programme is the quality of the environment. Here the framework programme (1987–91) provides for a wide range of activities. Some of them are being conducted under a shared-cost research programme (1986–90) on environmental protection in the strict sense of the word. This programme covers all the research sectors concerned by the problems of environmental protection: soil protection, pollutant pathways and transfer in ecosystems, effects on the organism of exposure to low levels of heavy metals over a prolonged period (for example, the effects of low doses of lead on the central nervous system), quality of surface waters, fresh and sea water and estuary waters (eutrophication of lakes), methods of processing toxic and dangerous industrial waste, the dieback of forests and the exact role (probably less important than was believed some years ago) played by acid rain and fog, elucidation of the way in which these are formed, etc.

Alongside and closely linked to the environmental research programme, the Community is also organizing a shared-cost programme on climatology. It is a direct extension of the earlier programme since its central theme is the study of the impact of human activities on climatic systems. One problem studied under the climatology programme is the accumulation of CO_2 in the atmosphere (as a result of the massive use of fossil fuels) and the greenhouse effect that it causes.

These two programmes are accompanied by a third shared-cost programme on major technological hazards. It is intended to give a better understanding of the mechanisms involved so as to help mitigate the consequences of chemical or petro-chemical accidents and consists essentially of modelling work.

A significant proportion of the research on the environment is carried out by the Joint Research Centre. The Ispra establishment of the JRC is for example developing its

Ecdin data base, which today contains more than 5000 toxic substances, with details of chemical structure, properties, precautions for use and what to do in the event of accidents, effects on the organism, etc. The JRC is also completing the Lidar airborne system which it designed for the characterization of oil slicks at sea, based on the principle of laser-induced fluorescence. It is continuing its research on indoor pollution (air pollution in residential and working premises) and the side of its remote sensing activities that is relevant to the study of marine pollution, etc.

Information technology and telecommunications

Information technology and telecommunications, now a vital factor for industrial competitiveness, constitute the fastest growing sector in the world and one in which European technological dependence is high: the Community's trade deficit for electronics was approximately 15000 million ECU in 1986 and European manufacturers today hold no more than 25% of the world market in information technology and telecommunications. The European market represents 12% of world demand for integrated circuits and 26% of world demand for information processing and office systems and yet the share of the world market going to European firms in those two subsectors in only 9% and 24% respectively.

A look at the economies that have succeeded most spectacularly in this field shows that their success is due to a combination of factors that until recently were not found in the European economy. Two of these factors are particularly significant. The first is the existence of a strong scientific and technical base resulting from spontaneous or organized cooperation between universities, research centres and industry. The second is the existence of a vast internal market capable of absorbing a large production and offering economies of scale to its industries. These two factors tend to ease the severest constraint on industry in the information technology and telecommunications sector, the steadily increasing cost of R&TD investment, the volume of which continues to grow as technological development speeds up (the life of a generation of electronic components today is no more than two years): industrial cooperation enables the investment cost to be spread and economies of scale reduce the payback time.

On the basis of these findings, the Community has defined a policy for IT and telecommunications incorporating several inseparable features which should help European industry to increase its competitiveness in IT and telecommunications and to acquire both on the world market and on its own European market a position more in keeping with its considerable, if poorly exploited, technological potential. The two most important components are the strengthening of the Community's technological capacity through R&TD programmes carried out by cross-frontier cooperation between universities and industry and the establishment of a vast internal market for IT and telecommunications products and services with all that this involves in the way of a common standardization policy: encouraging the early definition of standards, protocols and technical specifications, in particular on the basis of the work done under the Community's R&TD programmes.

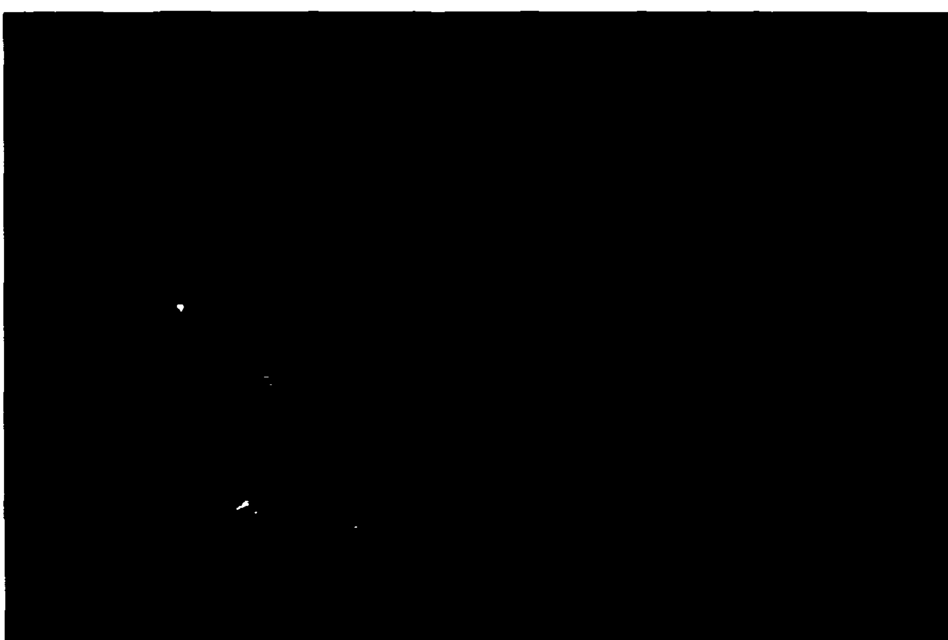
These R&TD programmes, it is clear, are the spearhead of the European strategy for IT and telecommunications. They account for a considerable proportion of all Community R&TD activities: 45% of the total amount of the framework programme (1987-91) goes to them.

'Hot cell' for handling radioactive materials (JRC, Ispra establishment).

The first of the Community IT and telecommunications programmes to be implemented (and the most ambitious in volume terms) is the Esprit programme. Esprit (European strategic programme for research and development in information technology) first saw the light in the early 1980s. It was devised by the Commission after extensive consultations with the academic world and the industries concerned, both large and small firms, and was designed for a 10-year period (1984–93).

The projects carried out under Esprit necessarily involve two or more independent industrial partners from two different Member States. All participants in the programme are linked to each other by an electronic information network, the Eurokom system.

After a brief pilot phase, Esprit got off the ground in 1984. The first phase covered five major sectors: two basic technologies, advanced microelectronics (very large-scale integrated circuits) and software development; two application areas, office systems and computer-integrated manufacturing (robotics, computer-aided design, automatic assembly, computerized management networks, etc.) and finally advanced information processing to provide the link between the other two (highly parallel architectures, voice and image recognition and synthesis, etc.).



In vitro *vegetative propagation of field beans* (vicia faba) *by multiplication of adventitious buds (biotechnology programme).*

The first phase of Esprit had a budget of 1500 million ECU (750 million of which came from the Community) which financed 219 projects involving 450 different partners, more than half of whom were manufacturers; amongst these were some 170 companies with less than 500 employees.

It is generally recognized that the first phase of Esprit, in which some 3000 researchers were involved, was instrumental in sparking off genuine European cooperation in information technology. It provided an opportunity for European academics and manufacturers to get to know each other, to learn to work together and often to discover unexpected partners.

The first phase of Esprit rapidly yielded significant results: one example from the field of microelectronics is the design of a bipolar gate array circuit of 10 K gates with an access time of 200 picoseconds, for which a production line has just been set up. In advanced information processing several Esprit projects led to interesting developments concerning the logical programming language Prolog. A new Prolog compiler, Prolog-Bim, generating a particularly fast-running object code was put on the market some time ago. Under a project headed by the creator of the language himself a more efficient version of Prolog (Prolog III) has been developed. A major motor manufacturer was also associated with the project: Prolog III was used to produce an expert system for detecting engine defects. In the field of software engineering mention may also be made of the work on the PCTE (portable common tool environment) system designed to standardize interfaces between components of software environments. Six of the main European computer manufacturers were involved in the project which yielded practical industrial applications, for example the Emeraud software.

The budget for the second stage of Esprit was double that of the first. Three R&TD areas were selected for the second phase: microelectronics and peripheral technologies, information-processing systems and IT application technologies. In each of them the emphasis is on topics shown by a study of the current IT situation to merit priority: high-density integrated circuits, multifunction integrated circuits, peripheral technologies, systems architecture and knowledge engineering, etc.

Generally speaking, special importance is given to application technologies (computer-integrated manufacturing, robotics and office systems) and to technology transfer.

Related as it is to information technology, telecommunications is a sector of an importance that cannot be exaggerated: the telecommunications infrastructure will have an extremely strategic role to play in the general economy in the years ahead since its influence on all aspects of economic life is growing at an exponential rate. In only a few years it has become the focus of both public and private investment.

These general comments naturally apply to Europe as well: the telecommunications sector, which in 1984 accounted for only 2% of the Community's gross domestic product, should generate 7% by the end of the century; by the year 2000 between

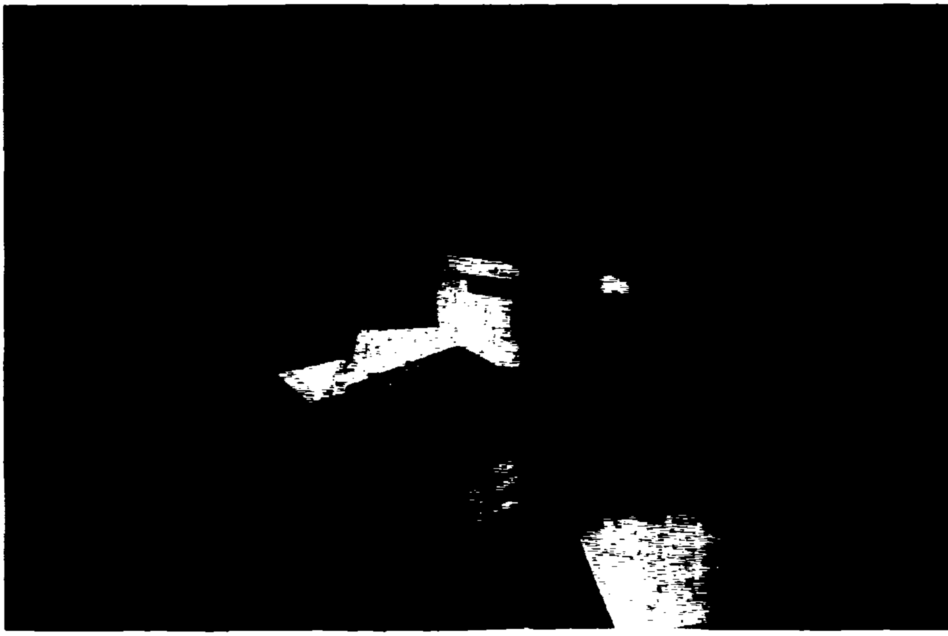
500000 and 1000 million ECU are expected to be invested in it. What is more, the future European telecommunications structure will have a fundamental role to play in the completion of the large Community market by providing the material conditions it needs to function satisfactorily. It is obvious, however, that Europe will not be able to develop an infrastructure of this kind unless it can closely coordinate the efforts made in and by the Member States.

Consequently the Community has defined, and is now implementing, a coordinated development strategy for telecommunications as well, the broad lines of which are described in the Green Paper on the development of the common market for telecommunication services and equipment. Once again an R&TD programme plays an important part in the Community strategy: this is the RACE programme. The strategy is designed to ensure that the different telecommunication systems and services now being developed in Europe remain consistent. The specific aim of RACE is to enable the Community to move towards integrated broadband communications (IBC) based on integrated services digital networks (ISDN). This system would be able to handle a very wide range of new and conventional services, one-way or interactive including telephones, video-phones, cable and pay television, data transmission and electronic mail.

The RACE definition phase was completed in 1987. It had a total budget of 40 million ECU and was divided into two sections. The first consisted of theoretical and assessment work. A number of scenarios for the development of European telecommunication were constructed on the basis of an IBC reference model (network, terminals and services) defined by the network operators meeting within the CEPT (European Conference of Postal and Telecommunications Administrations).

The second section consisting of shared-cost research contained some 30 research projects involving a total of 109 participants in the various technological sectors: very high speed integrated circuits, highly complex integrated circuits, integrated opto-electronics, broadband communications, passive components for optical links, components for high bit-rate long haul links, dedicated communications software, large-area flat-panel display technology, etc.

The definition phase was succeeded by the RACE programme proper. The first phase of RACE covers the period 1987 to 1991 and has a budget of 1100 million ECU, 50% of which is provided by the Community. Following up the results of the definition phase, this first phase was divided into three parts. In the first the IBC reference model will be extended and functional specifications developed for systems, the second continues and amplifies the research on IBC technologies, hardware and software (opto-electronic equipment, audio and video signal processing, digital image recording techniques, etc.) while the third consists of the simulation and testing of IBC techniques to enhance their capability for integration in a standardized IBC system.



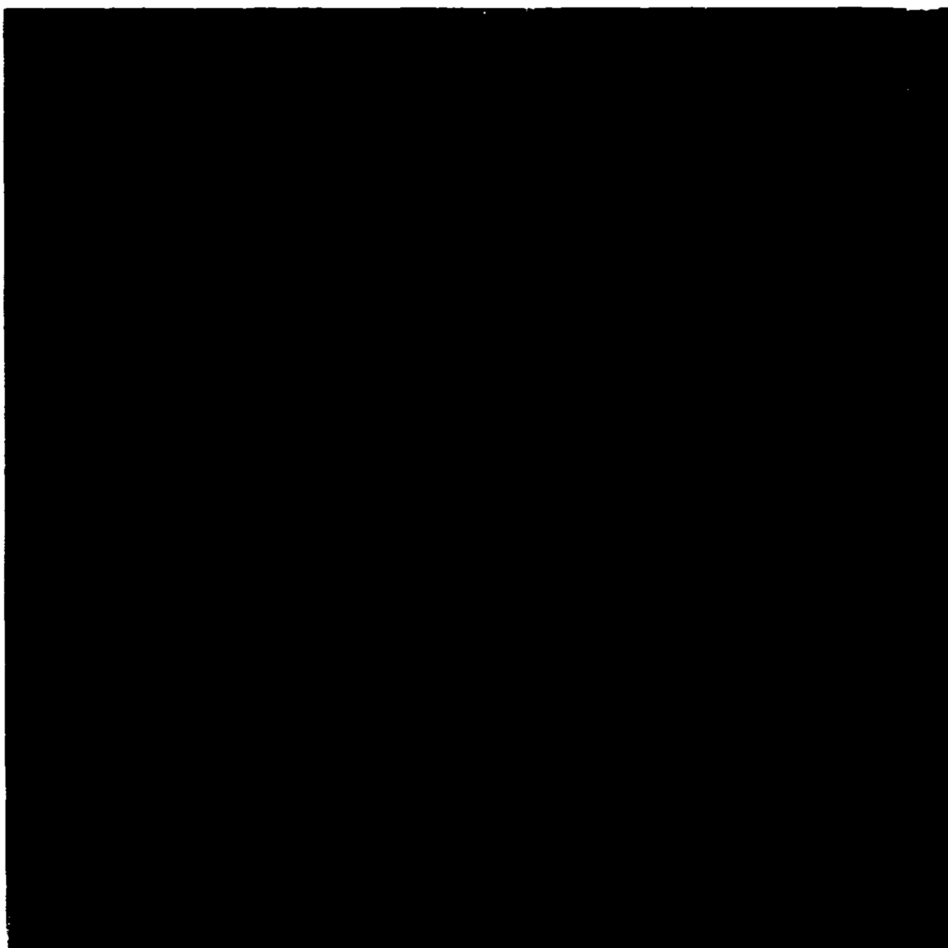
Office automation: word-processing system (Esprit programme).

One of the vital aspects of the development of both telecommunications and information technology in Europe is clearly standardization. This is obviously receiving special attention from the Community as otherwise the Community IT and telecommunications policy would be virtually meaningless.

Launched in 1985, the Community policy on IT and telecommunications standardization is designed to encourage the harmonized application of international standards in the European context. Developed in close cooperation with the industry and in collaboration with the European standards institutions, CEN and Cenelec, the main plank of this policy is the promotion of standards defined by reference to the OSI (Open System Interconnection) model of the International Organization for Standardization (ISO), so as to guarantee effective compatibility between different equipment and systems and their ability to communicate on networks.

In the implementation of the standardization policy a specific role falls to R&TD programmes such as Esprit and RACE, in which a large number of projects are relevant to standardization problems (28 Esprit projects have led to the development of IT and telecommunications standards).

The Community's R&TD activities in the field of information technology and telecommunications are not confined to the two flagship programmes Esprit and RACE. There are also a number of more specific initiatives. In 1987 the Commission prepared three programmes for the integrated application of IT and telecommunications in new services. These are the Delta programme (Development of European learning through technological advance) in the field of computer-aided education (development of a reference model for a learning system, personal computer technologies, satellite transmission systems, etc.); the AIM programme (Advanced informatics in medicine) in the two fields of biocomputing and medical computing (expert systems, data banks, biosensors, imaging techniques, patient monitoring and



Small-scale experimental reactor for studying chemical accidents in industrial establishments (JRC, Ispra establishment).

medical record systems, etc.) and the Drive programme (Dedicated road infrastructure for vehicle safety in Europe) on computer aids for road traffic (route guidance, navigation systems, vehicle-to-vehicle communications, etc.).

Industrial technologies

The action line covering industrial technologies in the framework programme identifies four separate sectors: manufacturing industry, advanced materials, raw materials and technical standards and reference materials.

The first is covered by the Brite programme. Brite is typical of the second-generation Community programmes. Its specific field is the application of new technologies in manufacturing industries: the motor industry, chemicals, textiles, aircraft, shipbuilding, machine tools, civil engineering, etc. These 'traditional' industrial sectors are of considerable economic importance. They account today for the greater part of the GDP generated by industry and provide jobs for more than 24 million people in the Community. In all these sectors a whole series of recent technical advances (lasers, computer-aided design, mathematical modelling, powder metallurgy, etc.) herald radical innovations and far-reaching changes in both products and production processes.

Like Esprit, Brite was prepared by the Commission in close cooperation with industry. Several hundred firms were consulted and asked to specify the fields in which they felt that research was most necessary and industry would be prepared to put up joint financing for projects. Nine key sectors were identified: reliability, wear and deterioration; laser technology; joining techniques; new testing methods; computer-aided design and manufacture (CAD/CAM) and mathematical models; polymers, composites and powder metallurgy; membrane science and technology; catalysis and particle technology; new technologies for products made from flexible materials. Since it was launched in 1985 Brite has aided several hundred projects often involving original associations between university and industrial laboratories: lasers for sheet-metal welding, flexible pilot cells for garment manufacture, etc.

The Community has devoted a complete programme to materials technology, which has widespread applications and is essential to progress in many areas (microelectronics, the motor and aviation industries, biomedical techniques, etc.). This is the Euram programme, designed to help Europe develop and produce for itself a whole range of sophisticated materials that it currently has to import or manufacture under American or Japanese licence. It covers virtually the full range of advanced materials:

metal materials (aluminium, magnesium and titanium alloys, superplastic forming techniques and powder metallurgy); engineering ceramics for gas turbines or high-temperature internal combustion engines; a whole range of composites: organic matrix, metal matrix (magnesium or aluminium alloys), vitreous matrix, etc.

A complementary Community project on materials is the high-temperature materials programme being run by the JRC's Petten establishment. It covers numerous experiments on the mechanical properties and corrosion resistance of steels, alloys and engineering ceramics. It has led to the setting-up of a data base on the properties of high-temperature materials, to help improve the effectiveness of design, development and prediction of the life of those materials.

Some of the Community R&TD activities on raw materials are also relevant to industrial technologies. The first sector is primary raw materials: prospecting techniques (geochemical and geophysical methods, remote sensing), mining technology (automation of mineworking), and new ore treatment processes. The second is the recycling of non-ferrous metals (nickel, chromium, tungsten, aluminium, zinc), new materials (alloys and composites), and urban, agricultural and industrial waste. The third is wood, from the beginning to the end of the chain: genetic improvement of cultivated trees through the application of biotechnology, improved forestry techniques, protection against parasites and pollutants, use of wood as a structural material and as a source of papermaking fibre (new mechanical pulping processes) and products for the chemicals industry (development of compounds from cellulose), etc.

Finally, the Community's industrial research activities also include extensive work on research prior to standardization. The Community Bureau of Reference (BCR) programme, which brings together numerous metrological and analytical laboratories in the Community, provides technical back-up for Community-wide standardization necessary for the achievement of the single market. Its precise aim is to make measurements and analytical results more uniform throughout the Community: physical measurements (e.g. length, mass, volume, electrical current intensity, noise); measurement of the physical properties of materials (e.g. mechanical strength, heat conductivity); and chemical analyses (including those for medical purposes). The BCR activities take place both upstream and downstream of standardization proper. Some projects in the programme concern the preparation and application of technical standards or Community directives on industrial matters (insulating or soundproofing properties of double glazing, for example), on the environment (traces of heavy metals or carcinogenic organic compounds) or on food.

Alongside these activities, the programme on nuclear measurements and reference materials of the JRC's Geel establishment covers a wide range of metrological work relevant to the nuclear fuel cycle, reactor design and safety, and radiation protection. The Central Bureau for Nuclear Measurements at Geel also acts as a Community-wide standards bureau for the nuclear industry.

Biological resources

The framework programme (1987–91) contains a number of closely linked activities on the intelligent exploitation of living resources (from the double viewpoint of scientific exploitation and respect for the constraints on human action imposed by living matter itself and its balances). These activities are divided into three groups.

The first is precompetitive research in biotechnology proper. Biotechnology is not a discipline but a group of techniques at the interface of numerous disciplines (molecular genetics, microbiology, biophysics, bio-informatics, etc.) with a variety of applications (in agriculture, the food industry, pharmaceuticals, medicine, environmental protection, etc.). Although Europe has a substantial research potential in basic and applied biology (which has brought it many Nobel prizes) and a powerful chemical and pharmaceutical industry, it was slow off the mark in biotechnology and, despite recent progress, is still lagging well behind the United States.

In biotechnology, Europe for many years suffered from the tremendous handicap of an extremely fragmented research effort. As a result, duplication was rife, some excellent teams had to work in isolation and because projects were confined to a national framework their scope remained fairly insignificant. To remedy this state of affairs, the Community decided some years ago to extend its research activities to biotechnology.

The Community effort first took the form of a small research and training programme in molecular biology (1982–86). This was the BEP (Biomolecular engineering programme). Despite a model level of funding, the programme nevertheless helped to get genuine cross-frontier cooperation going on a European scale in biotechnology. It covered research sectors relevant to biotechnological applications in agriculture and agro-industry: plant gene identification and transfer, identification of diseased genes in breeding animals, genes in micro-organisms used in the dairy industry, etc. In 1985 a second programme with more generous funding (a budget of 55 million ECU) took over and extended the activities carried out under the BEP programme: this was the biotechnology research and training programme (1985–89) known as BAP (Biotechnology action programme).

This second Community programme covered the same research areas as its predecessor and also tackled new fields, with projects in the following sectors: bio-informatics (data capture, data banks, modelling techniques); collections of biotic materials; enzyme engineering (development of advance bioreactors, protein design); genetic engineering (genetic engineering of micro-organisms of importance to industry, plants and associated micro-organisms, breeding animals); assessment of risks (development of methods for detecting and assessing risks associated with biotechnology and, in particular, risks associated with the release of engineered organisms); *in vitro* test methods (development of methods to evaluate the toxicological properties of molecules). During the second half of the framework programme, the Community's biotechnology activities are to be further expanded and the industrial world will be more closely associated with them.

To complement the biotechnology research described above, the framework programme contains a programme of projects for the application of biotechnology to agro-industry. These are designed to demonstrate the technical feasibility and economic value of the new uses of land and agricultural products made possible by recent developments in biotechnology. European agriculture has now reached a level of productivity that enables it to cover most of the Community's food requirements and even produce surpluses of some products. It must now adapt and turn its attention to the new requirements emerging. The spectacular progress made in recent years in understanding and mastering living systems and matter can revolutionize agriculture: changes in the species cultivated, cultivation methods and the use of agricultural produce. The range of possible applications of biotechnology in agro-industry is extremely wide, but they will not all be developed to the same degree. The function of the projects launched during the framework programme (1987–91) will be to evaluate and establish the viability and economic efficiency of those applications which appear the most promising. This programme of biotechnology application projects in the agro-industrial sector links up with (and complements) the third group of activities under the heading of 'biological resources' in the framework programme (1987–91) — agricultural research. Agricultural research is one of the oldest of the Community's activities. It has long served as an instrument for the common agricultural policy and can be of considerable help in adapting it to the current circumstances of the market.

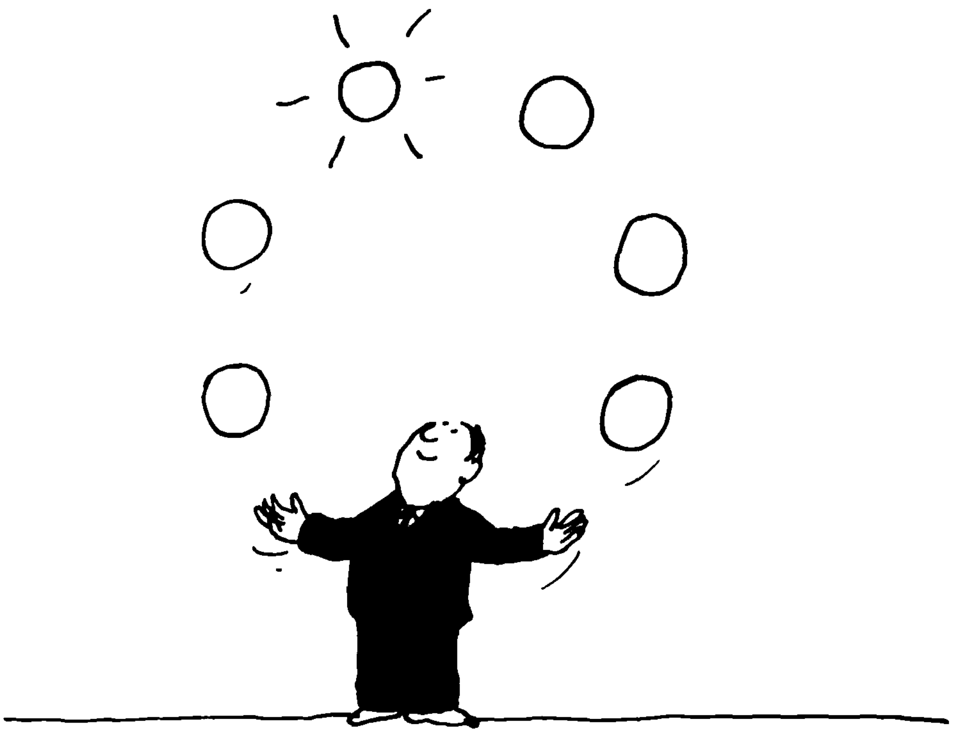
Energy

Three major types of energy are the subject of research at Community level. The first is thermonuclear fusion.

Looking to the next century, controlled thermonuclear fusion is an extremely valuable potential energy source. The fuels used are virtually inexhaustible: the least difficult fusion reaction involves two hydrogen isotopes, deuterium, which can be extracted from sea water, and tritium, which can be obtained from lithium, an element found in abundance in the earth's crust and in the ocean. What is more, the quantity of fuel required to produce 1 million kilowatt-hours of electricity in a nuclear fusion power station is extremely small: 35 grams of lithium and 10 grams of deuterium (240 tonnes of oil or 360 tonnes of coal would be required to obtain the same quantity of electricity in a power station burning fossil fuels).

The use of fusion energy has very little environmental impact since no radioactive waste is generated and it requires tiny quantities of the only element in the fusion reaction that is radioactive. This is tritium, which in normal operation is in any case strictly confined within the reactor. However, to generate fusion energy on earth extremely demanding physical conditions, especially as regards temperature, have to be attained, causing complex technological problems, and the research now being conducted in almost all the developed countries is designed (initially) to demonstrate the scientific feasibility of fusion (the possibility of producing fusion reactions with a positive energy balance).

Thermonuclear fusion research is one of the flagships of Community research. It is carried out under a single Europe-wide integrated programme in which all the



relevant laboratories in the 12 Member States are associated, together with those of Sweden and Switzerland, which are linked to the Community by contracts of association. It is thanks to the fusion programme that Europe leads the world in this field. The ultimate objective of the programme is to construct a prototype fusion reactor; it is following a three-part strategy: demonstration of scientific feasibility, then technological feasibility, and finally economic feasibility. A major part of the programme is being carried out by the JET Joint Undertaking, 80% financed by the Community.

The Joint European Torus, set up at Culham in the United Kingdom, is the largest experimental fusion device in the world. It is a tokamak machine using the principle of the magnetic confinement of high-temperature plasma to a toroidal field. In 1987 JET was fitted with additional heating systems to bring the plasma to a temperature higher than can be obtained by ohmic heating, i.e. merely by passing a current through the magnetically confined plasma. These systems consist of two neutral beam injectors and five high-frequency antennae. The results obtained so far indicate that JET will succeed in attaining the objectives for which it was designed.

Fusion research under the framework programme (1987–91) is not, however, confined to the activities of JET. The fusion programme (1987–90) includes, for example, research on tritium technology being carried out mainly by the JRC. It also includes work on other, smaller tokamaks set up at Cadarache in France, Garching in Germany, Frascati in Italy, and Culham, and on machines of other configurations (the stellarator and reversed-field pinch).

The next few years should above all see a start being made on the detailed design work for NET, the next large European experimental fusion machine to succeed JET. NET is meant to demonstrate the technological feasibility of fusion and is the penultimate stage on the way to a commercial reactor. The overall design of the machine is now being completed. The JRC is involved in the preparations for its construction which include, in addition to the detailed design, the development of various technologies that will be required: superconducting magnets, suitable materials for the reactor, for the first wall and for heat insulation, components of the tritium recovery system, etc.

Until fusion energy becomes commercially viable, nuclear fission will continue to provide much of Europe's energy supply. Research on nuclear fission, based on the Euratom Treaty, was one of the first two major fields of scientific cooperation in the Community. Today, as in the last few years, Community action in this field is focused on vital safety issues. It comes within the framework programme (1987–91) and, as in the past, is being carried out both by the JRC (which has acquired vast experience in this field) and under a shared-cost programme involving national and private laboratories.

The first area covered by the Community action is reactor safety. Here a great deal of the work is done by the JRC. Its reactor safety activities focus essentially on two aspects: prevention of accidents, and the analysis, monitoring and mitigation of their consequences. They concern both pressurized water reactors (PWR), the great majority of the reactors now in use in the Community, and the more advanced fast-breeder reactors (LMFBR). The most recent development at the JRC in this field concern research on the FARO facility used to study various types of incidents on fast reactors, the PISC project for non-destructive methods of inspecting metal reactor structures, the ERDS (European reliability data system) data base, the experimental LOBI installation to study thermohydraulic phenomena in the core of water reactors in the event of accidents, etc. Shared-cost research on reactor safety is being conducted alongside and in conjunction with these activities.

The second aspect of nuclear safety is radioactive waste management and storage. These topics are being studied under an extensive shared-cost research programme on radioactive waste management and storage which includes two *in situ* projects in a salt formation at Asse in Federal Germany and a clay layer at Mol in Belgium. At the same time, work is being continued on the characterization of waste, the migration of radionuclides in the geosphere (Mirage project), the long-term performance of

Vacuum chamber of the JET (Joint European Torus), the experimental thermonuclear fusion machine.

various geological disposal systems (Pagis and Pacoma projects), and management strategies. The JRC is closely associated with these activities and, with the help of the Petrea multiple-use facility, is involved in two projects coordinated on a Community scale involving several laboratories in the Member States.

The third group of problems studied under the framework programme (1987–91) concerns the decommissioning and dismantling of nuclear facilities, in particular power stations that have reached the end of their operating life. Economically and above all ecologically satisfactory solutions to these new problems are now being developed; they still require further research and tests under actual conditions, which are being carried out under a Community shared-cost programme.

These three groups of research are not all that is being done by the Community in the field of nuclear fission energy. Mention should also be made of the activities of the Joint Research Centre on fissile material safeguards and the work on the fuel cycle and actinides at the Karlsruhe establishment.

The Community energy research activities also extend to the numerous forms of non-nuclear energy. Since 1975 the Community has launched three shared-cost programmes on non-nuclear energy that could equally well be called research programmes on energy technologies: the latest, the 1985–88 programme, covers virtually the full range of technologies required for the generation, conversion, transmission and use of energy: solar energy, wind power, geothermal energy, energy from biomass, energy conservation, use of solid fuels, production and use of new energy sources, optimization of hydrocarbon production and use, analysis of energy systems and modelling.

The solar energy projects, for example, cover both photovoltaic conversion, (development of photovoltaic cells based on crystalling or amorphous silicon) and the passive use of solar energy (solar architecture). For geothermal energy the programme concentrates on the 'hot dry rock' technology suitable for use wherever the energy potential of the subsoil can be exploited by the traditional method of using ground water. A wide range of different technologies, often very advanced, are covered in the other sections of the programme: heat pumps and heat exchangers, improved internal combustion engines, new types of highly efficient batteries and fuel cells, fluidized bed combustion and coal desulphurization, coal liquefaction, new ways of exploiting natural gas and new oil prospecting methods, etc.

The Community's non-nuclear energy activities also rely to a considerable extent on the work done by the JRC. The Ispra establishment has a major testing and evaluation facility for solar energy components and systems (photovoltaic cells and panels, heat traps).

Science and technology for development

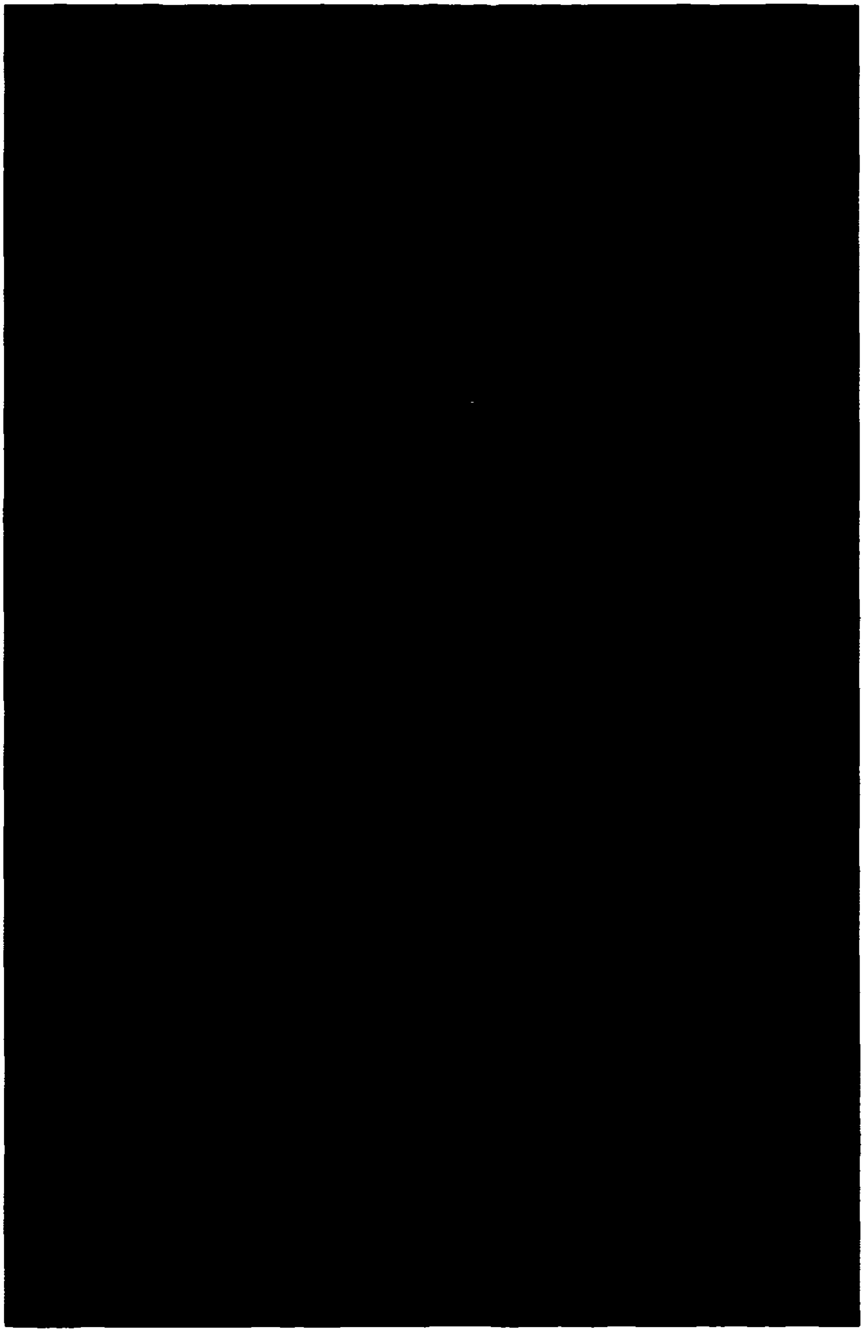
As far as development aid is concerned, the Community's R&TD activities are obviously intended to promote the use of science and technology to solve Third World problems, where they can be of considerable assistance. Here it is not sufficient merely to apply results obtained from research not carried out specifically for that purpose; the environment (physical, human and social) in developing countries is extremely specific, while the subjects of research (fauna, flora, diseases, crops) and the problems encountered (economic, cultural, medical) have a number of peculiar features for which specialized research is required.

The Community programme of science and technology for development has the two-fold purpose of improving the coordination of the work of European laboratories specializing in the sectors concerned and above all of strengthening the research potential in the developing countries themselves by associating their laboratories with projects conducted by European laboratories. It covers the two areas of tropical agriculture and medicine, health and nutrition in the tropics. There are many research topics: improvement of tropical crop and livestock production, integrated pest control techniques, new fishing methods, management of tropical forest ecosystems, evaluation and use of water resources, control of diseases caused by parasites (malaria, sleeping sickness, bilharziasis, etc.), bacteria (leprosy, tuberculosis, etc.) and viruses (haemorrhagic fevers, infectious hepatitis, AIDS, etc.), environmental hygiene and many other areas.

Marine resources

Community research on the exploitation of marine resources covers two separate fields. The first, marine science and technology, is being tackled by the Community for the first time in the framework programme 1987–91. It is also an area in which Community R&TD may prove particularly effective because it will help to optimize the very sporadic research now being done in Europe.

Once it is launched and operational, the research programme on marine science and technology will cover three types of research: research to increase the knowledge of the ocean environment and European coastal area (for example mathematic modelling of the behaviour of the sea), the design and development of suitable instruments and equipment (buoys, data recording and transmission systems, undersea research) and studies on fishing and aquaculture techniques.



Array of lamps forming a solar simulator for testing photovoltaic cells and panels (ESTI Centre at the JRC, Ispra establishment).

This marine science and technology programme will supplement an older programme of fisheries research which from 1987 to 1991 will concentrate on the management of fishing resources, catching techniques at sea and in fresh water and aquaculture.

European scientific and technical cooperation

Under the general heading of 'improvement of European scientific and technical cooperation' the framework programme 1987–91 contains a number of activities having the common purpose of speeding up the creation of a real 'Science and technology Europe'. The first is the stimulation of European scientific and technical cooperation and exchange. This stimulation programme is rather special in that it covers the whole field of the exact and natural sciences. Its precise aim is to promote the removal of various barriers handicapping European scientific integration: national barriers, of course, but also sector and interdisciplinary barriers. Under the stimulation programme the Community awards research grants to research scientists for stays of up to three years in foreign laboratories (the mobility of researchers is a central theme of the programme), organizes laboratory twinning and funds target-oriented research projects, generally in promising fields at the interface between several disciplines. Examples include the EJOB project on the optical computer (which has development components of an optical logical circuit based on the property of optical bistability exhibited by certain materials), the European concerted-action project on permanent magnets conducted in close cooperation with the Euram programme and bringing together 51 European laboratories for research on permanent magnets made from neodymium/iron/boron alloys and capable of replacing electromagnets in numerous applications; the Brain project in the field of neurocomputing, involving the study of computer systems modelled on the human brain and like it capable of reasoning, learning and adapting to experience.

Alongside the stimulation programme (which in the framework programme is continued and expanded under the name of Science plan), the Community has set up a plan for the optimum use of major European scientific installations. The aim is to improve the use and economic efficiency of large scientific facilities (radiation sources, particle accelerators, astronomic observatories, oceanographic ships, etc.) both by providing support for measures to make them even more specialized and therefore more complementary, and by facilitating access to them by research scientists from all Community countries.

To help define the aims and priorities of its own activities and to increase Europe's mastery of its scientific and technological development, the Community some years ago launched the FAST programme of forecasting and assessment. FAST is an instrument for studying the future developments, impact and social uses of sciences and technology. Without trying to predict the future in the popular sense of the term, the research under this programme attempts to analyse possible and probable scientific and technological changes in the long term and their implications for the Community.

FAST is a shared-cost research programme involving numerous research and forecasting centres in the Community. Like the Community's efforts in other fields, one of its major objectives is to promote cooperation between European research centres specializing in technology assessment.

Activities focus on five major themes crucial to the economic and social development of Europe: the relations between technology, work and employment, the transformation of services, the communication function, the future of the food system and the integrated development of renewable natural resources. The Esprit programme and the Community's biotechnology activities owe much to the thinking done under FAST.

At the same time the Community has set up a system of programme evaluation in order to ensure proper use of the funds spent on Community R&TD, to verify the quality of the results obtained and to improve its activities and adapt them to scientific

Software technology: computer-aided instruction system (Esprit programme).

and technological developments. This system is based on in-house evaluation procedures carried out during the programme and reviews by panels of independent experts after the work has been completed. By examining written documentation, holding talks, using questionnaires, etc. these panels systematically evaluate Community programmes: the scientific and technical achievements of the programme, the quality and relevance of the results including their commercial potential where appropriate, the efficiency of resource management and use and the contribution they make to various Community policies and to the economic and social development of the Community as a whole.

In R&TD as in many other fields, language barriers are a major obstacle to European integration and their removal is the subject of a number of Community projects. For example, the Commission has developed and installed in its own departments and makes available to certain outside users the Systran machine translation system and the Eurodicautom terminological data base, which also contains data on new technologies.

The Community has also set up the Eurotra research programme designed to establish an advanced machine translation system in the nine Community languages. The Eurotra programme should shortly lead to a prototype multilingual translation system capable of operating in a limited subject field. It also includes research on future generation machine translation systems usable in a number of different fields and environments and other computer systems for the processing of natural language.

Finally, the Community does all it can to ensure the dissemination, protection and follow-through of the results obtained under its research programmes. Know-how is disseminated in various publications (reports, monographs, newsletters, articles, etc.) suited to different user categories. These publications are all listed in a bibliographic review (*Euroabstracts*) and catalogued in the appropriate data bases.

The Community also endeavours to identify and patent inventions stemming from the work done by its own laboratories or by the laboratories participated in Community programmes when they are not able to do it themselves. It is also working on the setting-up of several communication and information networks and scientific data bases. One of the most advanced networks is Euronet-Diane, which is constantly being extended: it now gives access to some 750 data bases and data banks through more than 80 different host centres.

Community R&TD in its environment

The foregoing review gives a relatively complete picture of the content of the framework programme (1987–91) and the European Community's current activities in the field of research and technology. For a full understanding of the purpose and scope of these activities, it may be useful to put them in context by describing what may be called their environment. The Community's research and technology activities are obviously not defined or implemented in a vacuum. It at least two different ways they dovetail into a number of other activities. First of all, they fit in to the range of other activities conducted by the Community in all the fields for which it is competent. Secondly, they take their place in the panoply of long-standing or more recent scientific and technical cooperation activities that have been developed in Europe or, more widely, at international level.

The place of R&TD in the Community's activities

What place does R&TD occupy in the Community's activities as a whole? What role does it play? What links does it have with these other activities? The best way to obtain a clear picture is once again to look at it in two ways. In close-up, R&TD appears to be the focal point of a system organized as a continuum: the training-research-demonstration-innovation system. Viewed from a greater distance, the Community research and technology policy is seen to have numerous close links with almost all major Community policies such as the industrial, health, environment, cultural, and telecommunications policies.

The training-research-demonstration-innovation system

In today's society, training, research (with all that it implies in the way of demonstrating commercial feasibility) and innovation (with its main instrument, technology transfer) are extremely interdependent. The progress of knowledge and economic development rely heavily on the satisfactory functioning of each of them individually and of the system which they form. There can be no good research without well-trained research scientists, new processes, products or services cannot be developed without high-quality research and conversely research will bring little economic or social benefit if innovation and technology transfer arrangements do not operate satisfactorily; to come full circle, research receives little stimulation in a society lacking economic drive.

The obvious links between these four requirements are of course borne in mind by the European Community. Its initiatives are always consistent and take into account what is being done in all the other fields; they may be seen as forming a system in which R&TD activities are the focal point because of their scope and the position they occupy. The majority of these initiatives take the form of clearly identifiable programmes, often called by acronyms which have the advantage of being more easily remembered.

One of the training programmes, for example, is Erasmus (European action scheme for the mobility of university students). It is designed to encourage student mobility in Europe, which is well below what might be expected at the end of the twentieth century. In proportion to their numbers at that time, students moved around far more in mediaeval Europe than they do today. Erasmus covers the whole academic field

Number of graduate research scientists (1983)

Belgium	11 000
Denmark	6 000
France	92 700
FR of Germany	133 000
Greece	2 400
Ireland	3 200
Italy	63 000
Luxembourg	—
Netherlands	21 500
Portugal	3 000
Spain	14 200
United Kingdom	104 000
EUR 12	454 000
USA	723 000
Japan	435 000

Source: OECD.

(including human and social sciences). For 1987–90 it has a budget of 85 million ECU which should be enough to finance 25 000 different measures such as grants for study visits to another member country or subsidies for seminars attended by students from different Community countries.

Also upstream of Community research and more closely related to it is the Comett programme (Community programme of education and training for technology). Comett is a programme of European university-industry cooperation in technological training. It serves as a framework for the development of associations between universities and companies for training, for exchanges of staff and students between universities and companies, for the implementation of joint university-industry projects on continuous training in new technologies, etc. Comett's budget for 1986–89 is 45 million ECU, enough to finance some 12 000 different projects.

Downstream of research proper there is a stage that in some fields is inevitable in the technological development process: the demonstration of commercial feasibility. There could be no question of exploiting new processes that have not proved their ability to pay their way. This is not always obvious at first sight. In many cases a process that has demonstrated its technical reliability must be given a full-scale trial under actual operating conditions to establish its commercial feasibility: this is the pilot project or demonstration project stage. In order to follow through the research it sponsors, the Community funds projects of this kind in three fields where the margins within which a new technical process may prove profitable are extremely narrow: environment protection (clean technology projects), the iron and steel industry and energy (alternative energy sources, energy conservation, solid fuel liquefaction and gasification, etc.).

The final stage in the technological development process is innovation. This is an extremely wide field: innovating means devising and putting into practice a new idea that might give birth to a product, a process or service of an economic, social or even cultural nature. In the genus 'innovation' of which it is a species, technological innovation is of particular importance. Its main instrument is technology transfer which takes two forms: the vertical transfer of a process or product from the laboratory to the factory and the horizontal transfer from one research centre or company to another.

The Community's innovation activities come under four programmes. The first is general and covers the whole field of innovation and technology transfer: this is the Sprint programme. It contains a wide variety of activities including the development of the technology watch system known as EuroTech Alert and the setting-up of the Icone data base, an index of national, European and international technical standards. The other three programmes address specific areas. Their aim is to encourage technology transfer in the field of clean technologies (the NETT programme), telecommunications (STAR) and energy technologies (Valoren).

The last two are specifically intended for less-developed regions of Europe, the first to modernize telecommunications infrastructures and the second to promote the exploitation of indigenous energy potential in peripheral regions of the Community.

The Community is also endeavouring to promote the general development of new electronic data interchange services on a European scale. It has three specialized programmes. The Insis and Caddia programmes concern data transfer in the public sector between the Member States and the Community institutions. The Insem and Ovide (Organization of Videotext for European Members of Parliament) systems and a European videocommunications network have been developed under Insis while Caddia deals with agricultural, customs and statistical data. The purpose of the Tedis programme is to promote trade data interchange systems.

More generally, the Community is also fostering the establishment of a European internal market for information services, and attempting to strengthen the supply capacity and promote the use of advanced information services (data bases and banks, electronic publishing, etc.). For example, a European information market observatory is to be set up and pilot projects will be launched for new generations of information services that are simpler to use and take account of the many different languages used in Europe.

R&TD and the major Community policies

Away from the immediate environment of the Community's R&TD activities, a more general look shows that they have numerous links with many of the major policies that have gradually been defined and implemented by the European Community.

This is particularly obvious in the case of industrial policy, as is clear from a review of the main action lines of the framework programme (1987–91): almost two-thirds of the activities have a direct industrial purpose. The framework programme concentrates much of its resources on diffusing technologies (information technologies, materials, biotechnology, etc.) that are rapidly spreading through the whole fabric of manufacturing industry. By aiding Community industries to acquire the capacity to design and manufacture a whole range of products and equipment that are generally imported today, the Community R&TD programmes will help them to become competitive or to regain their lost competitiveness both on external markets and on the European market. As mentioned earlier, by deliberately concentrating on the pre-standardization stage Community R&TD is also helping to establish the conditions needed by European industry to benefit from the economies of scale offered by a single market of 320 million inhabitants.

The link between Community research and the Community's health policy is equally clear. Consistent action in the field of public health is always taken on several fronts simultaneously but necessarily involves a major research effort as one of its essential components. This is the case in the two major public health areas in which the European countries recently decided on determined action at Community level: cancer and AIDS. The Community's campaign against these two diseases takes many forms, involving exchanges of information, information and education campaigns for the public, legal work, etc. An important role is of course played by research at the three levels of epidemiology, prevention and treatment. This is equally true of all the other public health areas in which the Commission is active, for example health and safety at work in the coal and steel industries (ECSC) or radiation protection (Euratom).

The same applies to the Community energy policy. The two oil shocks of 1972 and 1979 shone a harsh spotlight on the dangers of Europe's growing reliance on outside sources for energy. Since then the Community has worked to build up a coordinated energy policy, the main plank obviously being to reduce its reliance on oil imports. The aim is to achieve optimum exploitation of all the energy sources available in Europe in the short, medium and long term. This means that the Community must maintain a diversified technological capacity that can come only from research and development.

The link between R&TD and the Community telecommunications policy is just as obvious. Anxious to ensure that the many new telecommunications services now emerging are developed at European level, the Community has been making a great effort since 1984: it is promoting the establishment of an advanced European telecommunications infrastructure, together with the building of a single European market for terminals and equipment and the introduction of advanced services and networks in the least prosperous peripheral regions of the Community. The spearhead of this strategy based on coordination, harmonization and standardization is of course the RACE programme.

A review of many other Community policies would show the same thing: the agricultural policy (which research, especially in the application of biotechnology to agro-industry, can help to adapt to today's market conditions), the development aid policy, the policy towards small firms, the environment policy, etc. In each case there could be no doubt about the often decisive and always important place occupied by R&TD in these policies, demonstrating the numerous relations between Community research and technology policy and the other Community policies. This is hardly surprising: these relations merely reflect those which in our society link research and technological development inextricably to almost all sectors of human activity.

Community R&TD in the context of scientific and technical cooperation

However significant they may be for the Community countries, the framework programme (1987–91) and Community R&TD account for only a modest share of the total European research effort: some 2% of all R&TD activities in Europe, which even today remain essentially national.

Because they generate a European added value in their own fields, the Community programmes, despite their limited funding, make a vital contribution to the construction of Research Europe. Nevertheless, if this is to become a reality the national efforts must be better coordinated. Alongside its direct R&TD action the Community is therefore endeavouring to promote better coordination of Member States' programmes and policies.

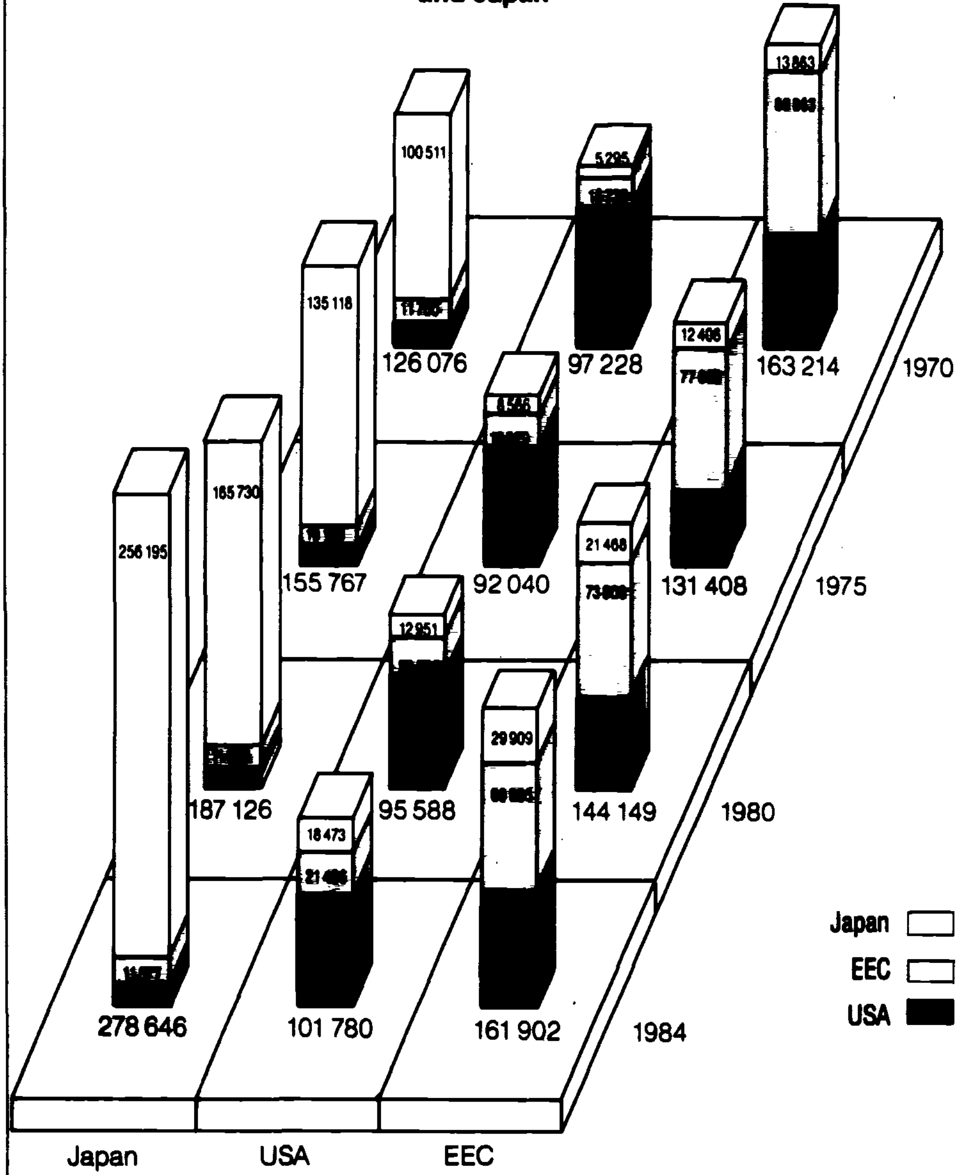
Community R&TD is in any case only one of the forms taken by scientific and technical cooperation in Europe. To complete the picture drawn here, two further aspects of Community R&TD must be highlighted: the role it plays within the array of European scientific and technical cooperation and the way it ties in with the wider international scientific and technical cooperation activities in which the Community is involved.

The Europeans' determination to cooperate in science and technology has resulted over the years in the creation of a number of different structures that must not be confused. These specialize to a greater or lesser extent and bring together a varying number of European countries. One of them is the European Space Agency (ESA) set up in 1975 to take over from the European Space Research Organizations (ESRO) and European Space Vehicle Launcher Development Organization (ELDO). The only ESA activity in which participation is compulsory is the scientific programme (development of scientific satellites — such as Giotto launched to meet up with Halley's comet in 1986 — or the future space telescope).

The other programmes are optional and are often piloted by one State: France for the Ariane launcher and the future space vehicle Hermes: Germany for the space lab put into orbit by the NASA shuttle or the Columbus element of the US future orbital station.

Another well-known institution is the CERN, the European high-energy physics laboratory. CERN has given Europe world status in the field of particle physics. Here in 1983 the existence of the intermediate vector bosons W and Z was demonstrated (a discovery which brought the Nobel prize to Carlo Rubblia and Simon Van Der Meer). Others include the European Molecular Biology Laboratory (EMBL), the European Organization for Astronomical Research in the Southern Hemisphere (ESO), the Institute Laue-Langevin (ILL) and the European Science Foundation (ESF).

Number of patent applications filed in the Community, the United States and Japan



NB: The patents filed in the Community do not include those filed at national level in the following cases: the 6 000 patents filed by the Member States in Italy and Luxembourg in 1984, the 6 000 patents filed by the United States in Italy in 1975, the 2 500 patent applications filed by the United States in Italy and Luxembourg in 1984.

Examples of industrial cooperation include of course the Airbus consortium, Airbus-Industrie, which has so far produced the A-300 and A-310 (medium-range large-capacity aircraft) and the A-320 (medium-range medium-capacity). It is now developing the A-330 (a large-capacity aircraft to succeed the A-300) and the A-340 (large-capacity four-engined aircraft). Another large industrial consortium (amongst many smaller ones) is Euro-Tunnel.

In 1985 a new start made its appearance in the firmament of European technological cooperation: the French-inspired multilateral venture Eureka bringing together 19 European countries and the Commission of the European Communities. Eureka provides a framework for international cooperative projects in technological research. It concentrates essentially on the downstream end of research where goods and services are developed in response to market demand. Eureka's central body (the Ministerial Conference) does not give direct financial aid but endorses the award of a Eureka label on the basis of which industrialists can obtain financial backing for their projects from their national public authorities.

How do all these cooperative institutions and structures tie in with each other? How do Community R&TD and the framework programme (1987–91) tie in with the rest? A close look shows that a fully satisfactory division of work has been established between the various bodies. CERN, EMBL, ESO, ILL and ESF are the arenas for European cooperation in what is essentially pure basic research. Airbus-Industrie and Eureka operate in the area of commercial or quasi-commercial technological development. Community R&TD covers an area which may broadly be described as target-oriented basic research and precompetitive technological development. What does that mean? Target-oriented research, unlike pure basic research, focuses on possible applications; precompetitive research is an earlier stage in the technological process than commercial development. Finally, the ESA covers an area ranging from pure basic research to commercial development but in a single highly specialized field: space. The relations between the various bodies involved in European scientific cooperation are therefore complementary. This complementarity sometimes involves formal ties: for example, the Community maintains permanent relations with the ESA and is explicitly associated in the Eureka venture. Here there is a high degree of complementarity that obviously benefits from being organized: in the technological development process the Community programmes immediately precede Eureka — indeed several Eureka projects are a direct extension of projects carried out under Community programmes. The Community is involved in Eureka in several ways and at several levels. For example, it is associated in the management of Eureka through an official seconded by the Commission to the Eureka secretariat and it also participates in its own right in some Eureka projects with a particular Community appeal.

It would be wrong to believe that the Community's research and technology activities are strictly confined to the 12 Member States. For example, the COST arrangements also take in the Community's European neighbours. COST is a broad forum for

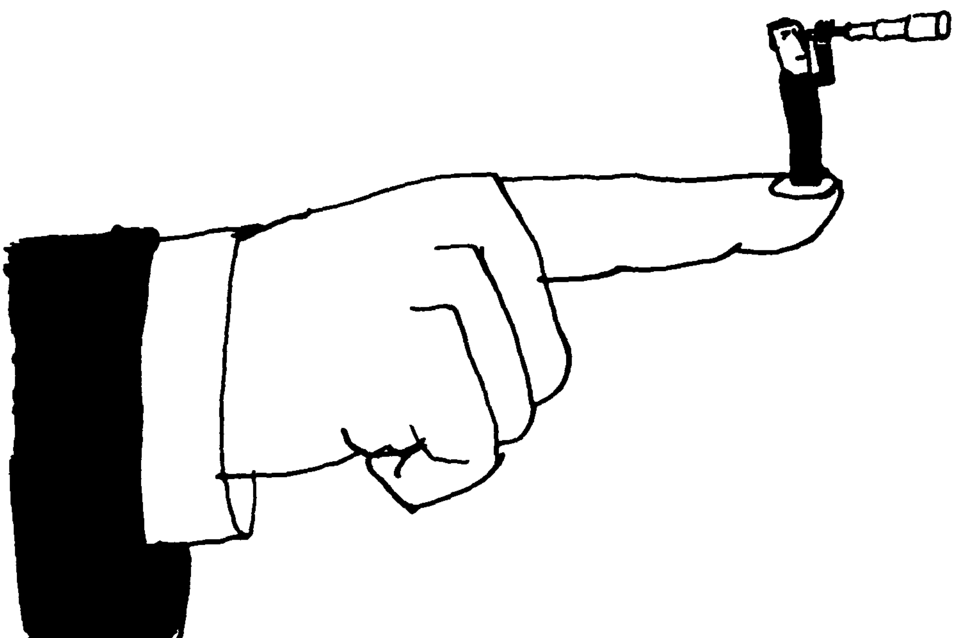
European scientific and technical cooperation that has been operative since 1971. The Community plays an important role: the COST secretariat is attached to the Council of Ministers of the European Communities while a group of Commission officials handles the technical management of COST projects.

The COST structure (bringing together the 12 Community Member States, Norway, Sweden, Finland, Switzerland, Austria, Yugosloavia and Turkey) provides a framework for specific projects in which all these countries are free to participate. Normally a minimum of three countries is required to launch a project but others may join them within the first six months. Each State pays the cost of research carried out on its own territory. In principle the coordinating costs are paid by the Community. In a small number of projects a specific joint fund is set up by the participating States to cover part of the expenditure. Since the inception of COST, more than 60 cooperative projects have been launched in computing, telecommunications, transport, oceanography, materials, environment, meteorology, agriculture, biotechnology, food technology, medical research and social sciences (but COST cooperation can extend to other disciplines).

An excellent illustration of COST cooperation is the setting-up of the European Centre for Medium-Range Weather Forecasting at Reading in the United Kingdom. This centre was founded by COST in 1973 and now operates independently. It supplies weather forecasts for periods of four to twenty days and provides back-up for the national meteorological services of the States associated in it. The best examples of COST cooperation, however, are to be found in telecommunications (e.g. optical fibres, high-definition television), transport (computerized traffic aids, simulation of ship movements) and materials; one long-term operation brings together a large number of European industrial and university laboratories working in the very specialized advanced field of ceramic coatings for jet engine turbine blades in the aircraft industry.

Alongside its COST activities the Community is also linked with the European countries in EFTA (European Free Trade Association): Norway, Finland, Austria, Sweden and Switzerland, by general framework agreements for scientific and technical cooperation, under which cooperation agreements in specific fields may be signed. Some Community programmes are already open to the EFTA countries.

The Community also has links with many countries outside Europe through bilateral framework agreements incorporating a scientific and technical section or through specific bilateral agreements on scientific and technical cooperation: these include major industrial powers such as the United States, Japan and Canada (for example, agreements on controlled thermonuclear fusion research), and new industrialized Third-World countries (Mexico, Brazil, India). It maintains permanent relations and frequently collaborates with other international organizations active in research such as the specialized UN agencies (WHO, FAO, Unesco), and OECD, the International Energy Agency (IEA) and the International Atomic Energy Agency (IAEA), etc.



Towards the European Research and Technology Community

What conclusions can be drawn from this review of Community R&TD? What can be learned from this detailed survey?

In a field such as science and technology it is no easy matter to weigh up strengths and weaknesses. As there are no clear quantitative criteria the assessment must generally be of a qualitative nature.

It is nevertheless possible and even relatively easy to make an overall evaluation of the results of the Community's scientific and technical cooperation effort.

In all the fields which have been or are being covered by the Community's research and technology activities there have unquestionably been two types of beneficial effects: valuable results in the form of advances in scientific knowledge or technological breakthroughs, and the development of a genuine tradition of collaborative research involving close, frequent and prolonged cooperation between research centres, universities and companies in all the Member States.

The successes already achieved show how far Community research has come in just a few years and give the stimulus needed to continue and complete the task of building a science and technology Europe.

This Europe, languishing in the doldrums only a few years back, is now forging ahead. The European Research and Technology Community will without any doubt fulfil the hopes placed in it and become a vital component of the single European market which the Commission is striving to achieve by 1992.

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Further reading

EEC publications

Council Decision of 28 September 1987 concerning the framework programme for Community activities in the field of research and technological development (1987–91). OJ L 302 1987.

Council Decision of 19 March 1987 amending Decision 83/641/EEC adopting joint research programmes and programmes for coordinating agricultural research. OJ L 85 1987.

Council Decision of 19 October 1987 adopting Community research and coordination programmes in the fisheries sector for the period 1988 to 1992. OJ L 314 1987.

Council Decision of 17 November 1987 adopting a research and development coordination programme of the European Economic Community in the field of medical and health research (1987–91). OJ L 334 1987.

Council Decision of 14 December 1987 relating to a research and development programme in the field of science and technology for development (1987–91). OJ L 355 1987.

Esprit-Première phase. Etat d'avancement et résultats. Communication de la Commission au Conseil. COM(86) 687.

Proposal for a Council Regulation adopting a research and training programme (1987–91) in the field of controlled thermonuclear fusion. Proposal for a Council Decision approving amendments to the Statutes of the Joint European Torus (JET) Joint Undertaking. Statement 'Environmental impact and economic prospects of fusion'. COM(87) 302.

Proposal for a Council Regulation concerning the European strategic programme for research and development in information technologies (Esprit). COM(87) 313 final.

Community support plan to facilitate access to large-scale scientific facilities of European interest 1988–92. COM(87) 319.

Proposal for a Council Regulation (EEC) on a Community programme in the field of information technology and telecommunications applied to road transport — Drive (Dedicated road infrastructure for vehicle safety in Europe). COM(87) 351 final.

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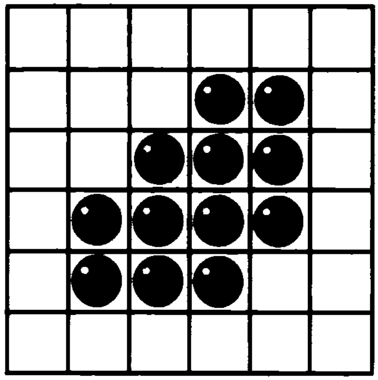

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